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Research Article

ERCoRe Learning Model to Improve Creative-Thinking Skills of Preservice Biology Teachers

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Abstract

It is a challenge for higher education in the 21st century to prepare the students with various skills to master, including creative-thinking skills. The present study aims to test the effect of Eliciting, Restructuring, Confirming, Reflecting (ERCoRe) learning model in improving the creative-thinking skills of preservice biology teachers. This quasi-experimental research employed a pretest-posttest control-group design. The samples came from a university in West Sulawesi Province, which was located in Indonesia. They were enrolled in the even semester of the 2018/2019 academic year with the Animal Structure course. The subjects of this research were 84 preservice teachers in 4 classes, which were divided into two experimental classes and two control classes. The number of preservice teachers in the experimental class was 44 and in the control class 40. The experimental class was taught with the ERCoRe learning model and the control class with the lecture and question and answer methods. The instrument of the research consisted of an essay test of creative-thinking skills totaling 13 items. The research data were analyzed using one-way ANCOVA. It was found that the creative-thinking skills of the preservice teachers generated by the ERCoRe learning model were higher than those generated by the conventional model. The use of the ERCoRe learning model influences and can improve the creative-thinking skills of preservice biology teachers at the university in West Sulawesi. The authors recommend that the ERCoRe learning model be used for other subjects as considered to have the potential in developing 21st century skills, especially creative thinking.

Keywords:

creative-thinking skill, preservice biology teacher, ERCoRe learning model

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Introduction

Preservice teachers of the 21st century are expected to have numerous skills and competencies to be ready to face the increasingly complex challenges of times. These skills refer to the pillars of education, i.e., learning to know, learning to do, and learning to live together (Valli & Buese, 2007; Zubaidah, 2018). Teachers are the key to changing and improving the quality of Education (Prachagool, Nuangchalerm, Ganakumaran, & Dostal, 2016). They have a big duty to recognize, identify, and know the characteristics of their students so that positive interactions are created in providing advanced education to young people (Kaendler, Wiedmann, Rummel, & Spada, 2015; Yazici, Akman, Uzun, & Kardes, 2017; Macaulay, Betts, Stiller, & Kellezi, 2018). Preservice teachers must have a good understanding of helping students develop thinking skills (Amponsah, Kwei, & Ernest, 2019) by paying attention to individual needs and abilities (Agbowuro, Saidu, & Jimwan, 2017). One of the skills to master is creative-thinking skills (Ananiadou & Claro, 2009).

Creative-thinking skills are a well-known concept of thinking today in the education system (Neergaard, Robinson, Tanggaard, & Krueger, 2012) and are one of the main goals of higher education. These skills help individuals find efficient, new, and innovative ideas in modern society (Kenett, Levy, Kenett, Stanley, Faust, & Havlin, 2018). These skills are considered as a series of mental abilities involving cognitive processes, personality characteristics, and the environmental variable, as well as the interaction of other components (Kaufman, Plucker, & Baer, 2008; Sternberg, 2006). Creative-thinking skills can produce useful ideas in solving problems (Al-Oweidi, 2013; Eratay, 2017) and are a process that leads to the creation of a generation that can produce new or original products, which are certainly useful or effective (Runco & Jaeger, 2012). Creative thinking is a whole series of individual activities that involve cognitive processes with specific problems and solutions based on individual capacity (Birgili, 2015). This category is categorized by fluency, flexibility, originality, elaboration, and metaphorical thinking (Treffinger, Young, Selby, & Shepardson, 2002).

The development of creative-thinking skills of preservice teachers in tertiary institutions in Indonesia is aimed at preparing them to face the challenges of the world of work in the future (Kind & Kind, 2007) and to be competitive in their fields of work (Hidayati, Zubaidah, Suarsini, & Praherdhiono, 2019). The Universitas Sulawesi Barat as one of the state universities in the West Sulawesi Province in Indonesia, which has an important role in producing prospective teachers. The university has the responsibility to produce graduates who are reliable and productive in reaching future dreams and, of course, are ready to compete in the world of work and prepare them with 21st century proficiencies, one of which is skill or competence.

Several factors that influence creative-thinking skills include the learning environment. This is in line with the opinion of Trilling & Fadel (2009) that creative thinking can be learned in a supportive learning environment for questions, openness to new ideas, high confidence, and learning from mistakes and failures. A supportive environment and innate talent are the potential to enrich life experiences and trigger the emergence of creative thinking from each potential to be developed (Mahmud, Islam, and Rowshon, 2013; Ozyaprak, 2016; Eratay, 2017). Another factor is the role of the learning model. The right learning model will maximize the learning objectives to be achieved. This is in line with the statement of Muhlisin (2012) that the learning model influences the learning objectives. The syntax of the ERCoRe learning model can be easily memorized by the lecturers and students. The ERCoRe model includes four stages, wherein stages 2 and 4, preservice teachers are directed to create a mind map, which leads to an increase in their creative-thinking skills.

The results of the previous research indicate that Indonesian students' creative-thinking skills are still low, as done by Fatmawati (2011), who found that students' creative thinking skills were still low .i.e. from 34 students, the average score of creative-thinking skills was only 1.4 in the low category. Luthvitasari, Made, and Linuwih (2012) revealed that the creative-thinking test result of each indicator was still low by 35.42 for fluency indicators, 31.25 for flexibility indicators, and 33 for elaboration indicators. This finding indicates that students' creative-thinking skills are still low about the range of scores of 0-100.

The low creative-thinking skills in Indonesia demonstrate that the creative-thinking skills are not optimally developed (Musadad, 2011; Darmawan, 2014) because the ability to prepare learning designs is still not optimal. Also, low creative-thinking skills are due to the inaccuracy of the learning model applied. The selection of learning models is very important in producing an active learning process with a good level of effectiveness (Agustini & Suyatna, 2018; Saregar *et al.*, 2018). One learning model considered potential in improving creative-thinking skills is the ERCoRe learning model.

ERCoRe Learning Model is a learning model based on the constructivist approach, which prioritizes the active participation of preservice teachers in the learning process and the way to develop the knowledge and abilities of these teacher candidates. Constructivist learning can build knowledge of preservice teachers and find solutions to existing problems. ERCoRe is one of the learning models that have the potential to improve students' creative-thinking skills, provide opportunities for students to construct their knowledge and empower higher-order thinking skills (Ismirawati, Corebima, Zubaidah, & Syamsuri, 2018).

The ERCoRe learning model was developed based on strategies to empower higher-order thinking skills. ERCoRe stands for the syntaxes of Eliciting, Restructuring, Confirming, and Reflecting (Ismirawati, Corebima, Zubaidah, &

Syamsuri, 2015). Each syntax can help preservice teachers in improving their creative-thinking skills. In the *Eliciting* syntax, preservice teachers are allowed to read at home to gain initial knowledge. In the *Restructuring* stage, preservice teachers summarize the results of their reading in the form of mind maps in pairs. At the *Confirming* stage, they explain their reading results in the form of mind maps in class discussions. In the *Reflecting* stage, the preservice teachers remake mind maps individually. The ERCoRe learning model has advantages in improving the creative-thinking skills of preservice teachers because of the use of mind maps in stages 2 and 4 of the syntax of the ERCoRe learning model.

The ERCoRe learning model has several advantages, one of which is it can foster high learning motivation (Ismirawati *et al.*, 2018). The previous researcher (Ismirawati, 2018) applied the ERCoRe learning model only to the metacognition, learning outcomes and retention variables, and had never applied it to the creative-thinking skill variable. Therefore, this research is to investigate the effect of the ERCoRe learning model in improving the creative-thinking skills of preservice biology teachers.

Problem of Research

Nowadays, teachers are confronted with the increased challenges of education reform. These challenges continue to emerge despite various studies carried out in recent years. The challenge that is considered the most worrying is the lack of optimal thinking skills of preservice teachers in the learning process. This is certainly a problem as it affects their skills in the future. The results of the research conducted by Sulistiyono, Mahanal, & Saptasari (2017) show that 93.7% of learning in schools still uses lecture methods combined with practicum activities resulting in suboptimal improvement in students' creative-thinking skills.

Based on the observations, the learning process, especially at the Universitas Sulawesi Barat, has been carried out with a variety of methods. However, they are still less than optimal in empowering creative-thinking skills. This may occur because the learning model used is still not appropriate in empowering creative-thinking skills. Therefore, the ERCoRe learning model is considered as one of the learning models that can enhance the creative-thinking skills of preservice biology teachers. Thus, this research is conducted to improve creative-thinking skills by using the ERCoRe learning model.

Method

Research Model

This research is a quasi-experiment with the pretest-posttest control-group design. It involved two research groups, namely the experimental and the control groups. The experimental group was taught using the ERCoRe learning model while the control group was taught using the lecture and question and answer methods. This research was conducted in 16 meetings, consisting of 1 initial meeting for

introduction and delivery of the semester learning plan, one meeting for midtest, one meeting for posttest, and 13 meetings for face to face in the classroom. The pretest was given before learning, while the posttest was given after the completion of the learning process at the end of the semester. The ERCoRe learning model was applied by referring to the syntaxes of the ERCoRe model, as shown in Table 1.

Table 1.
Syntaxes of ERCoRe Learning Model

Phase	Activities	Lecturer Activities	Students Activities
Eliciting	The lecturer helps the students to express the main idea clearly by reading the material to be taught.	• Before the learning process takes place, the lecturer has divided the groups of four heterogeneously; then, the students sit accordingly.	• The students follow the lecturer's instructions.
		• The lecturer provides information in the form of readings to the students and asks them to take note of important concepts they get.	• They independently take note of the important concepts they get from reading activities and communicate them to group members.
Restructuring	Constructing student knowledge	• The lecturer asks the students to create mind maps in pairs and discuss them in their groups.	• The students create mind maps in pairs and communicate them with their group friends.
		• The lecturer asks to collect the results of their mind maps and assess them.	• They collect the results of their mind maps.
Confirming	Confirming student knowledge	• The lecturer directs students to explain mind maps in front of the class. The lecturer provides reinforcement and makes an assessment.	• The students describe the results of their group discussions in front of the class, while the other groups respond to them.
Reflecting	Reflection on learning activities	• The lecturer reflects on the learning process by asking students to remake mind maps independently	• They independently write their knowledge changes in mind maps

Adapted from Ismirawati et al., (2015)

Participants

This research involved 84 students of the Biology Education Department of the Faculty of Teacher Training and Education, Universitas Sulawesi Barat Indonesia, who were enrolled in the even semester of the 2018/2019 academic year with the Animal Structure course. The students were divided into two experimental classes

and two control classes. The number of preservice teachers in the experimental class was 44 and in the control class 40.

Instruments

The instrument used in this research was a creative-thinking skills test instrument in the form of an essay test of 13 items that were reliable and validated. The test was previously tested on students who have taken animal structure courses in the same university. The test reliability was determined using the Cronbach's Alpha test, obtaining a reliability value of 0.778, while the validation results showed all items were valid with values of 0.735 to 0.923.

The following is one example of creative thinking.

> *Crafts using animal skins, e.g., snakes and crocodiles, have high economic value. Good prices and high market demands are the cause of illegal hunting that leads to ecosystem damage. As a student, what solution can you give to address this problem? What is the right technology to use to support your solution?*

The students' answers are scored using the rubric developed by Treffinger (2002), shown in Table 2.

Table 2.

Assessment Rubric of Creative Thinking

Indicator	Criteria	Score
Fluency	Mentioning/writing down five or more different ideas, suggestions or alternative answers	4
	Mentioning/writing down three different ideas, suggestions or alternative answers	3
	Mentioning/writing down some ideas, suggestions or alternative answers that are not too different	2
	Mentioning/writing down one idea, suggestion or alternative answer	1
	No answer or incorrect answer	0
Originality	Mentioning/writing some unique ideas that are interesting and logical, relatively new and relevant to the given problem	4
	Mentioning/writing down some unique ideas that are logically interesting, relatively new but less relevant to the given problem	3
	Mentioning/writing ideas that are quite unique, interesting, logical and relevant to the given problem	2
	Mentioning/writing down ideas that are common, logical and relevant to the given problem	1
	No answer or incorrect answer	0
Elaboration	Explaining some logical details of an existing idea so that the idea formulation is easier to apply and clear	4
	Explaining one logical detail of an existing idea so that the idea formulation is easier to apply and clear	3
	Giving some logical details of an idea that already exists but is not following the concept of the idea so that it cannot be used to clarify the idea	2
	Not adding details to existing ideas so that the idea formulation is less applicable	1
	No answer or incorrect answer	0
Flexibility	Writing down some alternative answers that are very logical	4

	and relevant to the given problem from various perspectives	
	Writing down some alternative answers that are quite logical and relevant to the given problem from various perspectives	3
	Writing down some alternative answers that are quite logical but not relevant to the given problem from various perspectives	2
	Writing down one alternative answer that is quite logical and relevant to the given problem from only one perspective	1
	No answer or incorrect answer	0
Metaphorical thinking	Combining some ideas, modifying, and explaining the idea formulation with a logical and coherent analogy	4
	Combining some ideas, modifying, but less able to explain the idea formulation with a logical and coherent analogy	3
	Combining some ideas, modifying, but not explaining the idea formulation with a logical and coherent analogy	2
	Less able to combine relevant ideas into a coherent unit	1
	No answer or incorrect answer	0

Adapted from Treffinger (2002) in Zubaidah, Fuad, Mahanal, Suarsini (2017)

Data Analysis

The data of the research were analyzed using ANCOVA. The LSD (Least Significance Different) test was used for advanced analysis. LSD test was performed if the ANCOVA results showed an influence. Before conducting the ANCOVA analysis, the data were tested for normality (Kolmogorov-Smirnov test) and homogeneity (Levene's test) ($p > 0.05$). The results of the tests show that the data are distributed normally (*p-value* 0.239) and homogeneous (*p-value* > α (α = 0.05)) with *p-value of* 0.515.

Results

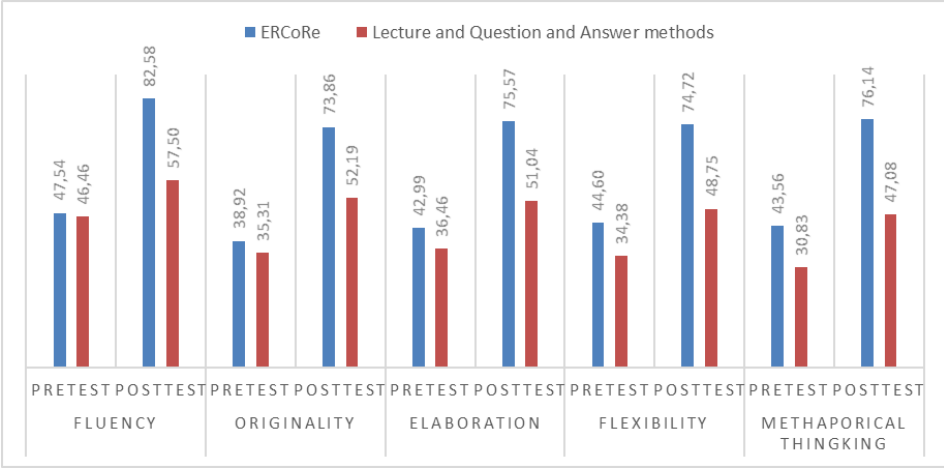

Figure 1.

Scores of Pretest and Posttest of Creative-Thinking Skills Based on Indicators of Creative-Thinking Skills

Among the indicators of creative-thinking skills, fluency reported the best outcomes. The highest score on fluency in the ERCoRe model learning is 82.58 while in the control (lecture and question and answer methods) class is 57.50. On the other hand, the lowest performance of preservice teachers is found in the originality indicator. The average originality score of the experimental class is 73.86 while of the control class is 52.19. Students' scores based on the indicators of creative-thinking skills are summarized in Figure 1.

The effect of the ERCoRe learning model and lectures using the discussion and question and answer methods on the creative-thinking skills of preservice teachers is determined based on the ANCOVA analysis of students' pretest and posttest scores. The results can be seen in Table 3.

Table 3.
Results of Ancova Test on the Effect of Learning Model on Creative-Thinking Skills

Source	Type III sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Square
Corrected Model	23157.732[a]	2	11578.866	214.205	.000	.841
Intercept	21311.977	1	21311.977	394.265	.000	.830
XCreative	9553.790	1	9553.790	176.742	.000	.686
Model	9214.410	1	9214.410	170.464	.000	.678
Error	4378.456	81	54.055			
Total	380137.622	84				
Corrected Total	27536.188	83				

Table 3 on the results of the Ancova analysis shows that the ERCoRe learning model obtains F = 170.464 with a sig value of 0.000. The significance value is < 0.05, which means there are differences in creative-thinking skills between preservice teachers taught with the ERCoRe learning model and those taught with the lecture and question and answer methods. The post hoc test was then performed using the Least Significant Difference (LSD) data analysis technique. The results of the analysis are shown in Table 4.

Table 4.
LSD Test on the Effect of ERCoRe Learning Model on Preservice Teachers' Creative-Thinking Skills

No.	Model	XCreative	YCreative	Deviation	CreativeCorr	LSD Notation
1	Lecture and question & answer methods	36.69	51.31	14.63	53.602	a
2	ERCoRe	43.52	76.57	33.05	74.960	b

The LSD test results in Table 4 show that the corrected average score of the creative-thinking skills is high, as seen in the ERCoRe learning model of 74.960, while the conventional learning model has a low corrected average score of 53.602. Based on the different notations, it can be explained that the average percentage of creative-thinking skills of preservice teachers in the ERCoRe learning model group

is different and 39.84% higher than the lecture and questions and answer methods. The corrected mean of ERCoRe is higher than that of the lecture and questions and answer methods.

Discussion Conclusion

This research found that the fluency indicator score is much higher than that of other creative-thinking skill indicators. This can be explained by the fact that preservice teachers can produce ideas relevant to the problem. One example is when they are asked about digestion, muscle, and menstruation, they can answer the questions given well. This is in line with the research conducted by Tan, Lee, Ponnusamy, and Koh (2016), who found that fluency as an indicator of creative-thinking skills is easier to master compared to other indicators.

The fluency indicator shows the highest average score among all indicators on creative-thinking skills, but preservice teachers are still weak in the originality indicator. Originality is one important component in creative-thinking skills and is the ability to produce ideas previously developed by individuals (Lucchiari, Sala, Vanutelli, 2018). The lack of students' skills in this indicator of originality is possible because they need a lot of time in generating original ideas. This is in line with the research conducted by Acar, Alabbasi, Runco, & Beketayev, (2019) that students need and use more time to be able to produce original ideas.

The results of this research indicate that the creative-thinking skills of preservice teachers in the experimental group who were taught with the ERCoRe learning model are higher than those of the lecture and question and answer methods. The ERCoRe learning model influences the creative-thinking skills of preservice biology teachers. This model can enhance creative-thinking skills because it is designed to support preservice teachers to empower higher-order thinking skills and develop independent learning abilities (Ismirawati *et al.*, 2015). Also, the ERCoRe learning model provides an opportunity for them to practice creatively (Ismirawati *et al.*, 2018).

The syntaxs of the ERCoRe learning model contribute to the improvement of creative-thinking skills of preservice as they are in line with the nature of the empowerment of creative-thinking skills. Ismirawati *et al.* (2015) stated that the ERCoRe learning model has four syntaxes. The first syntax is Eliciting, where the preservice teachers are expected to have initial knowledge by reading the material before learning. The reading activity can be done at home or on campus. A person who spends a lot of time reading would increase his/her literal understanding, interpretation, and then be able to make conclusion and creative understanding (Wang, 2012; Zubaidah, 2016; Muhlisin, Susilo, Amin & Rohman, 2016). Ritchie, Luciano, Hansell, Wright, and Bates (2013) further explained that reading skills could increase the diversity of mental representations, especially creative thinking,

by expanding the range of experience from the reading contents. Thus, the eliciting stage already gives the idea that there will be an increase in creative-thinking skills.

The second syntax is Restructuring, where the preservice teachers are directed to construct their understanding and then pour it in mind maps. This activity is considered very potential to develop creative-thinking skills if done continuously. Mind maps have the potential to improve higher-order thinking skills (Erdimez, Tan, & Zimmerman, 2017), think analytically (Muhlisin, Susilo, Amin, & Rohman, 2018), and strengthen the logical and innovative thinking skills (Liu, Tong, Yang, 2018), as well as provide understanding to students so that they can remember the material and then express it in their writing (Muhlisin, 2019). Holzman (2004) explained that students who are accustomed to using mind maps in learning activities are encouraged to focus on the process they use to get the right answers.

The making of mind maps, as part of the restructuring phase, has a major contribution to improving the creative-thinking skills of preservice biology teachers. This happens because the mind map is an ideal technique to improve creative-thinking skills (Zubaidah *et al.*, 2017; Hidayati *et al.*, 2019). Mind maps that utilize all general skills related to thinking, especially imagination and connecting ideas, are considered relevant to a particular problem (Kern, Bush, & McCleish, 2006). Mind maps can not only train creative thinking skills, but they can also create a pleasant learning environment for pre-service teachers, which in turn has an impact on improving their creative thinking skills.

The principle of mind maps is to summarize all material that is learned in a way that is not linear but branched (Hariyadi, Corebima, Zubaidah, & Ibrohim, 2018) using words, symbols, colors, lines and images (Chan, 2013). The use of mind maps in learning shows that teachers have been able to facilitate the process of connecting meaningful symbols in a way that is easy to remember to provide a good effect in improving teaching and learning activities (Liu, Zhao, Ma & Bo, 2014). This activity will make it easier for preservice teachers to understand a concept so that it gives birth to creative thinking.

The third syntax of Confirming is the activity of developing concepts obtained from the reading process, making a mind map, and then confirming through the heterogeneous class discussion. With this discussion, there will be an exchange of information and experience between one another, which has an impact on the creative thinking of preservice teachers. Apino & Retnawati (2017) revealed that discussion activities could improve students' creative-thinking skills. One of the keys to success in the confirming phase in improving creative-thinking skills is its questions from other students, resulting in a variety of methods for conveying questions and responses. Ulibarri, Cravens, Cornelius, Royalty, and Nabergoj (2014) explained that the key to success in a study that leads to an increase in creative thinking is to be able to generate many innovative and unique ideas and delivery methods in the percentage stage.

The confirming phase is very useful for preservice teachers because it is closely related to the basic competencies to be possessed by a teacher, including the skills to ask questions and provide reinforcement (Akkaya & Demirel, 2012; Luzyawati, 2015). At this stage, preservice teachers are trained to be able to explore their competencies. Asking questions is the delivery or raising of questions as a stimulus to grow answers to what is asked. Asking questions can improve the learning activities and thinking skills of preservice teachers. The questioning and reinforcement activities are very closely related to the confirming phase because in this phase, preservice teachers present their reading results and mind maps in the discussion activities. The basic skill of giving reinforcement will certainly have an impact on preservice teachers because it trains their skills in speaking and explaining. With the reinforcement, the preservice teachers will be satisfied with their explanation.

The fourth phase is Reflecting, where the preservice teachers are allowed to reflect on what they have gained during the learning process. This stage will hone their ability to develop mind maps independently, which makes them more adept at making mind maps. Reflecting can also be a means to develop the professional competencies of preservice teachers (Lyons, 2010). The reflecting phase is one stage to develop mindsets. This is in line with the opinion of Laboskey & Hamilton (2010), Evans (2013), and Davis *et al.* (2014) that reflection can be used to support beginners and professionals in developing the mindset needed to improve the effectiveness of their profession. This shows that reflection becomes an important part of the process of mentoring preservice teachers in improving their creative-thinking skills.

Making mind maps in ERCoRe learning is done twice. The first is in the restructuring phase carried out in pairs, for example, in Figure 2. The second mind map is created in the reflecting phase, which is arranged independently after conducting discussions in the confirming stage, for example, in Figure 3 and Figure 4. In general, it can be stated that the second mind map is better than the first.

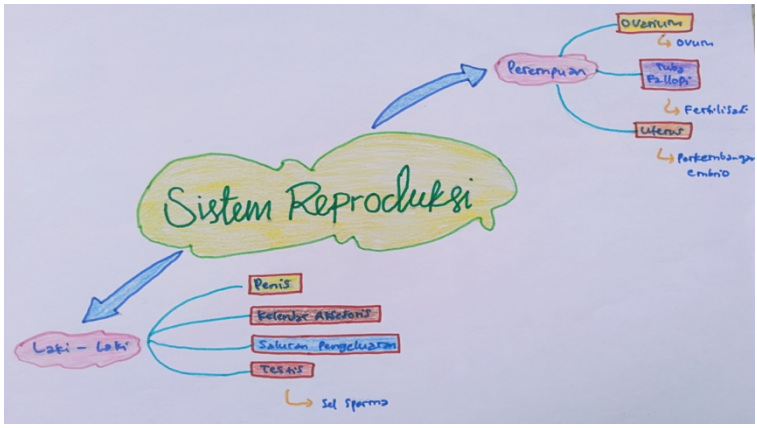

Figure 2.
Mind Map on the Restructuring Phase Made Collectively by Preservice Teachers IW & VR

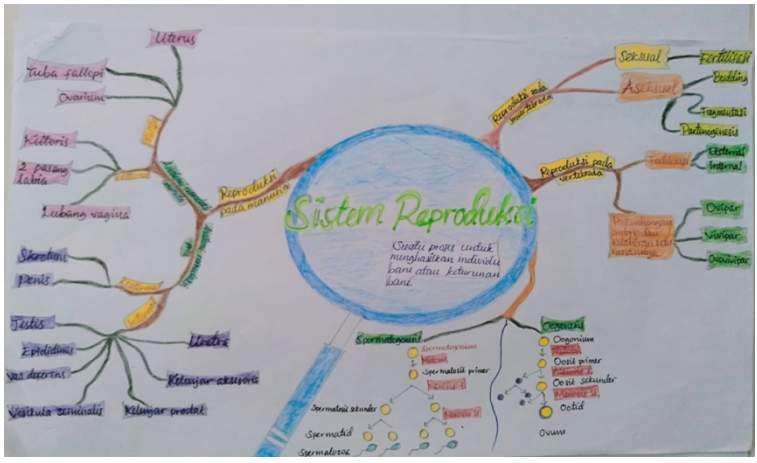

Figure 3.
Mind Map on the Reflecting Phase Made Independently by the Preservice Teacher IW

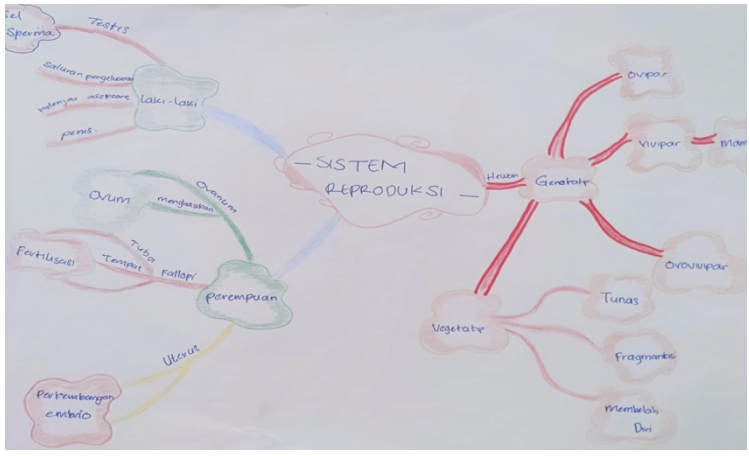

Figure 4.
Mind Map on the Reflecting Phase Made Independently by the Preservice Teacher VR

The mind map in the restructuring phase (Figure 2) still appears less detailed. For example, the mind map created by IW & VR can only have two branches, namely the reproductive system of men and women. From each of these branches, the preservice teachers can also only make a maximum of four branches. For example, in the male reproductive system, they can only write down the penis, glandular accessories, urethra, and testis. Aside from the lack of branching, the mind map made is still less attractive in color and not using pictures, and the central line is not thick enough. This might be because the preservice teachers still use the results of reading and have not obtained additional knowledge from other friends and lecturers in making mind maps. Meanwhile, a good mind map consists of components of lines, images, colors, diagrams, codes, symbols, and center lines that are thicker than branch lines (Buzan, 2005; Davies, 2010).

Unlike the mind map at the restructuring stage, the mind map produced at the reflecting stage appears more interesting and detailed, as can be seen in Figure 3 (Mind map created independently by IW) and Figure 4 (mind map created independently by VR teacher). The mind map in Figure 3 with the main topic of the reproductive system can be explained by the preservice teachers into five branches, namely reproduction in invertebrates, reproduction in vertebrates, reproduction in humans, oogenesis and spermatogenesis. Then, from each branch, IW can form many others, so that the mind map produced looks detailed. Also, in terms of the appearance of the mind map made, it looks attractive by using a combination of colors and images. This is in line with the statement of Liu, Tong, and Yang (2018) that mind maps combine words, images, symbols, and other means of information representation.

Another example of a mind map is at the reflecting stage made by VR. While still using the main topic of the reproductive system, VR makes three branches, namely the reproductive systems in men, women, and animals. VR can differentiate the reproductive organs in men into four, namely the testis, urethra, accessory gland, and penis and in women, namely ovary, fallopian tube, and uterus. At each branch, VR makes another. To make it easier to remember information, VR adds the green color to the main branch and orange to the next branch.

Making a mind map is better in the reflecting phase than in the restructuring phase, probably because it has been through the discussion phase in the confirming phase. The preservice teachers have gained additional knowledge from other teachers and reinforcement from the lecturer. Also, the mind maps of the preservice teachers improve at the reflecting stage because it seems that they have combined words and images. A good mind map combines words and images to produce strong comprehensive expressions (Buran & Filyukov, 2015; McTigue, Douglass, Wright, Hodges, & Franks, 2015). Furthermore, preservice teachers incorporate ideas and reflect on different perspectives to develop their knowledge,

which has an impact on the better mind map that they produce in the reflecting phase.

In general, ERCoRe has many advantages. Ismirawati *et al.* (2018) explained that the advantage of the ERCoRe learning model is that it is very suitable for contextual materials. It helps students rearrange the initial knowledge they have, be sensitive to see the phenomena that occur around them, and actively collaborate in discussions. Also, this model applies the collaborative principle, in which there is mutual cooperation, mutual interaction, and discussion with each other. The advantage of ERCoRe is it provides the opportunity to improve creative-thinking skills.

The results of this research also indicate that preservice teachers who are taught with the lecture and question & answer methods have lower creative-thinking skills than those who use the ERCoRe learning model. This is because the lecture and question & answer methods, which include lecture and discussion methods, are more teacher-centered. The learning process is more dominated by the teacher, and the students are not allowed to develop themselves (Mohammadjani & Tonkaboni, 2015). Also, the students have less opportunity to develop their learning and thinking activities in understanding a subject matter because they do not receive special attention from the teacher (Vijayaratnam, 2009; Warouw, 2011). These findings are also supported by previous studies that the lecture and question & answer methods or teacher-centered learning lacks the opportunity for students to develop creative-thinking skills (Tumurun, Gusrayani, & Jayadinata, 2016).

The limitation of this research is it only reveals creative-thinking skills. It is to be noted that other skills can also be developed through learning by using the ERCoRe learning model. Also, this research has been tested in the Animal Structure course. Therefore, it is recommended that future researchers apply this model to other subjects.

The average score of the creative-thinking skills of preservice teachers taught with the ERCoRe learning model is higher than that taught with the lecture and question & answer methods. It is recommended that the ERCoRe learning model be used for other subjects as considered to have the potential in developing 21st century skills. Also, the ERCoRe learning model provides the opportunity and experience for preservice teachers to continue to hone their creative-thinking skills in making mind maps that can help them follow the flow of thinking from the subject to be learned. Further research can also be carried out by focusing on the effect of the ERCoRe learning model on other variables.

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