Premiere Educandum
JURNAL PENDIDIKAN DASAR DAN PEMBELAJARAN

Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran
Volume 12(1) 12 – 25 June 2022
ISSN: 2088-5350 (Print) / ISSN: 2528-5173 (Online)
Doi: 10.25273/pe.v12i1.11745
The article is published with Open Access at: http://e-journal.unipma.ac.id/index.php/PE

Concept maps as dynamic tools to increase students' understanding of knowledge and creative thinking

Rida Fironika Kusumadewi, Universitas Islam Sultan Agung
Imam Kusmaryono ✉, Universitas Islam Sultan Agung

✉ *kusmaryono@unissula.ac.id*

Abstract: Concept maps are closely related to students' understanding of knowledge and creative thinking skills. This study aims to determine the effectiveness of concept maps as in increasing understanding of knowledge and creative thinking skills when students are involved in learning activities. The type of research method chosen is descriptive analysis. Research data were collected through (1) questionnaires, (2) concept map assessment rubrics, and (3) interviews. The results of the questionnaire were evaluated using the percentage technique. Students' answers to open-ended questions about the advantages and disadvantages of applying concept maps are summarized and analyzed descriptively. The results showed that most respondents stated that learning with concept maps was fully effective. Analysis of answers to questionnaires and open-ended questions clonclude that concept maps are effective as a tool to improve students' understanding of knowledge and creative thinking skills that have implications for meaningful learning, student positive attitudes, and student academic achievement.

Keywords: Concept maps, Knowledge, Understanding, Creative thinking

Received 08 January 2022; **Accepted** 08 April 2022; **Published** 02 June 2022

Citation: Kusumadewi, R.F., & Kusmaryono I. (2022). Concept maps as dynamic tool to increase students' understanding of knowledge and creative thinking. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*, *12*(1), 12 – 25. Doi.org/10.25273/pe.v12i1.11745

INTRODUCTION

Students' creative thinking competence iis crucial in the era of global competition because the level of complexity of problems in all aspects of modern life and the world of work is currently getting higher (Cooper & Zimmerman, 2020; Luton, 2021). Given the importance of creative thinking, this ability should be developed and get the teacher's attention. In learning, teachers can provide tasks that allow children (students) to engage in creative and imaginative thinking activities (Huang et al., 2020).

The development of creative thinking skills in education helps improvethe quality of human resources (Astuti et al., 2020). This development can be seen from the quality of the learning process, namely how the teacher's efforts to activate students in learning through appropriate learning strategies (Sayani, 2015). Learning strategies act as cognitive operators who are directly involved in completing student learning tasks (Darling-Hammond et al., 2020).

Constructivism states that learning is an active process that involves students building their understanding (Kojo et al., 2018; Kusmaryono et al., 2021). Meanwhile, the theory of Ausebel (1968, in Kusmaryono et al., 2021) argues that meaningful learning will occur when new knowledge or concepts are linked to existing concepts (already owned by students) previously. Based on the opinion of these experts, the acquisition of knowledge and understanding by students can occur if and only if students are mentally active in constructing their knowledge by linking new concepts with existing concepts (Kinchin et al., 2019). Referring to constructivism theory from Piaget (1964, in Kusmaryono et al., 2021) and Ausubel's meaningful learning theory (1968, in Kusmaryono et al., 2021), one effort that can be applied to improve creative thinking skills and meaningful learning is through learning strategies with concept maps (Kinchin et al., 2019).

Experts explain that a concept map is an image (visual) composed of interrelated concepts as a result of concept mapping (Åhlberg, 2013; Baig et al., 2016; Nair & Narayanasmy, 2013; Vodovozov & Raud, 2015). The preparation of a concept map is a process that involves identifying the concepts of a subject matter and arranging the concepts in a hierarchy (Baig et al., 2016; Erdimez et al., 2017). The nature of the hierarchy starts from the most general, less general concepts and more specific concepts in the form of terms and concept labels which are woven with conjunctions as propositions (Baig et al., 2016; Huang et al., 2020).

The application (strategy or method) of concept maps in learning is a creative activity (Cooper & Zimmerman, 2020), where students must exert efforts to clarify the meaning of concepts in specific domain knowledge, by identifying important concepts, building concept relationships and the structures they control (Kusmaryono et al., 2020). Concept maps can be an excellent activity to assess their mastery and understanding of the material and their level of creativity in representing their cognitive structures (Åhlberg, 2013; Romero et al., 2017).

Concept maps can be used as a solution option or alternative to solve problems in education (Erdimez et al., 2017). Teachers can use concept maps to find out what students already know and master while producing a meaningful learning process (Kinchin et al., 2019; Kuech, 2014; Safdar, 2012). Thus the concept map can be used as a study tool to evaluate lessons or plans in a lesson, or the entire curriculum (Mukhopadhyay et al., 2019; Safdar, 2012; Vodovozov & Raud, 2015).

Another expert opinion (Alkilany, 2017; Kinchin et al., 2019) says that a concept map is a creative exploration that represents the relationship between one concept and another, and the relationship between knowledge structures that a person has. Concept maps are very well used by teachers to improve memory, strong understanding of concepts, and increase student creativity through freedom of imagination (Alkilany, 2017; Taadi, 2019). This also makes students trained in linking the concepts they have to help

help solve problems in learning that involve several interrelated concepts (Davies et al., 2013; Ritter & Mostert, 2017). Learning with a concept map strategy allows students to think creatively in doing given tasks (Alkilany, 2017).

Creative thinking is the ability to find new relationships, see the subject matter from a new perspective, and form new combinations of concepts already in mind (Ülger, 2016). Creative thinking is seen as the ability to see things in new ways resulting in finding new combinations (Barchi, 2019). This illustrates that creative thinking skills allow an individual to view a problem from various perspectives, thus enabling him to find creative solutions to problems to be solved (Davies et al., 2013; Ritter & Mostert, 2017).

Creative thinking is a thinking activity to produce something creative and original (Dewi & Mashami, 2019). Someone is said to have the ability to think creatively if the results of his thoughts meet specific indicators. Some indicators of creative thinking (Arvyati et al., 2015; Dewi & Mashami, 2019; Ritter & Mostert, 2017) include (1) fluency, namely the ability to generate many ideas, (2) flexibility, namely the ability to generate various ideas, (3) originality, namely the ability to generate new ideas or ideas that previously did not exist, and (4) elaboration, namely the ability to develop or add ideas so that detailed or detailed ideas are produced.

The application of a concept map strategy oriented toward the ability to think creatively, where students construct and make connections between concepts from various knowledge possessed, is the teacher's effort so that students gain a thorough understanding (Mester, 2008).Some literature shows evidence that concept maps are helpful for better understanding a topic and improving student performance (Baig et al., 2016; Singh, 2015). Students who can connect information from one source to another into new informationare said to have the ability to think creatively and get meaningful learning (Darling-Hammond et al., 2020).

Many previous researchers have offered the results of research on concept maps Their research reports focus more on experimental research with relatively high effectiveness in improving learning outcomes in research samples of high school and college students (Latif et al., 2016; Safdar, 2012; Singh, 2015; Taadi, 2019; Taie, 2014; Vodovozov & Raud, 2015). Given the importance of conceptual understanding and critical thinking skills to be cultivated in students from an early age, the ability to compose concept maps needs to be trained since elementary school. Therefore, it is necessary to conduct research that focuses using of concept maps as a dynamic tool to improve knowledge understanding and creative thinking skills. Therefore it is necessary to conduct research that focuses on using concept maps as a dynamic tool to increase understanding of knowledge and the ability to think creatively.

This study investigates the effectiveness of concept maps in increasingi understanding of knowledge and creative thinking skills when students are involved in learning activities. The results of this study are expected to make a real contribution in revealing that concept maps can be used as an assessment tool for student performance on a learning topic. Also, it can improve understanding of knowledge, and creative thinking skills ,which have implications for meaningful learning, positive attitudes, and student academic achievement.

METHODS

Research Design

The research method chosen was qualitative with a phenomenological research orientation. This phenomenological research explores the significance of the themes raised based on students' learning experiences (Sharma, 2020), namely concept maps as a tool to improve understanding of knowledge and creative thinking skills. Researchers explore data and information using questionnaires and in-depth interviews then the data obtained is processed and analyzed to conclude (Kim et al., 2017).

TABLE 1. *The characteristics of the participants*

No.	Participants	Total	Characteristics
1	Teacher	1	The teacher has a professional certificate and has 8 years of teaching experience
2	Observer	1	Senior teacher and has a professional certificate
3	Male Students	30	Students are between 10 – 11 years old and are spread out in two classes of the same level
4	Female Students	30	Students are between 10 – 12 years old and are spread out in two classes of the same level
*	Total	62	

TABLE 2. *Concept map effectiveness indicators*

No.	*Concept map effectiveness indicators*	Questionnaire	Response (%)		
			Completely	Not Completely	Not at all
1	Concept maps help understand the topic of the lesson	Do concept maps help you understand the lesson's topic in greater depth?			
2	Concept maps help store information	Do concept maps help you retain muchof information?			
3	Concept map motivates learning	Do concept maps motivate you to study hard?			
4	Concept maps make learning fun and challenging	Do concept maps make you arere learning more fun and challenging?			
5	Concept maps help connect some knowledge	Do concept maps help you connect multiple pieces of knowledge			
6	Concept maps make learning meaningful	Do concept maps make for meaningful learning?			
7	Concept maps help assess and control self-knowledge	Do concept maps help you self-assessment and control self-knowledge?			
8	Concept map improves performance	Does the concept map improve your performance (competence) in taking the test?			
9	Concept maps promote active student learning	Can concept maps promote active student learning (construct knowledge)?			
10	Concept maps improve creative thinking skills	Do concept maps help you improve your creative thinking skills?			

Participants

This research was conducted in the sixth grade of a private elementary school in Semarang, Indonesia. The participants involved in this study were 62 people consisting of one teacher, one observer, and 60 students. The teacher carries out learning in different classes, namely classes VI-A (30 students) and VI-B (30 students), with the same choice of topics in learning mathematics. The activities of teachers and students in learning are observed and recorded by observers. The characteristics of the participants are presented in **TABLE 1**.

Instruments

The research data collection instrument consisted of (1) a concept map effectiveness questionnaire, (2) a concept map assessment rubric, and (3) a list of interview questions (semi-structured). The questionnaire instrument contains questions to determine the effectiveness of concept maps in learning. On the questionnaire, respondents can provide response options, namely completely appropriate, not completely appropriate, or not at all appropriate.

The reliability test resultsusing the Cronbach's Alpha formula obtained a value of 0.770 with high-reliability criteria (Taber, 2018). The value of the r table for n = 20 with an Alpha significance of 5% is 0.444 (Esezi & Eric, 2018). With these results, the result of the r count is greater than the r table so that the questionnaire instrument being tested can be declared reliable.

This concept map assessment rubric was developed and modified from the results of previous research by experts (Erdimez et al., 2017; Huang et al., 2020; Romero et al., 2017) for each point of the concept map, namely: (a) the main concept or main idea, (b) valid propositions, (c) hierarchical levels, (d) crosslinks, and (e) specific examples.

TABLE 3 . *Rubric of concept map assessment criteria*

No.	Assessed Aspects of Concept Map	Score			
		very satisfactory (20 points)	satisfactory (15 points)	good enough (10 points),	needs improvement (5 points)
1	The main concept				
2	Valid propositions,				
3	Hierarchical levels				
4	Crosslinks				
5	Specific examples				
*	Total score				

The interview instrument contains several main questions to determine the advantages and disadvantages of learning using concept maps. In the **TABLE 4,** a list of the main questions during the interview is presented. Interview questions can also be developed while in the field to obtain information about students' creative thinking abilities.

TABLE 4. *List of interview questions (semi-structured)*

No.	Questions
1	What are the advantages of learning by making concept maps?
2	What are the disadvantages of learning by making concept maps?
3	Is your learning concept map more systematic and structured?
5	Will learning with concept maps add to your learning load?

Procedure

The application of learning with a concept map strategy is carried out based on the following stages: (1) the first week the teacher determines the topic of learning about points, angles, lines, and planes, (2) the second week the teacher determines the topic of learning about flat plane geometry; (3) in the third week the teacher determines the topic of learning about geometric shapes, and (4) the fourth week the teacher gives a test. the teacher introduces a concept map strategy to discuss a topic in each meeting. The teacher explains how to compile a concept map to make connections between concepts. Student activities are to carry out discussions to discuss issues related to the topic and compile a

concept map according to the topic. (5) at the end of the meeting, the four teachers asked students to fill out a questionnaire, and (6) the teacher reflected and evaluated the implementation of learning.

Data analysis

The questionnaire resultson students' perceptions of the effectiveness of the concept map as a learning tool were evaluated using the percentage technique. The percentage of respondents' responses was calculated for each question item. Students' answers to open-ended questions about the advantages and disadvantages of applying concept maps are also summarized, analyzed, and presented in the table. The use of concept map effectiveness criteria in this study is shown in **TABLE 5** below (Mekonnen, 2020).

TABLE 5. *Criteria for the effectiveness of the concept map*

No.	Range	Criteria
1	81.00 % - 100.00 %	Very effective
2	61.00 % - 80.00 %	Effective
3	41.00 % - 60.00 %	Effective enough
4	21.00 % - 40.00 %	Less effective
5	< 21.00 %	Ineffective

RESULTS

learning with the concept map strategy applied in mathematics class was carried out for four weeks. At first, the students did not understand the concept of map-making. Some of the concept maps made by students are still not good because students are not used to learning with concept maps. However, after several exercises with the teacher's guidance, finally, the students were able to make a concept map quite well.

Concept Maps Students Work

Before we present concept map assessments and further discussion, it is to present two examples of concept maps of student work. Each concept map was taken from a group of students in class VI-A and class VI-B. The learning topic chosen was geometry. The results of student performance in compiling a concept map on the same material were deliberately chosen from two different concept map models to compare the two.

FIGURE 1 is a counseling map created by a group of class VI-A students. On this concept map, students have been able to construct their knowledge (Alkilany, 2017) about the concept of a quadrilateral, where a rectangle is a parallelogram. They can see the relationship between the quadrilateral - the levels - the rectangle. Whereas the rectangular shape is a quadrilateral that has two pairs of parallel sides (parallelograms) with right angles. Based on in-depth analysis, the concept map in **FIGURE 1** shows that students already understandthe topic at the relational understanding level (Hammond et al., 2019). Students who are already at the relational understanding stage will not experience significant obstacles in explaining the relationship between concepts (Abramovich et al., 2019).

FIGURE 2 is a concept map with the sub-topic "Plane Geometry and Space Geometry" which is an example of a concept map created by class VI-B students with group members consisting of 4 students. The arrangement of the concept map in **FIGURE 2** appears to be made systematically. The concept map explains several propositions and cross-links on the sub-topic "Plane Geometry and Space Geometry". The ability to make concept maps has a positive effect on students, where students can more easily

understand the relationship between topics as a whole (Taadi, 2019; Taie, 2014; Vodovozov & Raud, 2015).

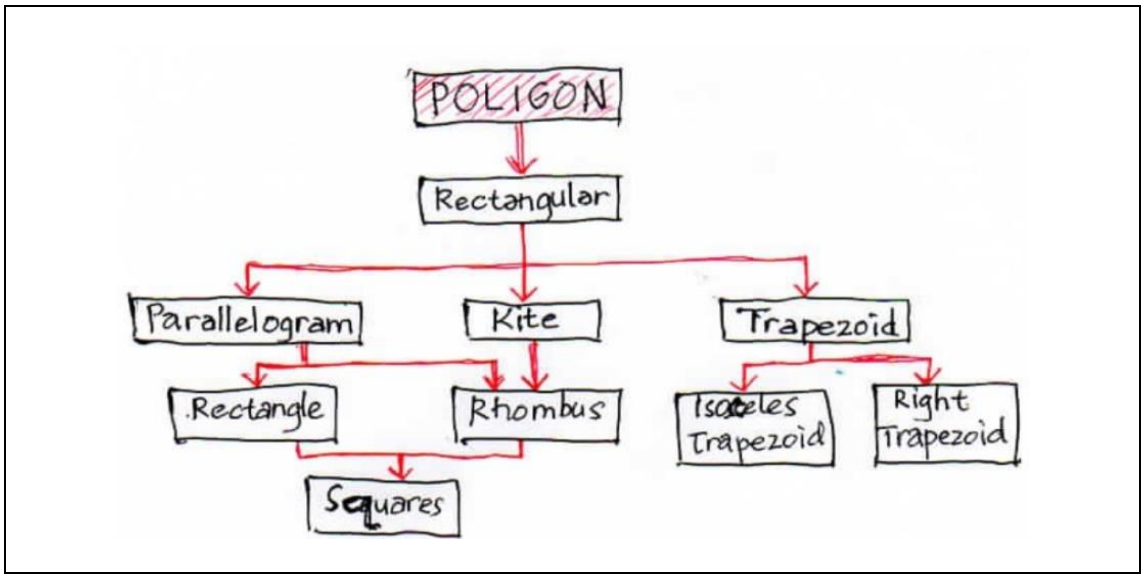

FIGURE 1. *Concept map with the sub-topic "Polygons"*

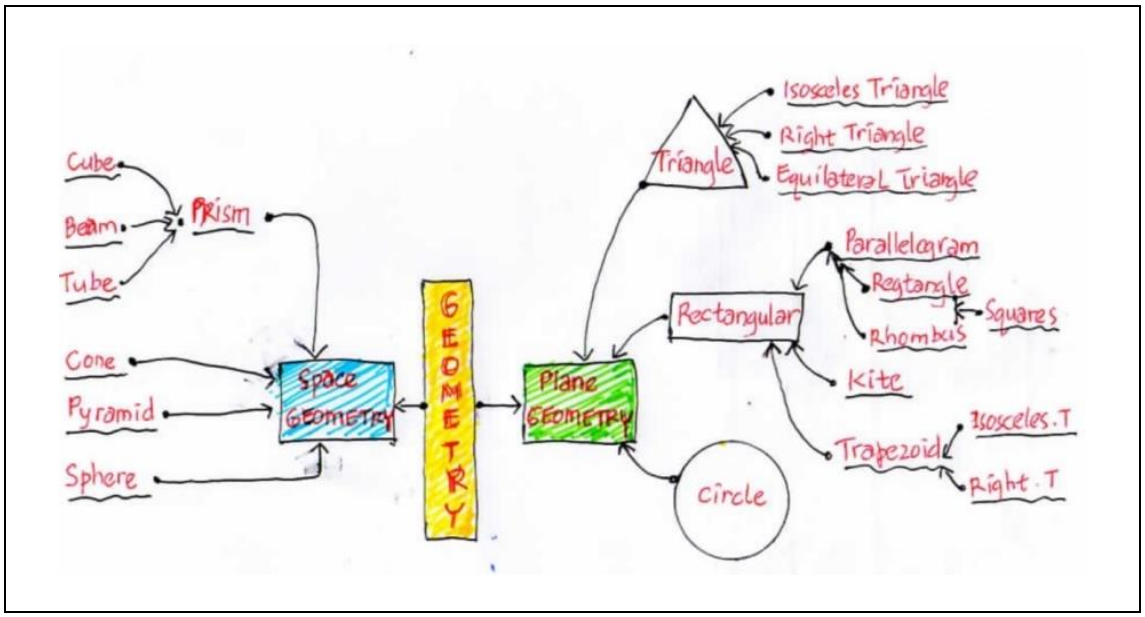

FIGURE 2. *Concept map with the sub-topic "Plane and Space Geometry"*

Questionnaire Response

The questionnaire responses of respondents (as many as 60 students) about the concept map have been recapitulated in Table 2. Analysis of students' perceptions about the concept map shows a percentage of 72.67%. This means that 72.67% or most of the students stated that the concept map was useful and liked by students. In other words, the level of perception of the effectiveness of the concept map application in learning reaches 72.67% with effective criteria. Meanwhile, respondents (students) who had the perception that concept maps were not useful at all were only 13.00%.

This concept map assessment rubric was developed and modified from the results of

previous research by experts (Erdimez et al., 2017; Huang et al., 2020; Romero et al., 2017) for each point of the concept map, namely: (a) the main concept or main idea, (b) Valid propositions, (c) hierarchical levels, (d) crosslinks, and (d) specific examples. The assessment score for each concept map criteria includes: very satisfactory (20 points), satisfactory (15 points), good enough (10 points), and needs improvement (5 points).

TABLE 6 . *Recapitulation of the questionnaire on the effectiveness of the concept map*

No.	Questions	N*	Response (%)		
			Completely	Not Completely	Not at all
1	Do concept maps help you understand the topic of the lesson in greater depth?	60	66.67	13.33	20.00
2	Do concept maps help you retain a lot of information?	60	70.00	20.00	10.00
3	Do concept maps motivate you to study hard?	60	73.33	6.67	20.00
4	Do concept maps make you're learning more fun and challenging?	60	70.00	16.67	13.33
5	Do concept maps help you connect multiple pieces of knowledge	60	83.33	13.33	3.33
6	Do concept maps make for meaningful learning?	60	76.67	10.00	13.33
7	Do concept maps help you self-assessment and control self-knowledge?	60	50.00	40.00	10.00
8	Does the concept map improve your performance (competence) in taking the test?	60	83.33	6.67	10.00
9	Can concept maps promote active student learning (construct knowledge)?	60	73.33	10.00	16.67
10	Do concept maps help you improve your creative thinking skills?	60	80.00	6.67	13.33
	Avarage	60	72.67%	14.33%	13.00%

*Information: N = number of respondents

TABLE 6 shows that each respondent (60 respondents) has responded well to each questionnaire questionabout the effectiveness of learning with concept maps. As many as 72.67% of respondents chose the answer "completely". This means that most respondents stated that learning with concept maps was fully effective. Meanwhile, as many as 14.33% of respondents stated that it was not completely effective, and 13% of the responses stated that it was ineffective.

In addition, we also analyzed the results of students' responses to 2 open-ended questions about the advantages and disadvantages of applying concept maps in learning. Each student provides at least one response in response to each of these questions. Various student answers were identified and the highest five answers that often appeared were taken as shown in **TABLE 7** below.

The responses to the open-ended questions tabulated in **TABLE 7** show that students know the importance of learning with concept maps. More than 70% of respondents stated that concept maps are useful in learning. The benefits of learning with a concept map are outlined in the top 5 answers, which are useful for (1) understanding a broader and deeper topic (2) increasing creative thinking skills, (3) connecting some knowledge, (4) controlling the occurrence of misconceptions, and (5) learning to be meaningful and many challenges.

TABLE 7. *Responses to open-ended questions, advantages, and disadvantages of the concept map.*

No.	Questions and Comments	Number of Respondens
1	***What are the benefits of learning by creating a concept map?***	
	a. Useful for understanding a broader and deeper topic	22 (73.33%)
	b. Useful for improving creative thinking skills	24 (80.00%)
	c. Useful for linking multiple knowledge.	26 (86.67%)
	d. Useful for controlling misconceptions	20 (66.67%)
	e. Learning becomes meaningful and challenges a lot	21 (70.00%)
2.	***What are the disadvantages of learning by creating a concept map?***	
	a. Requires a lot of study time	19 (63.33%)
	b. Makes learning less focused	10 (33.33%)
	c. The study load becomes more difficult	9 (30.00%)
	d. Must master many concepts (knowledge) beforehand	15 (50.00%)
	e. Makes me bored and lazy to study	8 (26.67%)

In addition, to provide answers about the advantages of learning with a concept map, the respondents also wrote down the disadvantages. It should be understood that students who write down the disadvantages of learning with a concept map do not mean that they do not like learning with a concept map. In **TABLE 7**, 63.33% of students said learning with a concept map takes much time and 50% said they needed much knowledge to make a concept map. Actually, this answer supports the advantages of learning with concept maps. By studying diligently, they will have more and more in-depth knowledge to make concept map relationships between the knowledge they already have and understand (Åhlberg, 2013; Alkilany, 2017).

The teacher's concept map of student performance results is examined carefully and thoughtfully. The assessment is carried out on the concept map of each group's workthen an average score is made. **TABLE 8** is a statistical description of the average score for the concept map assessment for each class.

TABLE 8. *Average concept map assessment scores*

Grade Class	Main Ideas	Proposition	Hierarchy	Cross Link	Examples	Average score
Class VI-A	82,14	82,14	64,29	82,14	67,86	75,71
Class VI-B	84,38	87,50	81,25	80,50	68,75	80,47
Average score	83,26	84,82	72,77	81,32	68,31	78,09

Paying attention to the teacher's response during the interview, the teacher is very open andflexible and appreciates students for asking questions about things that have not been understood. The purpose of this statement is for students to be active and understand mathematics better, the teacher needs to provide examples and encourage alternative solutions (Yeh, et al., 2019).

The aspects assessed from a concept map include main ideas, propositions, hierarchies, cross-links, and examples (Alkilany, 2017; Erdimez et al., 2017). In Table 4, it can be seen that the average score of the concept map assessment obtained by class VII-A students was 75.71, and class VII-B students were 80.47. All aspects of the concept map assessment were in a good category with an overall average of 78.09. Concept maps made by students are also used to measure creative thinking skills. Aspects of assessing students' creative thinking abilities are based on fluency, flexibility, originality, and elaboration. The assessment results of creative thinking skills are presented in the graphic image below.

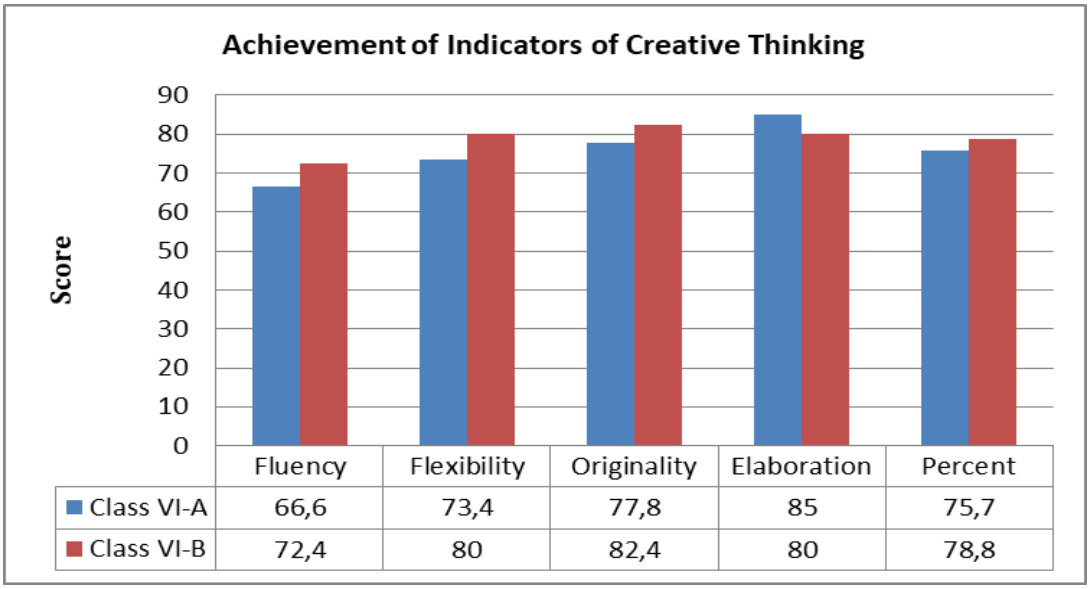

FIGURE 3. *Graph of creative thinking indicator achievement*

The graph in **FIGURE 3** shows the achievement of indicators of creative thinking in class VI-A students between 66.6 to 85.0 and class VI-B students between 72.4 to 82.4. Meanwhile, the average achievement of indicators for creative thinking of class VI-A students was 75.7, and grade VI-B students were 78.7. Based on the average score obtained (**FIGURE 3**), it can be said that students can think creatively as outlined in the form of concept maps (Cañas et al., 2017; Miranti & Wilujeng, 2018).

DISCUSSION

In the early stages of developing a concept map, some students had difficulty making a concept map. This difficulty is because the practice of learning is still conventional by applying the lecture and rote method in previous years, so it is difficult to switch to meaningful learning patterns (Baig et al., 2016). However, with diligent practice and guidance from the teacher in making concept maps, students can finally successfully construct a good concept map for learning. This concept map encourages students to explore the relationship between concepts holistically and creatively (As'ari, 2016).

In the early stages of developing a concept map, some students had difficulty making a concept map. This difficulty is because the practice of learning is still conventional by applying the lecture and rote method in previous years, so it is difficult to switch to meaningful learning patterns (Baig et al., 2016). However, with diligent practice and guidance from the teacher in making concept maps, students can finally successfully construct a good concept map for learning. This concept map encourages students to explore the relationship between concepts holistically and creatively (As'ari, 2016).

Students' work in the form of concept maps (see **FIGURES 1** and **2**) encourages students to build deep and creative thinking constructs (Latif et al., 2018). Student creativity is evident when compiling a concept map with an attractive visa presentation. Students' ability to represent ideas is presented in various forms: images, colors, and connecting lines to represent their creative ideas ((Alkilany, 2017). This shows that the concept map is made with good planning and careful presentation and with different forms between groups of students. The concepts presented in the concept map can be used as a tool for meaningful learning by students (Safdar, 2012)

Learning strategies with concept maps have the power to empower students'

creative thinking skills (Taie, 2014). The concept map method provides students with more opportunities to seek information from various learning sources and build their knowledge (Anohina-Naumeca, 2015; Vodovozov & Raud, 2015), and enables students to gain better learning experiences by developing creative and imaginative ideas (Alkilany, 2017). When students compile a concept map, factual, conceptual, and procedural abilities, critical thinking, and considering scientific thinking skills (high level) are needed (Cañas et al., 2017; Abdul Latif et al., 2016). Concept maps help students achieve mastery and understanding of knowledge in their disciplines theoretically and practically (Kinchin et al., 2019).

Using a concept map strategy as a learning design allows students to ignore rote learning, but it can support students' reflective thinking where ideas or concepts are systematically arranged (Alkilany, 2017; Anohina-Naumeca, 2015). Concept map strategies in learning have supported students in moving from rote learning to meaningful learning (Safdar, 2012). Changes in understanding knowledge are partial to holistic, from static to creative, and convergent to divergent (Åhlberg, 2013; Alkilany, 2017).

In addition, through concept maps, students can also reveal or recognize conceptual errors and make conceptual changes to be promoted (Pilar Ibáñez-Cubillas et al., 2017). In Figure 2, students build creative ideas through new links between new concepts and meanings so that learning becomes more significant in organizing and understanding information (Romero et al., 2017). The concept map strategy has increased power and creative thinking and and positively impacts self-motivation to learn better(Alkilany, 2017).

Paying attention to the achievement of creative thinking indicators (**FIGURE 3**) Concept maps of students' work have met the elements of creative indicators, namely (1) the ability to present concept maps with many different models (fluency aspects), (2) flexibility aspects, namely students solving problems from a different point of view, different (solving problems), (3) Aspects of originality, namely the ability to generate ideas different from the usual. Concept maps are original work of students, and (4) aspects of elaboration, appear in the diligent and careful work of concept maps. They can process knowledge better than others; they are able to combine the ideas;, these ideas come from the knowledge they have learned. When viewed from the level of creativity, students with higher levels of creativity, the more complex the student is in putting together ideas (Kupers et al., 2019).

According to Elaine B. Johnson (2007, in Ritter & Mostert, 2017; Ülger, 2016) creative thinking is a mental activity that fosters original ideas and new understandings. This creative thinking ability will support individual performance in problem-solving activities (Birgili, 2015; Khoiriyah & Husamah, 2018). Student creativity will grow and develop if they are trained to explore, inquire, discover and solve problems (Ritter & Mostert, 2017). In addition, student creativity will emerge if there is a stimulus from the environment (Barchi, 2019).

Concept maps in teaching provide a series of advantages in promoting dexterity and concept organizing skills in certain subjects (Hector, 2011). In this way, they (students) understandnew concepts (Ritter & Mostert, 2017; Ülger, 2016),, analyze and synthesize ideas, and explain them in their own words. What has been learned facilitates comprehensive learning and encourages reflective development through pooling ideas and collaborative activities (Yaacob et al., 2020). Empirical evidence shows that the experience of making concept maps has aroused interest in the majority of students and student academic achievement (Baig et al., 2016; Safdar, 2012). Although it always takes the teacher's effort to develop a concept map that is easy and attractive to students, and they can learn how to make it right.

CONCLUSION

Based on empirical evidence and discussion of this research, it can be concluded that

concept maps are effective to increase students' understanding of knowledge and creative thinking skills It also has implications for meaningful learning, student positive attitudes, and satisfying student academic achievement. We are aware that there are limitations to this study, namely that it involved 60 respondents in mathematics learning and respondents came from one junior high school only, thus limiting the generalizability of the research results to other subjects and other students. As a suggestion to increase student creativity, teachers must also develop themselves with creative thinking processes, especially in the STEM field (Chung & Li, 2021). Further similar research can be conducted with more respondents and a wider range of schools.

ACKNOWLEDGEMENT

Thank you to the leadership of Sultan Agung Islamic University Semarang for providing research funding so that this research can run smoothly. We also thank the teachers and students of the Sultan Agung Islamic elementary school in Semarang City, Indonesia.

REFERENCES

1. Abramovich, S., Grinshpan, A. Z., & Milligan, D. L. (2019). Teaching mathematics through concept motivation and action learning. *Education Research International*, *4*(1), 1–13. https://doi.org/10.1155/2019/3745406
2. Åhlberg, M. K. (2013). Concept mapping as an empowering method to promote learning, thinking, teaching and research. *Journal for Educators, Teachers and Trainers JETT*, *4*(1), 25–35.
3. Alkilany, A. (2017). The impact of using conceptual maps on the development of creative thinking of students. *Information and Knowledge Management*, *7*(6), 54–60.
4. Anohina-Naumeca, A. (2015). Justifying the usage of concept mapping as a tool for the formative assessment of the structural knowledge of engineering students. *Knowledge Management and E-Learning*, *7*(1), 56–72. https://doi.org/10.34105/j.kmel.2015.07.005
5. Arvyati, Ibrahim, M., & Irawan, A. (2015). Effectivity of peer tutoring learning to increase mathematical creative thinking ability. *International Journal of Education and Research*, *3*(1), 613–628.
6. As'ari, A. (2016). Using mind maps as a teaching and learning tool to promote student engagement. *Loquen: English Studies Journal*, *10*(01), 1–10. https://doi.org/10.32678/loquen.v10i01.25
7. Astuti, A., Waluya, S. B., & Asikin, M. (2020). The important of creative thinking ability in elementary school students for 4.0 era. *International Journal of Educational Management and Innovation*, *1*(1), 91–98. https://doi.org/10.12928/ijemi.v1i1.1512
8. Baig, M., Tariq, S., Rehman, R., Ali, S., & Gazzaz, Z. J. (2016). Concept mapping improves academic performance in problem solving questions in biochemistry subject. *Pakistan Journal of Medical Sciences*, *32*(4), 801–805. https://doi.org/10.12669/pjms.324.10432
9. Barchi, B. (2019). Development of creative thinking of students of psychologists. *International Scientific Journal «Education and Science»*, *2*(1), 68–71. https://doi.org/10.31339/2617-0833-2019-2(27)-68-71
10. Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments. *Journal of Gifted Education and Creativity*, *2*(2), 71–71. https://doi.org/10.18200/jgedc.2015214253
11. Cañas, A. J., Reiska, P., & Möllits, A. (2017). Developing higher-order thinking skills with concept mapping: A case of pedagogic frailty. *Knowledge Management and E-Learning*, *9*(3), 348–365. https://doi.org/10.34105/j.kmel.2017.09.021
12. Chung, S. K., & Li, D. (2021). Issues-based STEAM education: A case Sstudy in a Hong Kong secondary school. *International Journal of Education & the Arts*, *22*(2), 1–23.
13. Cooper, Y., & Zimmerman, E. (2020). Concept Mapping: A practical process for understanding and conducting art education research and practice. *Art Education*, *73*(2), 24–32. https://doi.org/10.1080/00043125.2019.1695478
14. Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications, Inc. 2455 Teller Road Thousand Oaks, California 91320.
15. Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications

for educational practice of thescience of learning and development. *Applied Developmental Science*, *24*(2), 97–140. https://doi.org/https://doi.org/10.1080/10888691.2018.1537791
16. Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education-A systematic literature review. *Thinking Skills and Creativity*, *8*(1), 80–91. https://doi.org/10.1016/j.tsc.2012.07.004
17. Dewi, C. A., & Mashami, R. A. (2019). The effect of chemo-entrepreneurship oriented inquiry module on improving students' creative thinking ability. *Journal of Turkish Science Education*, *16*(2), 253–263. https://doi.org/10.12973/tused.10279a
18. Erdimez, O., Tan, S., & Zimmerman, R. (2017). The use of concept maps as a tool to measure higher level thinking skills in elementary school science classes. *Journal for the Education of Gifted Young Scientists*, *5*(2), 1–18. https://doi.org/10.17478/JEGYS.2017.60
19. Hammond, D., Flook, L., Harvey, L. C., Barron, C., Osher, B., & Osher, D. (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, *0*(0), 1–44. https://doi.org/10.1080/10888691.2018.1537791
20. Huang, P., Lin, S., Yuan, J., & Chen, H. (2020). Course achievement evaluation using concept map in traditional learning. *Journal of Physics: Conference Series*, *1624*(5), 1–6. https://doi.org/10.1088/1742-6596/1624/5/052014
21. Isaac, O. E., & Chikweru, A. E. (2018). Test for significance of Pearson's correlation coefficient (r). *International Journal of Innovative Mathematics, Statistics & Energy Policies*, *1*(1), 11–23.
22. Khoiriyah, A. J., & Husamah, H. (2018). Problem-based learning: Creative thinking skills, problem-solving skills, and learning outcome of seventh grade students. *Journal of Biology Education Indonesia*, *4*(2), 151–160. https://doi.org/10.22219/jpbi.v4i2.5804
23. Kim, H., Sefcik, J. S., & Bradway, C. (2017). Characteristics of qualitative descriptive studies: A systematic review. *Res Nurs Health*, *40*(1), 23–42. https://doi.org/10.1002/nur.21768.Characteristics
24. Kinchin, I. M., Möllits, A., & Reiska, P. (2019). Uncovering types of knowledge in concept maps. *Education Sciences*, *9*(131), 1–14. https://doi.org/10.3390/educsci9020131
25. Kojo, A., Laine, A., & Näveri, L. (2018). How did you solve it? – Teachers' approaches to guiding mathematics problem solving. *Lumat*, *6*(1), 22–40. https://doi.org/10.31129/LUMAT.6.1.294
26. Kuech, R. K. (2014). Using concept maps to assess science knowledge of pre-service elementary methods students. *European Scientific Journal*, *1*(11), 290–294.
27. Kupers, E., Lehmann-Wermser, A., McPherson, G., & van Geert, P. (2019). Children's creativity: A theoretical framework and systematic review. In *Review of Educational Research* (Vol. 89, Issue 1). https://doi.org/10.3102/0034654318815707
28. Kusmaryono, I., Jupriyanto, J., & Kusumaningsih, W. (2021). Construction of students' mathematical knowledge in the zone of proximal development and zone of potential construction. *European Journal of Educational Research*, *10*(1), 341–351. https://doi.org/10.12973/eu-jer.10.1.341
29. Kusmaryono, I., Gufron, A. M., & Rusdiantoro, A. (2020). Effectiveness of Scaffolding Strategies in Learning Against Decrease in Mathematics Anxiety Level. *Numerical: Jurnal Matematika Dan Pendidikan Matematikaatematika*, *4*(1), 13–22.
30. Latif, Ab, Dahlan, A. H., & Mulud, A. (2018). The advantages of using concept mapping notes in classroom teaching. *Malaysian Journal of Medical Research*, *2*(1), 37–48.
31. Latif, Abdul, Mohamed, R., Dahlan, R., Nor, A. M., & Zarawi, M. (2016). Concept mapping as a teaching tool on critical thinking skills and academic performance of diploma nursing students. *Education in Medicine Journal*, *8*(1), 76–75. https://doi.org/10.5959/eimj.v8i1.406
32. Luton, C. (2021). Coaching preservice teachers to integrate the arts in STEM content. *International Journal of Education & the Arts*, *22*(5), 1–15.
33. Mekonnen, F. D. (2020). Evaluating the effectiveness of ' learning by doing ' teaching strategy in a research methodology course, Hargeisa, Somaliland. *African Educational Research Journal*, *8*(1), 13–19.
34. Miranti, M. G., & Wilujeng, B. Y. (2018). Creative thinking skills enhancement using mind mapping. *Advances in Social Science, Education and Humanities Research*, *112*(Iconhomecs 2017), 39–42. https://doi.org/10.2991/iconhomecs-17.2018.9
35. Mukhopadhyay, K., Mukherjee, S., Dhok, A., Chatterjee, C., & Ghosh, J. (2019). Use of concept map as a reinforcement tool in undergraduate curriculum: An analytical study. *Journal of Advances in Medical Education & Professionalism*, *7*(3), 118–122. https://doi.org/10.30476/JAMP.2019.74920
36. Nair, S. M., & Narayanasmy, M. (2013). The effects of utilising the concept maps in teaching

history. *International Journal of Instructionstruction*, *6*(2), 109–126.
37. Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*, *2*(3), 176–186. https://doi.org/10.1002/tea.3660020306
38. Pilar Ibáñez-Cubillas, D., Es, P., Dª, D., Gallego-Arrufat, M.-J., & Es, M. (2017). Design of a formative intervention using concept maps in learning communities. *Píxel-Bit. Revista de Medios y Educación*, *51*(7), 1133–8482. http://dx.doi.org/10.12795/pixelbit.2017.i51.06
39. Ritter, S. M., & Mostert, N. (2017). Enhancement of creative thinking Skills using a cognitive-based creativity training. *Journal of Cognitive Enhancement*, *1*(3), 243–253. https://doi.org/10.1007/s41465-016-0002-3
40. Romero, C., Cazorla, M., & Buzón, O. (2017). Meaningful leqarning using concept maps as a learning strategy. *Journal of Technology and Science Education*, *7*(3), 313–332.
41. Safdar, M. (2012). Concept maps: An instructional tool to facilitate meaningful learning. *European Journal of Educational Research*, *1*(1), 55–64. https://doi.org/10.12973/eu-jer.1.1.55
42. Sayani, A. H. (2015). My philosophy of teaching and learning. *Open Access Library Journal*, *02*(12), 1–4. https://doi.org/10.4236/oalib.1102109
43. Sharma, M. R. (2020). High school teachers' experiences in classroom ecology of language teaching: A study from the phenomenological perspective. *Journal of English Education and Teaching*, *4*(4), 466–482. https://doi.org/10.33369/jeet.4.4.466-482
44. Singh, I. Sen. (2015). The effect of using concept maps as study tools on achievement in chemistry at tertiary level. *Jouranal of Education and Practice*, *6*(15), 106–116.
45. Taadi, D. T. J. R. S. M. D. (2019). The Effect of mind mapping based imindmap application on the creativity and concept understanding of students. *Innovative Journal of Curriculum and Educational Technology*, *8*(1), 41–50.
46. Taber, K. S. (2018). The use of Cronbach's Alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2
47. Taie, E. S. (2014). Concept mapping as an innovative teaching strategy to enhance cognitive learning in nursing administration course. *International Journal for Innovation Education and Research*, *2*(7), 11–25. https://doi.org/10.31686/ijier.vol2.iss7.204
48. Ülger, K. (2016). The relationship between creative thinking and critical thinking skills of students. *Hacettepe University Journal of Education*, *31*(4), 695–710. https://doi.org/10.16986/HUJE.2016018493
49. Vodovozov, V., & Raud, Z. (2015). Concept maps for teaching, learning, and assessment in electronics. *Education Research International*, *12*(2), 1–9. https://doi.org/10.1155/2015/849678
50. Watson, M. K., Barrella, E., & Pelkey, J. (2016). Concept maps as teaching, learning, and assessment tools. *First Year Engineering Experience (FYEE) Conference*, *1*(August), 1–3.
51. Yaacob, A., Mohd Asraf, R., Hussain, R. M. R., & Ismail, S. N. (2020). Empowering learners' reflective thinking through collaborative reflective learning. *International Journal of Instruction*, *14*(1), 709–726. https://doi.org/10.29333/IJI.2021.14143A

PROFILE

Rida Fironika Kusumadewi is the head of the primary school teacher education study program at Universitas Islam Sultan Agung, Semarang. He has a doctorate in basic education with a concentration in mathematics education.

Imam Kusmaryono is a senior lecturer at the faculty of teacher training and education, Universitas Islam Sultan Agung , Semarang. His area of expertise is mathematics education. Some of his scientific articles have been published in reputable international journals (Scopus ID: 57189000884).