

## Improving Creative Thinking Skills of Students through Differentiated Science Inquiry Integrated with Mind Map

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### ABSTRACT

In inquiry-based learning, teachers usually only apply one level of inquiry from the four available levels. The diversity of students should be a serious consideration. Differentiated Learning Science Inquiry (DSI) implements the four levels of inquiry. To train students' creative thinking, inquiry can be integrated with mind maps. This research aims to determine the difference in creative thinking skills between male and female students who were given three different science learning models i.e., DSI, DSI integrated with mind map (DSIMM), and the conventional model. This research was a quasi-experimental research, which used a nonequivalent pretest posttest control group design. The samples of the research were 96 students from three classes spreading across three junior high schools in Kediri, Indonesia. The data on students' creative thinking skills were taken from an essay test on science learning assessed using a creative thinking skills rubric. The results of the research showed that there was a difference in students' creative thinking skills for different models. The highest creative thinking skills were exhibited by the students taught using the DSIMM model. The results of the research also showed that there was a difference in creative thinking skills between the male and the female students. The male students had higher creative thinking skills than the female students. This was presumably because in the differences of brain anatomy affecting the students' pattern of learning and activities.

**Keywords:** creative thinking skills, differentiated science inquiry, gender, mind map

### INTRODUCTION

In the 21st century, the improvement of all pathways and levels of education have become the driving issues to prepare the students (Mahanal, Zubaidah, Bahri, & Dinnurriya, 2016). There is a demand for qualified human resources in order to be able to compete globally. Qualified human resources are the outcome of qualified education processes. Qualified education equips students with thinking skills. One of the skills students are predominantly trained in to achieve the objectives of education in the 21st century is creative thinking skills (Moon, 2008).



Boden (2001) stated that creative thinking is the ability to bring new ideas that are surprising and valuable in many ways. Creative thinking is related to novelty, to the ability to create something, to implement new forms, to generate a lot of imaginative skills or to make something that already exists into something new (Greenstein, 2012). Furthermore, Abraham (2016) stated that creative thinking is a form of expressing oneself in a unique way.

Various indicators of creative thinking have been revealed by some experts. According to Treffinger, Young, and Selby (2002) there are five indicators of creative thinking, i.e., (1) fluency, the ability to generate ideas, ways, suggestions, questions, and alternative answers smoothly within a certain time; (2) flexibility, the ability to generate various ideas, answers, or question, where the ideas or answers are obtained from different viewpoints by changing the ways of thinking and the approaches used; (3) originality, the ability to generate phrases, ways, or ideas to solve a problem or make a combination of parts or elements unusually and uniquely that was unthinkable by others; (4) elaboration, the ability to enrich, develop, increase, describe or specify details of the object, idea, product, or situation to make it more interesting; and (5) metaphorical thinking, the ability to use a comparison or analogy to make a new connection.

Students' creative thinking skills which are different from one another require a learning condition involving a learning experience, so that the potential of creative thinking can develop (Yusnaeni, Corebima, Susilo, & Zubaidah, 2017). Creative thinking can be incorporated into learning by teachers, so teachers should be able to carry out the mandate of developing students' creative thinking skills. This is in accordance with the opinions of Wheeler, Bromfield, and Waite (2002), who stated that the teacher's task is to provide the best conditions for students to acquire relevant thinking skills. Creative thinking skills are considered to be very important for students (Baker & Rudd, 2001). Seyihoglu and Kartal (2010) stated that in order to face the challenges of modern life which is dynamic and full of uncertainty, it is necessary to develop creative thinking skills in learning. In fact, these creative thinking skills are the foundation of science (Hadzigeorgiou1, 2012). Thus, creative thinking skills need to be trained through learning, especially in science learning.

Based on the results of a preliminary study in science learning, it was revealed that the creative thinking skills of students in junior high schools in Kediri, Indonesia, were still low. Fuad, Zubaidah, Mahanal, and Suarsini (2015) stated that based on the results of a creative thinking test with the score range 0 -100, the total mean score on the indicators of creative thinking was 18.03. The scores on each indicator of creative thinking also showed low results. The indicators of creative thinking along with the scores obtained were as follows: (1) flexibility (18.75), (2) originality (12.05), (3) elaboration (16.28), and (4) fluency (15.90).

Science teaching in Indonesia mostly focuses on memorizing science concepts (Baskoro, Corebima, Susilo, Zubaidah, & Ramli, 2017). Science learning should put more emphasis on students' activities through inquiry (Harris & Rooks, 2010; Olson & Horsley, 2000; Ozdemir & Isik, 2015; Wyatt, 2005) and provide opportunities for students to develop their creative thinking skills (Davis, Sumara, & Luce-Kaper, 2000). The inquiry learning model is considered to be the most basic and widely used for encouraging creative thinking skills in science learning (Johnson, 2000; Kind & Kind, 2007; Meador, 2003). This was also supported by various researches, which have proven that inquiry learning can train students' creative thinking skills (Michalopoulou, 2014; Nurhadi et al., 2016).

Many sources explain the stages of inquiry learning, one of which is Llewellyn (2011); it mentions the following stages: (1) inquisition, starting with a question to be investigated; (2) acquisition, brainstorming the possible answers; (3) supposition, selecting a statement to be tested; (4) implementation, designing a plan; (5) summation, gathering evidence and drawing conclusions; and (6) Exhibition, sharing and communicating results or findings.

Llwellyn (2013) divides inquiry into four levels. The levels are differentiated by the amount of teacher intervention toward the students or based on the amount of guidance given by teachers to their students. Level 1 is demonstrated inquiry where the role of the teacher is to provide the problems, to plan the procedures, and to analyze the results. Level 2 is structured inquiry where the role of the teachers is to provide the problems and to plan the procedures while the students analyze the results. Level 3 is guided inquiry where the role of the teacher is only to provide the problems, while the students plan the procedures and analyze the results. Level 4 is self-directed inquiry where the students carry out all the activities, from providing the problems to planning procedures, to analyzing the results.

In practice in the classroom, the implementation of one level of inquiry sometimes encountered obstacles because each student in the class was different. Diversity is related to readiness, interest, learning style, and speed in receiving and processing information. In science learning, teachers usually select one type of inquiry model to be applied to all students for a particular topic. In fact, the implementation of one type of inquiry in one class has a disadvantage, which is not accommodating students' development levels. It means that if the teachers applied inquiry level 4, students having low ability would find it difficult to follow the lesson well. Conversely, if the teacher applied inquiry level 1, students having high ability would quickly get bored because it would be too easy for them. Therefore, a learning model that accommodates such diversity is very necessary.

DI (Differentiated Instruction) based-learning, developed by Llwellyn (2011) for science learning, can basically be used to cope with the diversity of students in the classroom. It is based on the reality that teachers usually choose one level of inquiry to be applied to all students for a particular topic. In fact, each level has its own advantages and disadvantages. For this reason, the Differentiated Science Inquiry (DSI) model which applies different types of inquiry according to students' needs, is introduced.

In DSI learning, the class is divided into four major groups based on students' abilities, from lower ability to higher ability. At level 1 (demonstrated inquiry), the teacher provides the problems, planning procedures, and analyzes the results. At level 2 (structured inquiry), the teacher provides problems and planning procedures while analyzing the results is by students. At level 3 (guided inquiry), the teacher provides only problems while the planning procedures and analysis of results are by students. At level 4 (self-directed inquiry), the students conduct all the activities, ranging from providing problems, planning procedures, and analyzing the results (Fuad, Zubaidah, Mahanal, & Suarsini, 2017).

Through the implementation of DSI learning, it is expected that each student will get the same opportunities for development (Llwellyn, 2011). The same opportunities to develop will be achieved if students receive instructions in accordance with the level of their readiness, interests, and learning styles so that it enables them to maximize their ability (Tomlinson, 2001). In DSI learning, the classes are divided into four major groups or posts or stations. This division is based on the level of students' readiness, interests, and learning styles. The learning given to each group represents the level of inquiry.

In addition to inquiry, to train creative thinking skills, mind map-assisted learning needs to be developed (Keles, 2012). In science learning, the mind map has been widely recommended and used in various ways to help teachers and students develop organized knowledge bases on particular topics at the intermediate level (Ritchie & Volkl, 2000). Mind maps can be integrated with other techniques that have the constructivist approach philosophy. This technique relies on images and the relationship with one another through the use of pictures, words, numbers, logic, and color to become a unique way. Mind map is a technique that stimulates the left brain and the right brain and makes visible the process of thinking, gives the big picture and details of something at the same time, makes it easy to

manage and understand the information effectively and systematically, improves the ability to think creatively and innovatively, and improves retention (Buzan, 2002).

A study by Al-Jarf (2009) showed that the mind map was a powerful technique for improving students' abilities to generate, visualize, and organize ideas. The students involved in the study stated that the mind map encouraged their creative thinking, and they could generate and organize ideas for writing faster. Mind map is also a tool that converts tacit knowledge into explicit knowledge. For instance, by reading particular lesson materials, students learn from the book or other resources, and then, constructing a mind map, students convert their tacit knowledge into explicit knowledge in their mind map (Handoko, Nursanti, Harmanto, & Sutriyono, 2016). The mind map can be integrated with a variety of learning models with the aim of encouraging students' abilities to explore the relationships between information and stimulating students to think creatively (Davis et al., 2000). The teachers also believe that the mind map can enhance students' creative thinking (Keles, 2010; Seyihoglu & Kartal, 2010; Weinstein, 2014). In relation to science learning, the mind map is a learning tool that can be used to help students learn science (Steyn & Boer, 1998).

In addition to the diversity of students in terms of readiness, interest, and learning style, diversity can also be in terms of gender. Gender is a general term referring to both male and female (Fin & Isaac, 2012). Gender is a grammatical classification of nouns that generally have two sexes. The word "gender" is derived from the English language; gender means "sex." Gender refers to the psychological and socio-cultural dimensions, male and female. Gender is related to how males and females think, act, and feel (Santrock, 2011).

Various studies related to the correlation between gender and creative thinking skills had different results. Some claimed that gender did not give a significant difference to creative thinking skills (Baer & Kaufman, 2008; Bakir & Oztekin, 2014; Charyton & Snelbecker, 2007; Kaufman, 2006; Potur & Barkul, 2009; Tsai, 2013). A study in Pontianak, Indonesia, revealed that there were no differences in students' creative thinking skills related to gender either for the students taught using problem-solving learning models or students taught using conventional learning (Hodiyanto, 2014). However, some other studies revealed that gender gave a difference in creative thinking skills (Hoff, 2005; Matud, Rodriguez, & Grande, 2007).

Various researches revealing the significance of gender for creative thinking skills are divided into two different groups. One group of researchers states that males are more creative than females (Proudfoot, 2015; Singh, 2014; Stoltzfus, Nibbelink, Vredenburg, & Thyrum, 2011). Another group of researchers reveals the opposite—that females are able to think more creatively than males (Reuter et al., 2005; Wolfradt & Pretz, 2001).

Male students had significantly higher creative thinking skills than female students (He, Wong, Li, & Xu, 2013; Stoltzfus et al., 2011). This difference is because men are more interested in science, engineering, and technology compared with women (Baer, 1997). Another opinion stated that men tended to show more dominance of the area of the brain associated with cognition of semantics and decision-making, while women showed more dominance in language processing and social perception. Furthermore, when they think divergently, the area associated with declarative memory tends to actively work in men. It was also reported that there was no difference in concept understanding between men and women. The difference lies in the problem-solving ability. Males have a better problem-solving ability than females (Gok, 2014). Problem solving is closely related to creative thinking skills.

The physical difference between males and females can be seen in their brain anatomy that affects the patterns of learning and activities of the human brain (Gurian, Stevens, & Patricia, 2010). The male brain tends to grow and to have more complex spatial abilities such as mechanical design, measurement, orientation, abstraction, and the manipulation of physical

objects. The area of the cerebral cortex in males performs more on the spatial functions and tends to give a little portion to produce and process words. The set of nerves that connects the left–right brain or corpus callosum in the male brain is a quarter smaller than that in the female brain. The female brain can use both sides of the brain well; in contrast, the male brain tends to be able to use the right hemisphere of the brain maximally (Hines, 2004). The right brain is involved in imagination and creative thinking.

Based on the opinions and the results of research on creative thinking, it seems that there is a difference in creative thinking skills, which is affected by learning models and gender. Therefore, it is necessary to conduct a research, especially on science subjects, that aims to investigate (1) the differences in the creative thinking skills of students who are given three different science learning models, i.e., the differentiated science inquiry combined with mind map (DSIMM), the differentiated science inquiry (DSI), and the conventional model; (2) the differences in creative thinking skills between male and female students; and (3) the differences in creative thinking skills as a result of the interaction between learning models and gender.

## METHODS

### a) General Background of Research

This research was a quasi-experimental research, which used a pretest–posttest nonequivalent control group design. The independent variables of this research were the learning models (DSI, DSIMM, and conventional) and gender (male and female), while the dependent variables were students' creative thinking skills. The design of this quasi-experimental research is presented in Table 1.

**Table 1.** *Quasi-experimental research design*

Pretest	Group	Posttest
O <sub>1</sub>	X <sub>1</sub> G <sub>1</sub>	O <sub>2</sub>
O <sub>1</sub>	X <sub>1</sub> G <sub>2</sub>	O <sub>2</sub>
O <sub>1</sub>	X <sub>2</sub> G <sub>1</sub>	O <sub>2</sub>
O <sub>1</sub>	X <sub>2</sub> G <sub>2</sub>	O <sub>2</sub>
O <sub>1</sub>	C G <sub>1</sub>	O <sub>2</sub>
O <sub>1</sub>	C G <sub>2</sub>	O <sub>2</sub>

X<sub>1</sub> = DSIMM model, X<sub>2</sub> = DSI model, G<sub>1</sub> = Male, G<sub>2</sub> = Female, C = Conventional, O<sub>1</sub> = Pretest scores, O<sub>2</sub> = Posttest scores.

### b) Sample of Research

The population used in this research was all 7<sup>th</sup> grade students of junior high schools (JHS) in Kediri, Indonesia. The population spread across 51 schools. Three schools were randomly selected as the sample. An equality test was conducted on the chosen schools. Three research classes were randomly selected from the equal classes. The selected samples were students of JHS 2 Puncu, who were the control group and were treated using the conventional model. The experimental groups were the students of JHS 1 Ngadiluwih, treated using the DSI model, and the students of JHS 1 Papar, treated using the DSIMM model. Each class was assigned 32 students so that the total number of the research's samples was 96 students (Nfemale = 48; Nmale = 48). In each treatment class, the students were divided into eight groups based on the sequence of the pretest scores, from the lowest to the highest. Each group consisted of four students. The two lowest groups were given structured inquiry worksheets. The two highest groups were given self-directed inquiry worksheets, and the middle four groups were given guided inquiry worksheets.

Learning in a conventional class uses methods that are generally applied by teachers in Kediri, Indonesia. The methods are lectures, discussions, question and answer, and doing the student's worksheets. In the DSI class, learning is done by applying the DSI model with syntax inquisition, acquisition, supposition, implementation, summation, and exhibition. The class is divided into three major groups according to the students' abilities. In each group, only one level of inquiry is applied. The higher the students' abilities, the higher the level applied. Learning in the DSIMM class, in principle, is the same as in the DSI class. The difference is that in each syntax inquiry, the mind map technique is inserted. Thus, at the end of each learning activity, students present the topic that has been studied using a mind map that has been developed.

The subject in this study was science. The teaching material applied in the study covers the following: observing objects, microscope, laboratory safety, characteristics of living things, and the classification of living things.

### *c) Instruments and Procedures*

Instruments used in this learning activity included the syllabus, lesson plans, student worksheets, and test items. The instruments had been previously validated by two experts/science education experts and two education practitioners (science teachers). The validation was done by giving scores to each component on the validation sheet with the score range of 1–4. A score of 1 indicated “not valid,” 2 indicated “less valid,” 3 indicated “valid,” and 4 indicated “very valid.” The data analysis of the validation results was done by calculating the average scores from the experts and practitioners. The results of the validation showed the following scores: 3.72 (valid) for the syllabus, 3.67 (valid) for the lesson plan, 3.70 (valid) for the students' worksheet, and 3.95 (very valid) for the test items.

Reliability test was also performed for the essay test instrument for creative thinking skills. The reliability test involved 96 students who were asked to finish 12 questions that had previously been validated. The score of the 96 students was then tested using Cronbach's alpha with Statistical Package for the Social Sciences (SPSS) 23.0 for Windows. The reliability test showed that the score was 0.986 (very high reliability, acceptable).

The test instruments of creative thinking skills that were valid and reliable were used for collecting data on creative thinking skills. Data collection was done twice, pretest and posttest, on all three learning models. The scoring rubric was modified from Treffinger et al. (2002), with a range of 0–4. The scoring rubric was developed from each indicator of creative thinking skills. The scoring rubric of creative thinking skills is presented in Table 2. Data were analyzed using multiple regression to test the correlation between predictor and criterion using SPSS 23.0 for Windows.

This modified assessment was used to test students' creative thinking skills using an essay test. The format of the assessment was arranged based on many considerations, including the form of test often used by educators in Indonesia.

**Table 2.** *Scoring rubric of creative thinking skills*

Indicator	Criteria	Score
Fluency	Mentioning/writing five or more ideas, suggestions or different alternative answers	4
	Mentioning/writing three ideas, suggestions or different alternative answers	3
	Mentioning/writing some ideas, suggestions or alternative answers that are not very different	2
	Mentioning/writing one idea, suggestion, or alternative answer	1
	Not answering or giving a wrong answer	0
Originality	Mentioning/writing several interesting unique ideas that are logical, relatively new and relevant to the given problem	4
	Mentioning/writing several interesting unique ideas that are logical, relatively new, but not quite relevant to the given problem	3
	Mentioning/writing quite interesting unique ideas that are quite logical, relatively new and quite relevant to the given problem	2
	Mentioning/writing an ordinary idea that is logical and relevant to the given problem	1
	Not answering or giving a wrong answer	0
Elaboration	Explaining several logical details of an existing idea, so that the formulation of the idea becomes clearer and can be applied more easily	4
	Explaining one logical detail of an existing idea, so that the formulation of the idea becomes clearer and can be applied more easily	3
	Giving several logical details of an existing idea, but not quite relevant with the concept of the main idea, so that not making the idea becomes clearer	2
	Not adding any details of an existing idea, so that the formulation of the idea cannot be applied well	1
	Not answering or giving a wrong answer	0
Flexibility	Writing several alternative answers that are very logical and relevant to the given problem from different points of view	4
	Writing a few alternative answers that are quite logical and relevant to the given problem from different points of view	3
	Writing several alternative answers that are quite logical but less relevant to the given problem from different points of view	2
	Writing one alternative answer that is quite logical and relevant to the given problem with only one point of view	1
	Not answering or giving a wrong answer	0
Metaphorical thinking	Combining several ideas, modifying, and explaining the formulation of the ideas using a logical and coherent analogy	4
	Combining several ideas, modifying, but less able to explain the formulation of ideas using a logical and coherent analogy	3
	Combining several relevant ideas but not explaining the formulation of ideas using a logical analogy	2
	Less able to combine relevant ideas so that they become coherent as a whole	1
	Not answering or giving a wrong answer	0

Modified from Treffinger et al. (2002).

#### d) Data Analysis

The pretest and posttest scores of creative thinking were converted into a range of 0–100. Then, normality and homogeneity tests were performed on the data. Hypothesis testing was done on the condition that data distribution was normal and homogeneous. Analysis of covariate (ANCOVA) was performed to analyze (1) the differences in creative thinking skills between students taught using three different learning models: DSI, DSIMM, and the conventional model; (2) the differences in creative thinking skills between males and females; and (3) the differences in creative thinking skills as a result of the interaction between the learning models and gender. If there was a difference, a post hoc least significant difference (LSD) test was conducted to determine whether there was a statistically significant mean difference.

## RESULTS OF RESEARCH

The data obtained from the creative thinking skill test were analyzed using SPSS 23.0 for Windows. The analysis was preceded by a normality test using one-sample Kolmogorov–Smirnov test and a homogeneity test using Levene’s test of equality of error variances. The summary of the normality and homogeneity can be seen in Table 3.

**Table 3.** Summary of normality and homogeneity tests

Data group	Normality		Homogeneity	
	N	Sig.	Levene’s test	Sig.
Pretest of creative thinking	96	0.524	1.803	0.120
Posttest of creative thinking	96	0.430	1.480	0.204

Table 3 shows that the data have normal distribution and the data group has homogeneous variants (sig of normality and homogeneity > 0.05). Based on these prerequisite tests, the data can be further analyzed using ANCOVA. The results of the ANCOVA analysis regarding creative thinking skills based on the learning models and gender are shown in Table 4.

**Table 4.** Summary of ANCOVA test results

Source	df	Mean square	F	Sig.
Pretest creative thinking	1	1527.675	87.008	0.000
Learning models	2	1237.577	70.486	0.000
Gender	1	83.314	4.745	0.032
Learning models * Gender	2	2.706	0.154	0.857
Error	89	17.558		
Total	96			
Corrected total	95			

The results of the ANCOVA test on the learning models as shown in Table 4 found that the value of  $F = 70.486$  with a significance value of 0.000 ( $p < 0.05$ ). It means that there was a difference in the creative thinking skills among the students treated with the three different learning models. Furthermore, to determine whether there was a statistically significant difference, a post hoc analysis using LSD was conducted for the learning models. The results of the LSD test for the learning models are presented in Table 5.

**Table 5.** The results of the LSD test based on learning models

Learning model	Pretest	Posttest	Difference	Corrected	Notation
Conventional	24.94	67.06	42.12	66.19	a
DSI	22.53	75.33	52.80	75.85	b
DSIMM	22.85	77.66	54.80	77.99	c

The results of the LSD test in Table 5 show that there was a difference in the mean score of creative thinking skills based on the learning models. Based on the notation, the students taught using DSIMM achieved the highest score for creative thinking skills, and it was significantly different from the other groups. The students taught using the DSI learning model achieved a higher creative thinking skills score that was significantly different from the students taught using the conventional model. The students taught using the conventional

model achieved the lowest creative thinking skills score, and this was significantly different from the other groups.

Based on the results of the ANCOVA based on gender as shown in Table 4, the value of  $F = 4.745$  with a significance value of  $0.000$  ( $p < 0.05$ ). It means that  $H_0$  was rejected and  $H_a$  was accepted. Thus, there was a difference in the creative thinking skills between male students and female students. Furthermore, to determine whether there was a statistically significant difference, the LSD was performed for gender. The results of the LSD test related to gender are presented in Table 6.

**Table 6.** *The comparison of mean score of creative thinking skills in terms of gender*

Gender	Pretest	Posttest	Difference	Corrected	Notation
Female	24.05	72.76	48.72	72.41	a
Male	22.83	73.93	51.10	74.28	b

The results of the LSD test in Table 6 show that there was a significant difference in the mean score of creative thinking skills between male students and female students. The male students achieved a higher creative thinking skills score than the female students, and it was significantly different.

The results of the ANCOVA test on the interaction between the learning models and gender, as presented in Table 3, found that the value of  $F = 0.154$  with a significance value of  $0.857$  ( $p \geq 0.05$ ). It means that  $H_0$  was accepted and  $H_a$  was rejected. Thus, there was no difference in students' creative thinking skills as a result of the interaction between the learning models and gender.

## DISCUSSION

The results of the research revealed that there was a score difference in creative thinking skills for different learning models. The students taught using DSI achieved higher creative thinking skills than those taught using the conventional model, and the students taught using the DSIMM model achieved the highest creative skills of all the learning models. The results of this research are in line with previous research findings, proving that the implementation of the inquiry model and the use of mind mapping in learning improved creative thinking skills (Al-Jarf, 2009; Keles, 2010; Michalopoulou, 2014; Seyihoglu & Kartal, 2010; Weinstein, 2014).

The inquiry learning model implemented in this research class was proven to significantly contribute to the improvement of the creative thinking skill score. The results of this research, which are consistent with the research by Michalopoulou (2014), revealed that through inquiry students can express their ideas and feelings in various ways and can have fun learning. The opportunity to express ideas in a variety of ways and fun learning conditions are the basis for the development of five aspects of students' creative thinking skills, i.e., (1) fluency, (2) flexibility, (3) originality, (4) elaboration, and (5) metaphorical thinking.

Llewellyn (2013) also recommended implementing inquiry learning so that students are actively involved in the process of exploring and empowering their thinking ability. Through inquiry, students have many opportunities to generate and discuss ideas, make plans, brainstorm, find solutions, give arguments, satisfy curiosity, and develop creativity (Michalopoulou, 2008). This is in contrast to conventional learning where students tended to learn individually and were more passive in receiving information from the teacher or just working on the students' worksheet (Listiana, Susilo, Suwono, & Suarsini, 2016).

Conventional teaching is concerned with the teacher being the controller of the learning environment (Aktamis, Higde, & Ozden, 2016). This was what caused the students' creative thinking skills in the conventional class to be low.

The contribution of the inquiry learning model toward the improvement of students' creative thinking skills was also through the syntax of inquiry learning, which is in line with the nature of empowerment of creative thinking skills. Michalopoulou (2014) stated that the investigation activities formed the basis of inquiry learning. The investigation involves efforts by the students, either individually or in groups, to find the answers to the questions or problems with or without guidance from the teachers. The activities of collecting information; exploring the surroundings; observing forms, colors, movements, natural phenomena, and events; comparing; recognizing nature; listening; testing samples; smelling; touching; conducting experiments to test ideas, hypotheses, and questions that arise during hands-on activities; and having group discussions will encourage students' creative expression and affect their competence of creative problem solving (Christidou, 2008). In addition, learning inquiry that is properly implemented can make students active in the classroom, provide opportunities for students to learn the material through the exploration of questions and by learning how to develop hypotheses, help students learn in an enjoyable manner, help them obtain depth regarding the concept of a material, and help them use higher order thinking, including creative thinking (Lane, 2007).

The subjects of this research were junior high school students whose age ranged from 12 to 15 years. According to the level of cognitive development by Piaget, students were at the formal operational stage; at this stage, students are able to think abstractly and logically and can analyze in combination and give some possible solutions to problems (Cook & Cook, 2005; Slavin, 2006). However, students' abilities to think logically and abstractly differed in speed. The ease for the students to access the curriculum should be appropriate for the students' abilities in the class of DSI contributed to these capabilities. Students having low skill were given more assistance with the worksheet. This assistance will be reduced in line with the higher ability of students. DSI learning allowed the students to develop and maximize their ability because all students were given easy access to the classroom curriculum that suited their needs.

The inquiry model is suitable for learning science in junior high school. A similar thing also occurred in this research. This was because science learning was related to ways of finding out nature systematically. Thus, science is not only about the mastery of knowledge in the form of a collection of facts, concepts, or principles but also about the process of discovery. Science education is expected to become a tool for students to learn about themselves and their environment as well as learn about prospects for further development for applying it in their daily lives. This reality is supported by the opinions of Minstrell and Zee (2000), who stated that inquiry learning is the basis for learning science because it provides students the opportunity to apply science as scientists do.

The combination of inquiry and mind map in learning science contributed highly to improving creative thinking skills. This was because integrating a mind map at each stage of inquiry would facilitate the students in managing and understanding information effectively and systematically. The ability to manage and understand information is key to achieving the five aspects of creative thinking.

Mind map is an ideal technique to train creative thinking skills. This is because mind map utilizes all the skills commonly associated with thinking, especially imagination, linking ideas, and flexibility. Based on these assumptions, learning using mind map is expected to map the students' minds and provoke their thinking in all directions and bring brilliant and creative ideas (Buzan, 2012). Long & Carlson (2011) suggested that the use of mind mapping helped students make connections between previous material information and the material

being studied. Wheeldon (2011) also revealed that respondents who used mind mapping could remember, organize, and frame the reflection of their past experience.

The implementation of mind map in this research was consistent with previous research by Keles (2010), Seyihoglu and Kartal (2010), and Weinstein (2014). The research by Al-Jarf (2009) proved that mind map was a powerful approach to improve students' abilities to generate, visualize, and organize ideas. The students involved in his research stated that mind maps encouraged creative thinking, and they became faster in generating and organizing ideas for writing. The ability to generate and organize ideas is an important part of creative thinking (Treffinger et al., 2002). It is supported by Zip and Maher (2013), who said that the use of different colors and patterns of lines in mind maps is an effective means for students to express themselves creatively.

In addition to the learning models, gender differences also contributed to the differences in students' creative thinking skills. The results of this research indicate that there is a difference in creative thinking skills between male and female students. Thus, the results of this research support the previous research that stated that there was a difference in creative thinking skills in terms of gender (He & Wong, 2011; Hoff, 2005; Matud et al., 2007). However, these results are not in line with the previous studies that stated that gender did not give a significant difference to creative thinking skills (Baer & Kaufman, 2008; Bakir & Oztekin, 2014; Charyton & Snelbecker, 2007; Kaufman, 2006; Potur & Barkul, 2009; Tsai, 2013).

This research revealed that male students had significantly higher creative thinking skills compared with female students. These results are consistent with previous researches (Proudfoot, 2015; Singh, 2014; Stoltzfus et al., 2011). However, these are different from the other studies (Reuter et al., 2005; Wolfradt & Pretz, 2001).

Differences in creative thinking skills in science learning are because males are more interested in science than females (Baer, 1997). In addition, males have a better ability to solve problems and making decisions compared with females (Gok, 2014), which is also a reason why males are more creative than females.

Gurian et al. (2010) stated that the differences between males and females can be seen from the differences in their brain anatomy. The differences in brain anatomy affect students in determining their learning patterns and activities. The parts of the brain that are responsible for the ability of abstraction as parts of creative thinking are also more developed in males rather than in females. In addition, males are able to maximize the right brain that plays a role in the creative thinking ability (Hines, 2004).

Although there was a difference in students' creative thinking skills for the different learning models and gender, the interaction between the learning models and gender did not indicate any difference in creative thinking skills. It means that for each class taught using a specific learning model, between males and females no significant difference in creative thinking skills was shown.

Based on the results of this research, the researcher recommends implementing DSIMM, especially for the science subject, to train students' creative thinking skills. This creative thinking skill needs to be trained because it is one of the key skills required in the 21<sup>st</sup> century. In fact, students' creative thinking skills need to be trained through learning from an early age.

## CONCLUSIONS

The results of this research support the theory and the previous research that state that there is a difference in creative thinking skills between learning models and gender. The students who received DSIMM learning had the highest creative thinking skill. Overall, male

students are more creative than female students. These differences can be observed from the anatomy of the brain that affects the learning patterns and activities of the human brain. In males, the brain tends to grow and have more complex spatial. Males also tend to be able to maximally use the right hemisphere that plays a role in imagination and creative thinking.

This research was limited to the subject of science in junior high school. The research may be continued on the subject of science or other subjects at the elementary school or senior high school level. Future research can also focus on other thinking skills, such as problem solving and metacognition, among others.

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