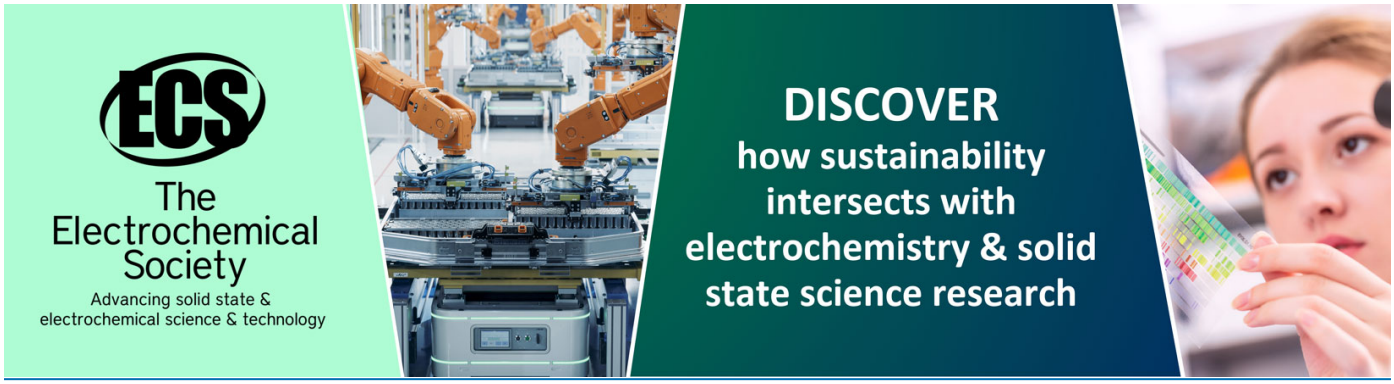
Guided inquiry learning model effectiveness in improving students' creative thinking skills in science learning



Guided inquiry learning model effectiveness in improving students' creative thinking skills in science learning

I N Suardana, K Selamet, A A I A R Sudiatmika, P Sarini[1], N L P L Devi

Science Department of Education, Mathematics and Science Faculty, Ganesha University of Education, Indonesia

*nyoman.suardana@undiksha.ac.id

Abstract. This study was aimed at analyzing the effectiveness of guided inquiry learning model in improving students' creative thinking skills in science learning. It was a quasi-experimental research with nonequivalent pretest-posttest control group design. The population was the eighth-grade students in secondary school. The sample included 54 students; 26 students in the experimental group and 26 students in the control group. The students in the experimental group learned through guided inquiry learning model, whereas the ones in the control group learning through direct instruction model. The data on students' creative thinking skills were collected through the creative thinking skills test. The data were analyzed through descriptively and inferential analysis, namely the independent sample t-test with 5% significance level. The results showed that guided inquiry learning model more effective than direct instruction model in improving students' creative thinking skills. The average score of students' creative thinking skills in experimental and control groups were 90.0 and 79.4 respectively.

1. Introduction

The 21st century education paradigm for Indonesian students at this time is really not negotiable considering the world is now in the industrial revolution 4.0 era. It's also referred to as an era of disruption shown by the emergence of fundamental changes in the fields of technology, economics, industry, and other fields. These changes are very massive, create uncertainty or unpredict about the future and ultimately can change people's life systems instantly. For this reason, students as next generation as well as human resources are the hope of the Indonesian Nation must be prepared to become graduates who have 21st century skills so that they will be ready to face various forms of life challenges in the industrial revolution 4.0 era. One of the important competencies of 21st century skills, namely creative thinking skills [1]. Creative thinking skills show someone's creativity and creativity are important aspects in the development of human resources [2]. Creative thinking skills in the context of learning not only in the field of art and science but also more in the ability to create ideas in everyday problem-solving. In problem-solving, creative thinking skills will enable someone to think flexibly. The cognitive flexibility provides us with the capacity to deal with the opportunities and changes that are part of our complex and the fast-changing world [1].

There are many ways to practice and improve students' creative thinking skills, especially in science subjects. Based on the results of previous research studies, the implementation learning model is a way that can be chosen to practice creative thinking skills in students. Even in the 2013-

Curriculum on actually a number of learning standards have been set that require teachers to design, implement and evaluate learning processes that can empower students' higher-order thinking skills in which creative thinking skills are one of them.

Indonesian students' creative thinking skills according to the facts on the field show a level that has not been so encouraging. Retnosari, Susilo and Suwono (2016) in their research about the initial study of students' critical thinking and creative thinking skills [3]. The results are eleventh-grade students high school in three public schools in Bojonegoro District, they have low-grade critical thinking skills and students' creative thinking skills are only good on fluence aspect. Other aspects such as flexibility, originality, and elaboration are still low. Armandita, Wijayanto, Rofiatus, Susanti, and Rumiana (2017) in their research about the analysis of the ability to think creatively in physics learning found that the creative thinking skills of eleventh-grade MIA 3 students of SMAN 11 Jambi City belonged to the medium category [4]. Sugiyanto, Masykuri, and Muzzazinah (2018) in their research about the analysis of creative thinking skills in the eleventh grade students of Klaten District found that the initial creative thinking skills of students were at a low level both students in an accredited school A and students in accredited schools B [5]. These data simply indicate a possibility that students since studying at junior high school (*SMP*) have not been accustomed to developing the ability to think in learning especially creative thinking skills.

Johnson (2010) states that creative thinking skills require perseverance, self-discipline and full attention to mental activities which include (1) asking questions, (2) considering new information and unusual ideas with an open mind, (3) building linkages, (4) connect things freely, (5) apply imagination to every situation to produce new things and (6) pay attention to intuition [6]. However, it is unfortunate that some junior high school science teachers tend to choose and apply learning models that do not fully accommodate mental activities in creative thinking skills. As was done by one of the science teachers of SMPN Sukasada, where based on preliminary observations, the direct instruction model still dominates science learning activities. Some direct instruction model advantages in learning according to Killen (2007) such as (1) are effective in teaching factual and highly structured information, (2) suitable for teaching explicit concepts and skills to students with low cognitive abilities, (3) can be applied to small class and large class and (4) as a way to demonstrate [7]. However, if the direct instruction model is implemented on most of the material, and not on certain materials, this model will show some weaknesses. These weaknesses include (1) causing boredom if learning is not well organized, (2) teacher-centered learning and little opportunity for students to develop certain skills one of them is thinking skills, (3) has a negative impact on students who have problem solving skills, independence and curiosity [7], (4) only a little material can be mastered by students if the teacher tends to implement one-way communication (lecture) and (5) the opportunity for students to explore in depth about the material very limited because the material has been presented final by the teacher. Some theoretical weaknesses and the fact that the direct instruction model is still being used is strongly suspected to be the cause of not yet the maximum creative thinking skills of junior high school students. It is quite apparent that there is no mental activity that can be facilitated by the direct instruction model to develop students' creative thinking skills.

The solution of these problems is to consider one constructivist-based learning model which in the learning syntax can facilitate mental activities that are able to develop students' creative thinking skills. The model is the guided inquiry learning model as one of the types of inquiry-based learning. Inquiry-based learning is a process where students are involved in their learning, formulate questions, investigate widely and then build new understandings, meanings, and knowledge. That knowledge is new to the students and may be used to answer a question, to develop a solution or to support a position or point of view [8]. The inquiry is a way of learning new skills and knowledge for understanding and creating in the midst of rapid technological change [9]. Specifically, guided inquiry learning model based on the guided inquiry lab starts with clearly defined problems by teachers. After that, students are provided with some questions leading them to carry out the experiments. Finding the relationship between force and acceleration could be an example of this type of inquiry [10]. In class, guided inquiry learning model steps are carried out in five phases as presented in Table 1 [11].

Table 1. The phase of inquiry-based learning and their definitions

Phase	Definition
Orientation	Stimulating curiosity about a topic and coming up with a problem statement
Conceptualization	Stating theory-based questions and hypotheses
Investigation	Planning an experimentation and collecting and analysing data from the experiments
Conclusion	Drawing conclusions from the data and comparing them with the research questions or hypotheses
Discussion	Presenting findings by communicating with others and/or reflecting on the whole process or its phases

In guided inquiry learning models, phase orientation is fully controlled by teachers especially in terms of determining learning topics, materials for inquiry processes and processes to stimulate students' interest and motivation to learn.

2. Method

This research used the quasi-experimental method with nonequivalent pretest-posttest control group design. The population of this research included the eighth-grade students in SMPN 3 Sukasada-Bali, Indonesia. The sample was collected using the cluster random sampling. The sample included 54 students; 26 students in the experimental group (EG) and 26 students in the control group (CG). The students in the EG learned through the guided inquiry model and the students in the CG learned through the direct instruction model. This research was conducted in the even semester on academic year 2017/2018. Before the learning, both of groups were given a pretest to know the pre-knowledge of students. The pretest score was analyzed by the independent sample t-test with a 5% significance level to know what both groups had the same pre-knowledge or not. The main data of this research were the scores of the students' creative thinking skills, which were collected using the creative thinking skills test; 20 items of essay test. The creative thinking skills test was developed from Torrance Indicators. The data were analyzed descriptively and inferential analysis, namely: the independent sample t-test with a 5% significance level. The normality of data distribution was tested using the Kolmogorov-Smirnov Test. The homogeneity of variance data was tested using the Levene's Test of Equality of Error Variances.

3. Findings

Before learning, both groups of students were given a pretest to know their pre-knowledge. The normality of the data distribution of the pre-knowledge of the students in the experimental group and control group were tested using the Kolmogorov-Smirnov Test. The homogeneity of variance data was tested using the Levene's Test of Equality of Error Variances. The pretest score and the result of normality, as well as homogeneity test, are shown in Table 2.

Table 2. The pretest score and the result of normality and homogeneity test

Group of Data	Normality			Homogeneity	
	N	Score	Sig	Levene Statistic	Sig
1. Experimental Group	26	39.6	39.6	0.120	0.731
2. Control Group	26	38.7	0.200		

Based on Table 2, the data on the score of the students' pre-knowledge of the experimental and control are normally distributed (sig normality > 0.05) and homogeneous (sig homogeneity > 0.05). These

data are relevant to be analysed using the independent sample t-test. The summary of the result of analysis using the independent sample t-test is shown in Table 3.

Table 3. The summary of the result of Independent Sample T-Test

Description	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	,120	,731	,732	50	,468	,88462	1,20848	-1,54268	3,31191
Equal variances not assumed			,732	49,965	,468	,88462	1,20848	-1,54272	3,31195

Based on Table 3, the value of sig is 0.731 > 0.05, meaning that the pre-knowledge of the students in experiment group is not significantly different from those of the control group so both groups had the same pre-knowledge.

The main data of this research were the scores of the students' creative thinking skills, which were collected using the creative thinking skills test. The average score of creative thinking skills of the students who learned through the guided inquiry model and direct instruction model were 90.0 (very good category) and 79.4 (good category) respectively. The distribution of the students' creative thinking skills is shown in Table 4.

Table 4. The Distribution of students' creative thinking skills

No	The Score of Creative Thinking Skills	EG	CG
1	Sum of Samples (N)	26	26
2	Mean	90.0	79.4
3	Standard Deviation	8.3	6.9
4	Minimum	74.7	68.0
5	Maximum	98.7	94.7

The normality of the data distribution of the creative thinking skills of the students in the experimental group and control group were tested using the Kolmogorov-Smirnov Test. The homogeneity of variance data was tested using the Levene's Test of Equality of Error Variances. The summary of the result of the normality and homogeneity test are shown in Table 5.

Table 5. The summary of the result of normality and homogeneity test

Group of Data	Normality		Homogeneity	
	N	Sig	Levene Statistic	Sig
3. Experimental Group	26	0.100	1.765	0.190
4. Control Group	26	0.200		

Based on Table 5, the data on the score of the students' creative thinking skills of the experimental and control are normally distributed (sig normality > 0.05) and homogeneous (sig homogeneity > 0.05). These data are relevant to be analysed using the independent sample t-test. The summary of the result of analysis using the independent sample t-test is shown in Table 6.

Table 6. The summary of the result of Independent Sample T-Test

Description	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1,765	,190	-4,992	50	,000	-10,57692	2,11890	-14,83286	-6,32098
Equal variances not assumed			-4,992	48,431	,000	-10,57692	2,11890	-14,83628	-6,31756

Based on Table 6, the value of sig is 0.000 < 0.05, meaning that the creative thinking skills of students who learned through guided inquiry model are significantly different from those of the students who learned through the direct instruction model. The creative thinking skills of the students who learned through the guided inquiry model are better than those of the students who learned through the direct instruction model. On the other word, the guided inquiry learning model is effective in improving creative thinking skills compared to the direct instruction model in science learning.

There are four indicators of creative thinking skills of the students, that are: fluency, flexibility, originality, and elaboration. The score of creative thinking skills of students in experiment and control groups are shown in Table 7.

Table 7. The Creative Thinking Skills Score of Students in Experiment and Control Groups

No.	Creative Thinking Skills Indicator	Score	
		Experiment Group	Control Group
1	Fluency	94.9	84.1
2	Flexibility	90.5	83.3
3	Originality	85.3	80.8
4	Elaboration	86.6	72.0

Based on Table 7, all of the creative thinking skills indicators of students in the experiment group better than the control group. The highest and the lowest scores of creative thinking skills indicators of students in experiment group are fluency and originality indicators respectively. On the other hand, the highest and the lowest scores of creative thinking skills indicators of students in the control group are fluency and elaboration indicators respectively.

4. Discussion

Based on statistical analysis of the data of creative thinking skills in two groups of students after implementing of the guided inquiry learning model in the experimental group and the direct instruction learning model in the control group, it was decided that the null hypothesis was rejected so it could be stated that creative thinking skills in the two groups of students differed significantly. Table 4 shows the average score of creative thinking skills in the experimental group is higher than the control group. Likewise, in Table 7 the comparison of two groups is seen from the average score of the creative thinking skills of each indicator. The four indicators of creative thinking skills in the experimental group were all higher than the control group. So the guided inquiry learning model effective to improving creative thinking skills in science learning.

The excellence of guided learning model in improving creative thinking skills because theoretically inquiry learning is the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information,

constructing models, debating with peers, and forming coherent arguments [12]. The whole process is a very good process for developing students' thinking skills especially for creative thinking skills and not fully accommodated in direct instruction learning model.

Empirically, the excellence of guide inquiry learning models in improving creative thinking skills can be seen from the contribution of each model syntax implemented through student worksheets. In the phase of orientation and conceptualization, the determination of the topic of inquiry by the teacher, the stimulation of curiosity, the formulation of hypotheses and the determination of basic theory become opportunities for students to practice fluency and flexibility skill aspects. When it starts to enter the investigation phase, the skills in the aspects of elaborating and originality begin to be trained in students because, in this phase requires students to think and plan an action to find a solution to the problems given by the teacher. These actions can be in the form of an experimental design or the unique idea design that is obtained after students conduct discussions and literature studies. Overall these four aspects are strengthened in the last two phases of inquiry learning, namely conclusions and discussions. At this stage, students are already in the process of solving problems by answering hypotheses based on investigations and communicating them to other students. Most of these processes are not accommodated in the direct instruction model because in this model, the material has been given and presented in a final and fixed manner to students. The results obtained in this study indicate conformity with the results of previous studies. Soltis, Verlinden, Kruger, Carrol, and Trumbo in their research found that the implementation of process-oriented guided inquiry learning models in pharmacy schools in pharmaceutical science subjects was superior in improving student performance, increasing higher thinking skills and provided and interactive class student settings compared than the implementation of traditional learning [13]. Nurhadi, Lukman, Abas, Erni, Yuliana, and Hamrina in their research concluded that the implementation of inquiry-based learning can improve the understanding of the concept of dynamic electricity and creative thinking skills in the experimental group of ninth-grade students of Kendari State 4 Junior High School [14]. This increase is better than the control group that applies conventional learning. Zubaidah, Fuad, Mahanal, and Suarsini in their research concluded that the creative thinking skills of ninth-grade students in Kediri, Indonesia increased better for students who applied inquiry learning integrated mind map than students who applied conventional learning [15].

There are two main findings that still need to be a further study in this research. The first finding is as follows. Although the increase in creative thinking skills of students in the evaluated experimental group was superior to the control group but in the experimental group had a higher variability (standard deviation) than the control group (Table 4). This shows that the variation of critical thinking skills between a student and his friends (the control group) tends to approach similarity compared to the experimental group students. In other words, in the experimental group, students' creative thinking skills tend to vary. It can be expected that this is caused by one of the internal factors in students, namely the variation in cognitive abilities. Second, the results of the achievement of creative thinking skills in the experimental group show the same thing as some of the previous studies, namely the highest aspect of fluence compared to other aspects. While the originality aspect which is also the main part of creative thinking skills occupies the lowest position compared to other creative thinking aspects (Table 7). This shows that in the fluency aspect, it tends to be easy to develop and be trained by students because it is in accordance with the definition, namely the process of collecting various ideas and answers based on observations or observations of various issues. While the originality aspect is actually the ability to produce a number of unique and unusual ideas and this idea is generated in connection with efforts to solve a problem. This aspect of ability seems to be the most difficult for students. So, the implication in learning is that students need longer duration or more meetings in mental activity in guided inquiry learning. In addition, efforts are made in learning, the most difficult aspects of creative thinking skills such as the ability to originality or produce a unique idea or plan to get a greater portion of learning.

5. Conclusion

Based on the results of the research (findings and discussion), it can be concluded that the guided inquiry learning model is effective in improving creative thinking skills compared to the direct instruction model in science learning. Suggestions for teachers, that creative thinking skills are important to be developed in students, especially when they are still studying at the junior high school level. Guided inquiry learning models can be considered as a model that can be implemented in the classroom to improve students' creative thinking skills. Suggestions for researchers and teachers, aspects of thinking skills that are considered the most difficult such as originality need to get a larger portion of science learning, especially in the presentation on student worksheets.

References

[1] Ritter, S. M. & Mostert, N. 2017. Enhancement of creative thinking skills using a cognitive-based creativity training. *Journal Cogn Enhac* 1: 253-253.

[2] Daud, A. M. D., Omar, J., Turiman, P. & Osman K. 2012. Creativity in science education. *Procedia – Social Behavioral Science* 59: 467-474.

[3] Retnosari, N., Susilo, H., & Suwono, H. 2016. Studi pendahuluan serta kemampuan awal keterampilan berpikir kritis dan berpikir kreatif siswa SMA Negeri di Bojonegoro. *Seminar Nasional Pendidikan dan Saintek 2016.*

[4] Armandita, P., Wijayanto, E., Rofiatus, L., Susanti, A. & Rumiana, S. 2017. Analysis the creative thinking skill of physics learning in class XI MIA 3 SMAN 11 Jambi City. Jurnal Penelitian Ilmu Pendidikan 10(2): 129-135.

[5] Sugiyanto, F. N., Masykuri & Muzzazinah. 2018. Analysis of senior high school students' creative thinking skills profile in Klaten regency. *International Conference on Science Education (ICoSEd)*: 1-5.

[6] Johnson, E. B. 2010. *Contextual teaching and learning: Menjadikan kegiatan belajar mengajar mengasyikan dan bermakna*. Bandung: Kaifa.

[7] Killen, R. 2006. *Effective teaching strategies: Lessons from research and practice*. South Melbourne: Cengage Learning Australia.

[8] Alberta Learning and Teaching Resources Branch. 2004. *Focus on Inquiry: A Teacher's guide to implementing inquiry-based learning*. Edmonton: Learning Resource Centre.

[9] Kuhlthau, C. C. 2010. Guided Inquiry: School libraries in the 21st Century. *School Libraries Worldwide* 16(1): 17-28.

[10] Kapucu, S. 2016. Guided Inquiry-based electricity experiments: Pre-service elementary science teachers' difficulties. *Journal of Education and Future* 10: 71-93.

[11] Lehtinen, A. 2017. Pre-service teachers and guided inquiry-based science teaching with simulations. Dissertation: University of Jyvaskyla.

[12] Vlassi, M., Karaliota, A. 2013. The comparison between guided inquiry and traditional teaching method. A case study for the teaching of the structure of matter to 8th grade Greek students. *Procedia-Social and Behavioral Science* 93: 494-497.

[13] Soltis, R., Verlinden, N., Kruger, N., Carrol, A. & Trumbo, T. 2015. Process-oriented guided inquiry learning strategy enhances students' higher-level thinking skills in a pharmaceutical sciences course. *American Journal of Pharmaceutical Education* 79 (1).

[14] Nurhadi, Lukman, Abas, R., Erni, Yuliana, & Hamrina. 2016. Implementation of inquiry-based learning to improve understanding the concept of electric dynamic and creative thinking skills (An empirical study in class IX Junior High School Students State 4 Kendari). *International Journal of Science and Research* 5(3): 471-479.

[15] Zubaidah, S., Fuad, N. M., Mahanal, S., & Suarsini, E. 2017. Improving creative thinking skills of students through differentiated science inquiry integrated with mind map. *Journal of Tourkish Science Education* 14(4): 77-91.