

THE EFFECT OF INDUCTIVE-DEDUCTIVE APPROACH ON STUDENTS' MATHEMATICAL CREATIVE THINKING ABILITY AND SELF EFFICACY

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Abstract

This research was a pre test-posttest experimental control group design having a goal to analyze the role of Inductive-Deductive Approach (IDA) on improving students' mathematical creative thinking ability (MCTA) and self efficacy (MSE). Subjects of this research were 70 eleventh grade students from two classes selected purposively in a Senior High School in Garut. Instruments of this research were a MCTA test, and a MSE scale. The research found that the role of IDA was greater than the role of scientific approach (SA) on improving students' MCTA and MSE. Students getting treatment with IDA approach obtained MCTA and MSE at good grades qualification. While students taught by SA attained MCTA and MSE at low-moderate grades level. Apart of those findings, the research found that students getting treatment with IDA encountered a little bit difficulty in solving MCTA tasks. In contrast students taught by SA experienced in almost items of MCTA tasks. In addition, the research also found there was no association between MCTA and MSE and students performed good and active learning during IDA lessons.

Keywords: Mathematical Creative Thinking, Mathematical Self-Efficacy, Eliciting Activities Model (IDA)

Abstrak

Penelitian ini merupakan penelitian pre test-posttest experimental control group design yang bertujuan untuk menganalisis peran Inductive-Deductive Approach (IDA) dalam meningkatkan kemampuan berpikir kreatif matematis (MCTA) dan self efficacy (MSE) siswa. Subjek penelitian ini adalah 70 siswa kelas sebelas dari dua kelas yang dipilih secara purposive di sebuah SMA di Garut. Instrumen penelitian ini adalah tes MCTA, dan skala MSE. Hasil penelitian menemukan bahwa peran IDA lebih besar daripada peran pendekatan saintifik (SA) dalam meningkatkan MCTA dan MSE siswa. Mahasiswa yang mendapat perlakuan dengan pendekatan IDA memperoleh MCTA dan MSE dengan kualifikasi nilai bagus. Sedangkan siswa yang diajar oleh SA mencapai MCTA dan MSE pada tingkat kelas rendah-sedang. Terlepas dari temuan tersebut, penelitian menemukan bahwa siswa yang mendapatkan pengobatan dengan IDA mengalami sedikit kesulitan dalam menyelesaikan tugas-tugas MCTA. Sebaliknya siswa yang diajar oleh SA berpengalaman di semua item tugas MCTA. Selain itu, penelitian juga menemukan tidak ada hubungan antara MCTA dan MSE dengan siswa melakukan pembelajaran yang baik dan aktif selama pembelajaran IDA.

Kata Kunci: Kemampuan Berpikir Kreatif Matematis, Matematika Self-Efficacy, Model Eliciting Activities (IDA)

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INTRODUCTION

Based on our experience on visiting to a Senior High School in Garut in 2018, we get interesting impression as follows (Mahmudin, Ratna, Susilawati, Reni, Mulyana, Mellyana, 2018). From the beginning of the lesson students were ready to learn in small groups. During the lesson's students performed positive activities such as learn new content and solve problems enthusiastically in student work sheets (Figure 1). When students encountered difficulty to solve problem, without hesitation they asked for teacher's help (Figure 2). As well as, when teacher asked students to present their work group, they confidently are willing to solve matrix and determinate problem in front of the class (Figure 3).



Figure 1. Students worked actively in small group discussion



Figure 2. Student explained solution of a tasks in SWS to other member of the group



Figure 3. Students presented their work voluntarily in front of the class

Those positive student's learning habit illustrated student's self-confidence that he is able to complete well the mathematical tasks in the student work sheet. The view of him that he is able to complete mathematical tasks illustrates positive behavior called mathematical self-efficacy (MSE). Canfields & Watkins (as cited in Miliyawati, 2010) propose that self-efficacy is a kind of behavior accompanied by discipline and effort wisely and intelligently. Some studies (Aziz, Rochmad, Wijayanti, 2015, Hidayat, Sabandar, Syaban, 2018) by using different teaching approaches found that students attained MSE at fairly good grade level.

Basically, mathematics teachers and researchers believe that mathematical creative thinking ability (MCTA) is an essential mathematics ability should be improved on senior high school students. There is a rational reason which support to that statement, namely the MCTA is enclosed on the goal of mathematics teaching that is: to improve the potency of students to become a critical, creative and innovative individual (Indonesian Mathematics Curriculum, 2013). Apart from that, the statement is in line with the opinion of Puccio and Murdock that creative thinking is part of life skills needed by people in everyday life especially in facing the rapid advancement of technology and information.

A well-known expert on creative thinking (Munandar, 1987), elaborates creative thinking as a process of thinking which contains: fluency, flexibility, originality, and elaboration processes. Further, Puccio and Murdock (as cited in Costa, ed., 2001) detail the creative thinking similar to Munandar's conception and covers: to compose excellent and different answers and questions (fluency), to distinguish relevant and irrelevant data, to generate many and different ideas (flexibility), to create new product or ideas or connection (originality), to modify old of thinking, mode and habit (elaborate), and to enlarge and to renew previous ideas (elaborate). Different with findings on MSE which classified at pretty good grade level, several recent studies (Damayanti, Sumarmo, Maya, 2018, Hendriana, Sumarmo, Carli., Ristiana, 2019, Ruhayat, & Sugandi, 2017, Wardani, Sumarmo, NISHITANI, 2011) found that students taught by ordinary teaching obtained MCTA grades at relatively unsatisfactory level (about 35% up to 50% out of the ideal score). In those studies, students' who get

innovative teaching approaches attained MCTA at higher grades than the grades of first groups students, but their grades were still at low to moderat quality. Those situations illustrated that MCTA problems were classified as difficult tasks for high school students. However, because of the importance of mastering MCTA by high school students, teacher should analyze teaching and learning variables that might play a role in improving student's MCTA.

Concerning mathematics teaching-learning, Kurikulum 2013 of Indonesia suggests that hard-skill for instance MCTA and softskill for example MSE should be improved accordingly and propotionally. Apart from that, Polya (1975) suggests that tobtained MCTAis not only to deliver teaching mathhematics content but the more important thing is to create a classroom atmosphere so that students can learn actively, express opinions in their own words, and encourage students to develop their thinking skills. Those suggestion, motivate researchers to seek teaching learning approach which can meet those expectations. Based on its steps of the learning process, researchers predicted that inductive-deductive approach (IDA) will comply both suggestions. Joyce, Weil and Calhoun (2000) propose that inductive and deductive approach (IDA) is an approach which begin with presentation of cases, and then find a rule followed by identifying, distinguishing, generalizing, applying the rule in solving problem. Habibah. Rohaeti, Aryan, (2018) and Hidayat, Sabandar, Syaban, (2018) reported the advantages of IDA in improving student's mathematical communication and problem-solving abilities and self-efficacy.

Those aforementioned arguments and findings motivated researchers to execute a study to analyze the role of IDA and student's cognitive stage, on obtaining student's MCTA, and MSE and then we compiled research questions as follow.

1. Are MCTA grade and its normalized gain, and MSE grade of students getting treatment with IDA better than the grades of students taught by SA?
2. What are student's difficulties on solving MCTA tasks?
3. Is there any association among MCTA, MSE?
4. What are student's activities during IDA lessons?

In addition to aforementioned arguments about the importance of possessing creative thinking ability, Hendriana, Rohaeti, & Sumarmo (2017) clarify the benefits of someone having the ability to think creatively as follow. Someone who has habit of creative thinking will be able to solve difficult and unexpected problems. Conversely, people who rarely think creatively will tend to be easily frustrated and feel unable to deal with complex problems.

Munandar (1987) elaborates indicators of creative thinking in more detailed as follow: a. Fluency covering: to provoke many ideas, answer, solutions, questions; to give many strategies, to think more than one solution; b. Flexibility covering: to produce various ideas, answers, or questions, to see a problem form different point of view; to seek different alternatives, to change an approach or way of thinking; c. Originality covering: to produce a new or unic idea, to think an anusual way; to make unusual combination from its parts or elements; d. Elaboration covering: to enrich and to develop an idea or a product; to increase or to detail an object, idea, or situation so that became more attractive.

Other writers analyze creative thinking term in similar notion as follow. Creative thinking containtain activities: a. To generate new relationship, to formulate a non-routine concept, to create a new solution for prior problem, and to pose a new question (Musbikin, (2006); b. To produce a new idea or a new way in generating a produc (Martin, 2009); c. To formulate hypothesis, to compile mathematical pattern, to break the deadlock by proposing new

solutions, to propose unusual ideas, to identify missing information. And to detail the main problem into its parts (Balka, as cited in Mann, 2005). Basically, those senses of creative thinking illustrated the flexibility, fluently, originality and elaboration properties of Munandar's notion of creative thinking.

Some writers explain notion of self-efficacy term in different expression, however they contain similar notion that is self-perception on his or her abilities, as follow: a. Self-efficacy is personal confidence in its ability to manage and carry out activities in achieving the expected results (Bandura, 1997); b. Self efficacy is personal believe on something can be done (Schunk as cited in Moma, 2014); c. Self efficacy is personal believe on its ability in coordinating its skills and abilities for reaching wished goal in a certain domain and condition (Maddux, 2000); c. Self efficacy is personal believe that someting is good or bad, pricise or false, able or unable to be done (Alwilsol, 2010); d) Self efficacy is personal assessment that he able to do the wished activity when facing something hapened.

Further, Bandura (1997) expresses that students with high SE have greater ability for example in: a. Designing activities that will be carried out better, b. Showing greater effort; c. Having stronger stamina in the face of adversity; d. Having higher resiliency toward failure; e. Performing better mindset; f. Decreasing stress and, f) Improving performance. Then Bandura (1987) put forward several indicators of self-efficacy, namely: a) Able to overcome the difficulties encountered; b) Believe on own success; c) Unafraid to face a chalenge; d) Unafraid to take risk on his own dicision; e) Realize on his own advantages and disadvantages; f) Able to interact with other people; g) Persistent and uneasy give up. Further, Bandura (1997) explains that there are four main information resourses for improving self efficacy namely: a) Own experiences of success and failure; b) Experience other people's successes and failures (vicarious experience); c) Verbal persuasion; d) Psychological state

The main difference between inductive and deductive approaches to research is that whilst a deductive approach is aimed and testing theory, an inductive approach is concerned with the generation of new theory emerging from the data. Bruce, Weil & Calhoun. (2000) propose some strategies for inductive thinking such as: a. Concept formation, b. Interpretation data; and c. Aplication of principle. While deductive approach is an approach which using a series of premises and logical reasoning then derive a conclusion.

Inductive-deductive learning begins with the presentation of examples, then students identify, differentiate, interpret, generalize and finally draw conclusions. Next students deductively provide examples of generalizations. Taba (Joyce & Weil; 2000) develops an inductive-deductive approach based on three assumptions namely: The thought process can be learned, the thought process is an active transaction between individuals and data, develops the thought process according to the rules.

Bagus (2013) proposes some steps in inductive-deductive approach that are: a. Identify accurately the concepts or principles wich will be learned; b. When the concept or principles are simple and easy to understand by students, so the mathematics content is learned deductively, c. When the rules or the principles were complex, abstract, and difficult, so the mathematics content was learned inductively. To gain meaningful understanding, after the teacher sets an example, then students are motivated to arrange a problem and then solve them.

In addition to findings which were reported in the previous section, in the following we presented findings of another relevant research. Several studies (Nadia, Rohaeti, Kustiana, 2018, Sumaryati, Sumarmo, 2013) reported the superiority of IDA than scientific approach (SA) on improving variety mathematical abilities and on mathematical self-efficacy.

Some other studies (Fajriyah & Asiskawati, 2015, Iskandar, & Riyanti, 2015, Ramlah, & Maya, 2018, Rohaeti, & Budiyanto, 2014, Rosita. 2016, Sunaryo, 2014) by using different innovative teaching approaches reported that students obtained MCTA at low-medium level.

In addition to the findings regarding MSE, other studies (Krismayanti, Sumarmo, Maya, 2018, Miliyawati, 2012, Nadia, Rohaeti, Kustiana, 2018, Putri & Santosa, 2015) with different learning approaches reported that students achieved MSE at quite well grade level.

METHOD

This research was a pre test-post test experimental design which having a goal to analyze the role of model eliciting activities (IDA) and cognitive stage on students' mathematical creative thinking ability (MCTA) and mathematical self efficacy (MSE). The research involved 70 eleventh grade students, a MCTA test, and a MSE scale. By using Hendriana and Sumarmo (2014) as references it were obtained description of MCTA test and MSE scale as attached in Table 1.

Table 1. Description of Instruments of This Research

Test and Scale	n Subject	n Test Scale	Item & Discrimin at power	Difficulty index	Item Validity (t _{table} = 1.70)	Relia-bility
MCTA test		5	.31 - .49	.64 - .85	.85- .94	.93
MSE Scale		30	-	-	1.79 < t < 6.41	.82

In the following, we attached sample items of TOLT, MCTA test, sample item of MSE scale.

1. Sample MCTA Test (originality)

Given Δ PQR, the length of PQ = 10 cm, $\angle Q = 60^\circ$ and T is middle point of QR.

- a. Draw the sketch of Δ PQR and list the known elements.
 - b. Compile a question related to trigonometry.
 - c. Then solve it accompanied with rules and or explantion in each step of the computation
2. A farmer buys a plot of land in the form of parallelogram ABCD, the length of AB is $60\sqrt{3}$ meter, the length of AD is 40 meter, and $\angle BAD = 60^\circ$ at price of Rp. 7,200,000,000, - Then half of the land was sold for Rp. 2,000,000 per square meter.
- a. Draw the situation and complete it with relevant data.
 - b. Identify of the known data
 - c. Calculate the area of the farmer's land using several ways.
 - d. Regardless of the remaining land area, count profit or loss from the sale of the land

Sample Item of Mathematical Self Efficacy Scale in table 2

Tabel 2. Item of Mathematical Self Efficacy

No.	Statements	SA	A	DA	SD
		A			
1.	I am sure I can apply the sine formula to solve difficult area problem				
2.	I avoid solving trigonometry problems in various ways				
3.	I dare to explain the results of the group discussion of trigonometric problems in front of the class				
4.	I am worried about being criticized for my wrong answers in solving trigonometric problems				
5.	I am trying to prove a difficult trigonometric identity even though it takes longer time				
6.	I am afraid to try new ways to solve area problem using sine formula because there is a risk of failure				
7.	I dare to refute friend's opinion about trigonometric problem when his opinion is wrong				
8.	I gave up facing complex trigonometry problems				

RESULTS AND DISCUSSION

Results

1. Students' Attainment on MCTA and its N<G> and on MSE

The attainment of students' MCTA and its gain (N-G), and MSE were attached in Table 3.

Table 3. Student's MCTA and Its Gain (N-G), and Student's MSE In Both Teaching Approaches

Variable s	Stat. Des c	IDA				Saintific Approach (SA)			
		Pretes	Postes	$\langle g \rangle$	n	Pretes	Postes	$\langle g \rangle$	n
MCTA	\bar{x}	14,77	35,91			14,14	29,11		
	(%)	1,77	72.67	.57	35	23.33	57.50	.43	35
	s	1.80	6,14	.15		2,26	5,87	.13	
MSE	\bar{x}		92,40				89,88		
	(%)		80.12		35		63.05		35
	s		18,61				18,70		

Note: MCTA: mathematical creative thinking ability,

Ideal Score: 62

MSE: mathematical self-efficacy
score: 120

Ideal

In pre-test there were no different students' grades of MCTA of both teaching approaches and the grades were at very low level. These findings were reasonable, because students haven't studied the material in the MCTA assignment. But after teaching approaches, the research found that on MCTA and its N Gain, and MSE, student getting treatment with IDA obtained better grades than the grades of student taught by SA. First group students obtained MCTA and MSE succesivley at prety good and good grade qualification, while the second group students attained MCTA and MSE at almost moderate and moderate grades level. The testing hypothesis of those means were attched in Table 4.

Table 4. Testing Hypotesis of Mean Difference of Mathematical Creative Thinking Ability (MCTA) Its N-Gain, and Mathematical Self Efficacy (MSE) on the Both Teaching Approcahes

Variable	Teaching approach	\bar{x}	SD	n	Sig.	Interpretation
MCTA	IDA.	35,91	6,14	30	.00 < .05	MCTA _{IDA} > MCTA _{SA}
	SA	29,11	5,87	30		
N-Gain of MCTA	IDA.	.57	.15	30	.00 < .05	N-Gain MCTA _{IDA} > N-Gain MCTA _{SA}
	SA	.43	.13	30		
MSE	IDA.	96.14	5.37	30	.00 < .05	MSE _{IDA} > MSE _{SA}
	SA	75.66	3.96	30		

Note: MCTA: mathematical creative thinking ability Ideal score MCTA: 62
 MSE: mathematical self-efficacy Ideal score MSE : 120

The greater role IDA than the role SA on improving student's MCTA, and its N<G> in this research, were similar to findings of other studies (Fajriyah & Asiskawati. 2015, Iskandar, & Riyanti, 2015, Moma, et.all, 2013, Rosita, 2016, Rochmad, Wijayanti, 2015) that variety of inovative teaching approaches took bigger role than ordinary teaching on improving students' MCTA.

2. Students Difficulties in Solving MCTA Tasks.

Further analysis concerns with students' difficulties on solving MCTA tasks and those difficulties were illustrated in Table 5. Students getting treatment with IDA, except in no 3, that is about did not encounter in both teaching approaches encountered difficulties in almost items test except on no 4, that is about to compile of identity in trigonometry (originality). In contrast, students taught by SA encountered in almost items of MCTA test, except on no 4 that is about elaboration on calculation of elements in a triangle by using trigonometry rules.

Table 5. Mean Score of Each Item Of Mathematical Creative Thinking Ability Test of Students in Both Teaching Approaches

Teaching approach	Stat.Desc	No.1	No.2.	No.3	No.4	No.5
	Ideal score	10	10	12	10	10
IDA	\bar{x}	6,06	7,66	5,97	9,23	7
	% out of	60,57	76,57	49,75	92,38	70,00

		IS				
SA	\bar{x}	5,06	5,49	4,40	8,91	5,26
	% out of IS	50,57	54,86	36,67	89,14	52,57

3. Association between MCTA and MSE in IDA Class

The next analysis was about association between MCTA and MSE in IDA Classroom. Analysis data about that association was carried out by using contingency table and statistics Pearson-Chi Square (χ^2) as in Table 6 and Table 7.

Table 6. Contogency between MCTA and MSE

MSE \ MCTA	High	Medium	Low	Total
High	7	5	2	14
Medium	4	8	4	16
Low	0	2	3	5
Total	11	15	9	35

Based on the data in Table 6, and Table 7, the research attained that there was no association between MCTA and MSE. That finding was different with findings of previous studies (Aziz, Rochmad, Wijayanti. 2015, Rohaeti & Budiyanto, 2014, Ruhiyat & Sugandi 2017, Wardani, Sumarmo, & NISHITANI, 2011) which reported there were association between MCTA and variety mathematical soft skills. However, those findings were similar to findings of other studies (Damayanti et.all, 2019, Ramlah, & Maya, 2018) that there were no associtioan between MCTA and variety mathematics soft skills

Table 7. Test of Pearson-Chi Square and Contingency Coefficient between MCTA, CS, MSE in IDA Class

Variables	Pearson-Chi Square (χ^2)	DF	Sign 2 tailed	Sign 1 tailed
MCTA- MSE	6.685 ^a	4	.154	.077

Discussion

Next analysis was about students' activities during IDA lessons. Students show learning with pleasure during IDA lessons (Figure 4), they observe problems presented in the worksheets then draw conclusions and solve open-ended questions with enthusiasm (Figure 5), they presented their work in front of the class voluntary (Figure 6), and students and teacher summarized conclusion about mathematics has been learned in IDA lessons.



Figure 1. Students identify Problem on their work sheet actively



Figure 2. Students formulate and solve problem enthusiastically



Figure 3. Students presented voluntarily their work in the front of the class

Indeed, at first the students feel confused by the new assignments, but then they get used to and can learn comfortably. Students posed that IDA encourages students to find concepts actively and apply them in solving problems. Likewise, teacher felt lack of time whereas IDA needed more time for students to construct their knowledge, to discuss in their group, and to derive conclusion. Then, in further sessions the obstacles could be handled by offering more interesting mathematics task and guidance during students working together in each small group.

CONCLUSION

Based on research findings, the research obtained some conclusion as follow. Model Eliciting Activities (IDA) gave bigger role than SA on improving students' mathematical creative thinking ability (MCTA) it gains and on MSE. Students getting treatment with IDA attained MCTA and MSE at successively pretty good and good grades level. While students taught by scientific approach (SA) obtained at low-medium grade level. Student getting treatment with IDA experienced only on an item namely to check whether three lines of known length can form a triangle, and students taught by scientific approach experienced in almost of MCTA tasks. Other conclusion was that there was no association between MCTA and MSE, and students posed positive opinion on IDA and performed active learning during IDA lesson. In order students to master MCTA better, students should more practice on open-ended problems, write rules or principles in each calculation step, and pose question toward the given known elements and solve it in some different ways.

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