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Research Article

Exploring Metacognitive and Critical Thinking Skills of Pre-Service Elementary School Teachers through Discovery Learning Method by Integrating Various Cognitive Styles

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Abstract
This research examines the effect of discovery learning method using various cognitive styles on metacognitive and critical thinking skills of pre-service elementary school teachers. Quasi-experimental pretest-post tests non-equivalent control group design is selected to be the method of this research. The subjects of this research are 144 pre-service teachers. The instrument used to measure the subjects' metacognitive skill is Metacognitive Awareness Inventory (MAI) questionnaires as adapted from Schraw & Dennison (1994), whereas modified essays of Ennis (1985) are to evaluate critical thinking skills. Embedded Figure Test Group (GEFT) as adapted from Witkin, et al (1977), is utilized to measure the cognitive styles of the research subjects. The data is then analyzed through two-way MANOVA technique. The findings of the research conclude that: (1) there are significant differences in metacognitive and critical thinking skills between groups which learned using discovery learning method and discussion method; (2) there are significant differences in metacognitive and critical thinking skills between pre-service elementary school teachers when integrated with field independence cognitive style and field dependence cognitive style; (3) there is an interaction between discovery learning and discussion method integrated with cognitive styles on metacognitive and critical thinking skills of pre-service elementary school teachers.

Keywords:
metacognitive skills, critical thinking skills, discovery learning method, cognitive style.

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Introduction

Developing the skills and ability of pre-service teachers in cooperating and solving a problem is one of the most essential elements in learning. Critical thinking and metacognitive skills are several fundamental aspects of high demand in the 21st century (Yasushi, 2016; Yulianto et al., 2019). The more critical one contemplates and proposes, the better they will be at solving problems and formulating arguments by applying their broad knowledge as a basis. Promoting critical thinking skills require higher order of thinking skill, or also known as metacognitive skills (Su, Ricci, et al., 2016). The ability to think critically enables one to become more successful in their profession. Critical thinking is vital to be promoted for pre-service teachers at university in order to hone and sharpen their critical thinking skills when preparing their future career. (Murat, 2016; Schraw, Crippen, & Hartley, 2006; Fauziah, 2013; Djamahar et al., 2018).

One's progress in gaining knowledge depends greatly on the ability to think critically. Critical thinking is one of the most needed skills in learning and teaching, especially in the teaching of pre-service elementary teachers. Al-Busaidi (2014) stated that the ability to think critically is mandatory in facing the career world in the future, in which individuals are to emphasize on their ability to think critically. Critical thinking is the act of thinking done reflectively with the purpose of deciding the actions, in this case, of a pre-service elementary school teacher. Recent studies demonstrated that research concentrating on critical thinking skill has been the main focus in the field of education research (Renjith, 2015). In developing metacognitive and critical thinking skills for pre-service elementary teachers, the most appropriate method which can hone both of the skills must be carefully selected. Several studies stated that the use of discovery learning method is able to assist pre-service teachers in improving their metacognitive and critical thinking skills (Chich, 2016; Basman, 2016). Discovery Learning Method is a learning theory defined as a learning process in which students are demanded to develop their own materials which they favoured in learning and exploring the way to learn the materials by themselves. The basis of Bruner's idea is Piaget's opinion which declared that pre-service teachers must hold an active role in the classroom (Bruner, 1966). The six syntaxes covered in discovery learning, as adapted by Bruner (1960) include stimulating, problem identifying, data collecting, verifying and generalizing will enhance pre-service teachers' metacognitive skills. According to Ennis (1985), one's ability to think critically will create a much more systematic and orderly problem solving.

Systematic thinking will be of a better help by the implementation of six syntaxes found in discovery learning. The process of building metacognitive and critical thinking skills obliged pre-service teachers to be able to reflect on their experiences and reactions towards any learning situation, which could be more optimal as accordance to each cognitive style of the pre-service teachers. Cognitive style is an individual's characteristic in thinking, feeling, recalling, solving a problem, and

making a decision, which becomes one of the considerations in designing learning and teaching activities (Bruce Joyce, 1996). As stated by Vendiagrys, L., Junaedi, I., & Masrukan (2015), cognitive style holds a critical role in problem solving or metacognitive skill. To add, Jena (2014) stated that there is a positive relationship between cognitive styles and problem solving. Cognitive style has a significant effect on the selection of learning strategies for pre-service elementary teachers. Hence, in order to equip pre-service teachers with metacognitive skills, lecturers must pay attention on each cognitive style of the learners and search for the most competitive learning models which could be adjusted with their learning styles, as accordance with the course outcomes. Based on psychology differences, cognitive styles are classified into two: field dependent and field independent. This research focuses on field dependent and field independent which are cognitive styles suggested by Witkin. According to Al-Salameh (2011), field independent cognitive style and field dependent cognitive style are the most important dimensions. Cognitive style is the term described to express the way one thinks, feels, and remembers information (Lusweti, 2017; Jozef, 2014; Saxena, 2014).

There have been numerous studies conducted investigating metacognitive and critical thinking skills. Halil (2015) conducted a study in California, proving that in online learning situations, the development of metacognitive and critical thinking skills are highly demanded. The research found an improvement in critical thinking skills when using metacognitive learning strategies through online courses. Solberg (2015) and Nilgun (2016) also conducted a research on critical thinking skill, in which he found that critical thinking greatly improved the results and learning process in science classes. Lestari, et al (2019) and Wongsila, et al (2019) proved that metacognitive skill became one of the solutions in solving learning problems in biology classroom. Throughout this study, one of the aspects of metacognitive skills, which is planning, enable students to determine their own aims in biology and it improved greatly on the pre-service teachers' scores. Hui Fang (2016) also conducted a research on metacognitive and critical thinking skills which discovered that in mathematics class, the learners' skills of metacognitive and critical thinking are urgently needed. However, those studies show gap that the urgency of integrating both metacognitive and critical thinking skills in a classroom have not yet been investigated.

The studies also had not yet express the importance of developing both metacognitive and critical thinking skills for pre-service elementary school teachers' learning (Halil, 2015; Solberg, 2015; Lestari et al., 2019; Hui Fang, 2016; Wongsila et al., 2019). At universities, especially the classes for pre-service elementary school teachers, there have not been much developments on promoting and encouraging the skills of metacognitive and critical thinking. Elementary school teachers tend to implement traditional methods of learning, which does not help in developing their metacognitive and critical thinking as teachers remained as the only source for

learners. This stays as one of the problem in education unsolved (Tota, 2017). Teachers need to adopt learning methods which focus on honing critical thinking and metacognitive skills to prepare students in encountering challenges in workplace and developing education in 21st century (Tuzlukova, 2017). Critical thinking and metacognitive skills are mandatory for pre-service elementary school teachers to have as a fundamental base in developing elementary school students' ways of thinking. Therefore, it can be concluded that metacognitive and critical thinking skills are essential to be developed within this research (Feryal, 2009; Batdal., et.al., 2017; Lestari, P., Ristanto, RH, & Miarsyah, M, 2019). This research aims to measure the level of success of integrating discovery method and cognitive style in enhancing metacognitive and critical thinking skills of pre-service elementary school teachers.

Research Problems

Viewing the background literature above, the researcher wishes to focus her observation in exploring the metacognitive and critical thinking skills of pre-service elementary school teachers through discovery learning in various cognitive styles. The following are research problems which are formulated throughout this study:

- Examining the differences on the learning outcomes in metacognitive and critical thinking skills of pre-service elementary school teachers by the use of discovery learning and discussion method (controlled)
- Examining the differences on the learning outcomes in metacognitive and critical thinking skills of pre-service elementary school teachers by field independence and field dependence cognitive styles
- Analyzing the interaction between discovery learning and discussion method when integrated with field independence and field dependence cognitive styles focusing on the metacognitive and critical thinking skills

Method

Research Design

This research is an experimental research which examines the effect of independent variable on controlled variable. Quasi experimental pretest-post test nonequivalent control group design by Tuckman (1999) is selected. The independent variable is discovery learning method, whereas the controlled variable is the metacognitive and critical thinking skills. The moderator variable in this research is the cognitive styles. The factorial planning of this research can be seen in the following table:

Table 1.

Experiment Factorial Design Pattern 2x2

Independent variable		Learning Method			
		Discovery Learning (X_1)		Discussion (X_2)	
Moderator variable		Metacognitive Skill (Y_1)	Critical Thinking Skill (Y_2)	Metacognitive Skill (Y_1)	Critical Thinking Skill (Y_2)
Cognitive Style	Field Independence (Z_1)	$Y_1.Z_1.X_1$	$Y_2.Z_1.X_1$	$Y_1.Z_1.X_2$	$Y_2.Z_1.X_2$
	Field Dependence (Z_2)	$Y_1.Z_2.X_1$	$Y_2.Z_2.X_1$	$Y_1.Z_2.X_2$	$Y_2.Z_2.X_2$

Participants

The subjects of this research are 144 pre-service elementary school teachers who are currently undertaking elementary school teaching undergraduate degree. They are divided into 4 classes (two classes are experimental classes and the other two are controlled classes). Each class consists of 36 students: 67 males and 77 females. These students are all enrolled on science course on their third semester. The consideration of the two classes as experimental class and controlled class are done by cluster random sampling technique by assuming that all subject classes are homogeneous. The distribution of research subjects was carried out using random techniques.

Instruments

The instrument used to measure metacognitive skill is *Metacognitive Awareness Inventory* (MAI) with 52 items in a questionnaire which uses Likert scale. The subjects are to give a check on available columns. The use of check is to be as accordance to each of the statement done during learning process. The metacognitive questionnaire's drafting is done based on metacognitive indicators such as declarative knowledge, procedural knowledge, conditional knowledge, planning, strategies, information processing, monitoring, control, and evaluation as adapted of Schraw, G., & Denniso, R. S. (1994). On the other hand, the instrument utilized in measuring the critical thinking skills is in the form of an essay test modified from Ennis (1985) in the use of discovery learning in a science classroom based on critical thinking skill indicators. The scoring of the test is done by using rubrics assessing critical thinking skill with a scale from 1-5. The highest score for the essay questions is 5 and the lowest is 0. The tests given prior to and after the implementation of discovery learning and group discussion method contain the exact same items.

The instrument utilized to measure cognitive styles is Embedded Figure Test Group (GEFT) as adapted of Witkin, et al (1977). This test is in the form of pictures which are divided into three sections: the first section contains seven pictures, whereas the second and third section each contain nine pictures. The time allocated

for the subjects to do the first part of the test is 2 minutes. The real test used to measure the cognitive style is actually on the second and third section of the test, with each time allocated for approximately 5 minutes. For each correct answer, the subject receives 1 point and wrong answers does not subtract any points. The maximum score is 18. In classifying groups between those with field dependence and independence cognitive styles, the students' scores are used to determine where they are grouped into. Those who scored below 11 belonged to field dependence cognitive style, whereas those who scored more than 13 points belonged to field independence cognitive style group. Those who received 11, 12, and 13 belonged to students with neutral cognitive styles.

Procedures

The researcher conducted a direct study on two classes appointed as experimented classes and two other classes as controlled classes. In the experimented classes, the researcher carried out learning activities by the use of discovery learning method, whereas the controlled classes had their learning activities by using discussion method. The researcher identified the cognitive styles of the two research subjects, both the controlled and the experimented classes. This is done in order to identify which of the pre-service elementary school teachers have field independence cognitive style and which teachers have field dependence cognitive style.

The researcher held the pre-test for both research subjects at the same time. This is done in order to see how far the pre-service elementary school teacher mastered the materials which will be delivered by the researcher. Then, the researcher conducted the learning activities by the use of discovery learning method for the experimented class and discussion method for controlled classes. Discovery method is taught as aligned with the course subject at that time, which was science. Here, the role of the researcher is only as facilitator. The pre-service teachers are to search for their own knowledge as according to the guide and methods of discovery learning. As for the controlled class, the learning activities are implemented by the use of discussion method. The materials and topics are the same in both class, which focused on science.

The researcher carried out an evaluation for discovery learning and discussion method in the form of essay test which require one to think critically. The essay has been modified and adjusted with the taught subject. The result of the critical thinking essay is then analyzed to acknowledge the level of significance between learning methods and learning outcomes of critical thinking. The researcher identified the metacognitive skill by using questionnaire which have been adapted on both the research subjects. The result is then analyzed by the use of the Likert scale. After identifying the metacognitive skills of the pre-service teachers, the researcher conducted a post test at the end of the study in order to investigate the level of success of the method used in the research. This research was conducted in six months' time.

Data Analysis

Data analysis technique is divided into two groups: data analysis for the test requirement analysis and data analysis to test the research hypothesis. Analysis is conducted for all research variables. For the test requirement analysis, data normality test and variance homogeneity test are carried out. Data normality test uses *Kolmogorov-Smirnov* technique whereas variance homogeneity test uses *Levene's test*. Data normality test and variance homogeneity test are used to fulfil all parametric assumptions. The analysis to test the research hypothesis, however, is conducted by the use of MANOVA (*Multivariant Analysis of Variance)* statistic technique by the aid of *SPSS for Windows*. All the parametric assumptions above are carried out at a significance level of 5%.

Results

Identification Results of Pre Service Elementary School Teachers' Cognitive Styles on Experimented Class and Controlled Class

The identification result of pre-service elementary school teachers on experimented class and controlled class can be seen in the following table:

Table 2

Results of Identification of Cognitive Style Students

Cognitive style	Controlled Class	Experimented Class	Total
Field Independence	46	51	97
Field Dependence	26	21	47
Total	**72**	**72**	**144**

The result shows that within the controlled class there are 46 pre-service elementary school teachers with field independence cognitive style and 26 pre-service elementary school teachers with field dependence cognitive style. However, the experimented class consisted of 51 pre-service teachers with field independence cognitive style and 21 pre-service teachers with field dependence cognitive style. Therefore, it can be inferred that field independence cognitive style tends to be more dominant in both controlled class and experimented class.

Description of the Result of Metacognitive and Critical Thinking Skill Pretest

The recapitulation of the results of the pretest on metacognitive and critical thinking skill for pre-service elementary school teachers are presented in the following table:

Table 3.

Pretest Results of Metacognitive Skills and Critical Thinking Skills

Cognitive style	Controlled Class				Experimented Class			
	Metacognitive		Critical thinking		Metacognitive		Critical thinking	
	Average	Std. Dev	Average	Std. Dev	Average	Std. Dev	Average	Std. Dev
Field Independence	160.739	8.415	64.515	5.469	143.879	3.557	67.487	3.06
Field Dependence	163.539	9.83	66.345	2.656	146.62	10.1	67.423	1.672

Based on Table 3, the experimented class of pre-service elementary school teachers with field independence cognitive style obtained a score of 143.879 with the standard deviation of 3.557 in the average of pretest for metacognitive skill, whereas the pretest on critical thinking resulted in the score of 67.48 with the standard deviation of 3.06. However, pre-service elementary school teachers with field dependence cognitive style obtained a score of 146.62 with the standard deviation of 10.1 in the average of pretest for metacognitive skill, while the pretest on critical thinking skill reached up to 67.423 with the standard deviation of 1.672. As for the controlled group of pre-service elementary school teachers with field independence cognitive style, a score of 160.739 is obtained in the pretest for metacognitive skill along with the standard deviation of 8.415 and the average pretest score of critical thinking skill reached 64.515 with the standard deviation of 5.469. Meanwhile, pre-service teachers with field dependence cognitive style attained 163.539 for the average pretest of metacognitive skill with the standard deviation of 9.83 and the average pretest score of critical thinking skill earned a score of 66.345 with the standard deviation of 2.656.

Perceiving the overall of pretest results, there was no significant difference shown from the pre-service teachers' metacognitive nor critical thinking skills regardless of their cognitive styles being field independence or field dependence, both in the experimented and controlled classes. This provides an illustration that the research subjects' ability prior to the research is not significantly different.

The early learning outcomes which are based on the pretest result on Table 3 is then analyzed by the use of independent sample t test to obtain the idea of how significant the learning outcome of metacognitive and critical thinking skills are before the implementation of discovery learning method and discussion method are put into action. The result of the different analysis on the metacognitive and critical thinking skills of pre-service elementary school teachers before being taught by the use of discovery learning and discussion method are presented in Table 4 and Table 5 as the following:

Table 4.
Result of T Pretest Metacognitive and Critical Thinking Skills

Group Statistics

	Learning Method	N	Mean	Std. Deviation	Std. Error Mean
Metacognitive	Discussion Method	72	161.7500	9.12009	1.07481
	Discovery Learning	72	144.6944	6.35707	.74919
Critical Thinking	Discussion Method	72	64.8056	5.02848	.59261
	Discovery Learning	72	67.3611	2.70266	.31851

As Table 4 has presented the result of independent t test, the learning outcome for metacognitive skill between controlled and experimented classes with the

significance value of 0.000 (<0.05, H0 is rejected), which means that there is a significant difference in the learning outcomes of pre-service teachers' metacognitive pretest between the controlled class and experimented class. However, the independent t test which focuses on the critical thinking learning outcome showed that the pretest results between the controlled and experimented classes has a significance value of 0.000 (<0.05, H0 is rejected), which means that there is a significant difference in the critical thinking learning outcome of pre-service elementary school teachers in the controlled and experimented classes. In other words, before the treatment of implementing discovery learning and discussion method, the learning outcomes of metacognitive and critical thinking skills of pre-service elementary school teachers in experimented and controlled classes are significantly different.

Table 5.
Independent Sample Test

		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
Metacognitive Skill	Equal variances assumed	25.97	.000	13.018	142	.000	17.05556	1.31015	14.46563	19.64548
	Equal variances not assumed			13.018	126.817	.000	17.05556	1.31015	14.46296	19.64815
Critical Thinking Skills	Equal variances assumed	18.660	.000	-3.798	142	.000	-2.55556	.67278	-3.88552	-122559
	Equal variances not assumed			-3.798	108.861	.000	-2.55556	.67278	-3.88901	-1.22210

By analyzing the results of Table 5's Independent Sample, t-test proved that Sig. Levene's Test showed the score of 0.000 (metacognitive skills) and 0.000 (critical thinking skill). The two values are less than 0.05, and can therefore be concluded that there are variants and differences in metacognitive and critical thinking skills between the controlled and experimental groups. Hence, a further analysis can be conducted by implementing t-test independent with the assumption that the groups are heterogeneous.

On the next step, in order to distinguish the difference between the learning outcomes of metacognitive and critical thinking skills for pre-service elementary

school teachers prior to being taught using discovery learning and group discussion methods, a statistic test is conducted by the use of independent sample t test. Table 5 shows the result of independent sample t test for learning metacognitive (pre test) between controlled group and experimental group of 0.000 with the scale that (<0.05, H0 is rejected), which means that there is a significant difference in learning outcomes on metacognitive skills for pre-service elementary school teachers between the controlled groups and experimented group.

However, the result of independent t test for critical thinking skill (pre test) between controlled and experimented groups with the level of significance as big as 0.000 (<0.5, H0 is rejected), meaning that there is a significant difference in the score of critical thinking skill for pre-service elementary school teachers (pre test) between controlled and experimented group. In other words, before discovery learning and discussion methods are implemented, the scores of metacognitive and critical thinking skills of pre-service elementary school teachers in experimented group and controlled group has a significant difference.

Description of Post Test Result of Metacognitive and Critical Thinking Skills

The result of post test scores of metacognitive and critical thinking skills for pre-service elementary school teachers are delivered as the following:

Table 6.

Scores of Post in Learning Metacognitive and Critical Thinking Skills

Cognitive Styles	Controlled Group				Experimented Group			
	Metacognitive		Critical Thinking		Metacognitive		Critical Thinking	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Field Independence	205.740	5.614	84.352	5.028	221.929	4.442	92.755	3.777
Field Dependence	198.794	5.934	77.933	4.264	221.297	4.212	91.669	3.379

Based on Table 6, it can be inferred that the experimented group of pre-service elementary school teachers by the use of field independence cognitive style has scored in the post test for metacognitive skills achieving the average of 221.929 in field independence cognitive style with the standard deviation of 4.442, and the result of the post test for critical thinking skills reached 92.755 with the standard deviation of 3.777. Meanwhile, for pre-service elementary school teachers with field dependence cognitive style, the average post test result for metacognitive skill reached 221.297 with the standard deviation of 4.212 and the score for the post-test's average for critical thinking skills of pre-service elementary school teachers reaching 91.669 with the standard deviation of 3.379.

On the other hand, in the post test of the controlled group of pre-service elementary school teachers, the average score reached 205.740 in the metacognitive skill through field independence cognitive style with the standard deviation of 5.614, whereas the average post test result for the critical thinking skill for pre-service

elementary school teachers by the use of field dependence cognitive style reached 198.794 for the metacognitive skill with the standard deviation of 5.934 and the post-test average for critical thinking skill of pre-service elementary school teachers reached up to 77.933 with the standard deviation of 4.264.

Data Normality Test on Metacognitive and Critical Thinking Skills by the Use of Discussion and Discovery Learning Method

The result of data normality test on metacognitive and critical thinking skills by the use of discussion method and discovery learning method is presented in Table 7 as the following:

Table 7.

Result of Data Normality Test on Metacognitive and Critical Thinking Skills based on the Learning Methods

One-Sample Kolmogorov-Smirnov Test					
		Critical Thinking Skill by the use of Discussion Learning Method	Metacognitive Skill by the use of Discussion Learning Method	Critical Thinking Skill by the use of Discovery Learning Method	Metacognitive Skill by the use of Discovery Learning Method
N		72	72	72	72
Normal Parameters[a,b]	Mean	92.4167	221.7778	82.0139	203.2500
	Std. Deviation	3.71427	4.42853	5.70271	6.67927
Most Extreme Differences	Absolute	.104	.100	.101	.089
	Positive	.077	.100	.093	.089
	Negative	-.104	-.094	-.101	-.076
Test Statistic		.104	.100	.101	.089
Asymp. Sig. (2-tailed)		.052[c]	.069[c]	.068[c]	.200[c,d]
a. Test distribution is Normal.					
b. Calculated from data.					
c. Lilliefors Significance Correction.					
d. This is a lower bound of the true significance.					

According to Table 7, the result of Normality Test using Kolmogorov Smirnov concludes that the score of metacognitive skill by the use of discussion method shows a significance (probability) of 0.069, which is bigger than 0.05. In addition, the table also presented the result that metacognitive skill by the use of discovery learning showed a significance (probability) of 0.200, which is also bigger than 0.05. On the contrary, critical thinking skill by the use of discussion method proved a significance (probability) amount of 0.052, which is bigger than 0.05. Critical thinking skill by the use of discovery learning method, furthermore, proved a significance value (probability) of 0.068 which is bigger than 0.05. From the table, a conclusion can be drawn that the score of critical thinking skill in the controlled group and metacognitive skill in experimented group has a normal distribution,

whereas critical thinking skill in the experimented group and metacognitive skill in the controlled group has a normal distribution.

Result of Data Normality Test on Metacognitive and Critical Thinking Skills by the use of Cognitive Styles: Field Independence and Field Dependence

The result of data normality test on metacognitive and critical thinking skills by the use of two cognitive styles; field independence and field dependence, can be seen on the following table:

Table 8.

Result of Data Normality Test on Metacognitive and Critical Thinking Skills by the Use of Cognitive Styles: Field Independence and Field Dependence

		Critical Thinking Skill by the Use of Field Independence Cognitive Style	Metacognitive Thinking Skill by the Use of Field Independence Cognitive Style	Critical Thinking Skill by the Use of Field Dependence Cognitive Style	Metacognitive Thinking Skill by the Use of Field Dependence Cognitive Style
N		97	97	47	47
Normal Parameters[a,b]	Mean	887.320	2.142.784	840.851	2.088.723
	Std. Deviation	612.630	958.160	793.679	1.249.281
Most Extreme Differences	Absolute	.088	.081	.094	.090
	Positive	.065	.062	.094	.090
	Negative	-.088	-.081	-.063	-.083
Test Statistic		.088	.081	.094	.090
Asymp. Sig. (2-tailed)		.063[c]	.128[c]	.200[c,d]	.200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

In line with the results of Normality Data Test by the use of Kolmogorov Smirnov shown on Table 8, the score of metacognitive skill by the use of field independence cognitive style showed a significance value (probability) of 0.128, which is bigger than 0.05. On the other hand, the score of metacognitive skill with the use of field dependence cognitive style proved a significance (probability) of 0.200, which is also bigger than 0.05. Likewise, the result of critical thinking skill by the use of field independence cognitive style and field dependence cognitive style shows the significance values (probabilities) of 0.063 and 0.200 which are bigger than 0.05. Therefore, it can be inferred that the result of metacognitive and critical thinking skills on both controlled group and experimented groups have normal distribution.

Description of the Calculation Results by the Use of MANOVA Analysis Technique

The calculation result of MANOVA analysis technique on the significant value of 0.05 is presented in the following table:

Table 9.

Mutivariate Tests Analysis Result

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	132838.564[b]	2.000	139.000	.000
	Wilks' Lambda	.001	132838.564[b]	2.000	139.000	.000
	Hotelling's Trace	1911.346	132838.564[b]	2.000	139.000	.000
	Roy's Largest Root	1911.346	132838.564[b]	2.000	139.000	.000
Method	Pillai's Trace	.826	329.714[b]	2.000	139.000	.000
	Wilks' Lambda	.174	329.714[b]	2.000	139.000	.000
	Hotelling's Trace	4.744	329.714[b]	2.000	139.000	.000
	Roy's Largest Root	4.744	329.714[b]	2.000	139.000	.000
GK	Pillai's Trace	.227	20.427[b]	2.000	139.000	.000
	Wilks' Lambda	.773	20.427[b]	2.000	139.000	.000
	Hotelling's Trace	.294	20.427[b]	2.000	139.000	.000
	Roy's Largest Root	.294	20.427[b]	2.000	139.000	.000
Method * GK	Pillai's Trace	.147	12.021[b]	2.000	139.000	.000
	Wilks' Lambda	.853	12.021[b]	2.000	139.000	.000
	Hotelling's Trace	.173	12.021[b]	2.000	139.000	.000
	Roy's Largest Root	.173	12.021[b]	2.000	139.000	.000

a. Design: Intercept + Method + GK + Method * GK

b. Exact statistic

As reported on Table 9, it can be inferred that the learning methods have significant value as tested by the procedures of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, dan Roy's Largest Root. All procedures indicate a significant value of 0.000, which is smaller than the alpha 0.05 ($p<0.05$). Hence, H0 is rejected, and it can be derived that the post test result of metacognitive and critical thinking skills have a difference on the two learning methods. Based on the post test scores, the teaching of metacognitive and critical thinking skill by the use of discussion method proved to score lower than the result of post test scores of teaching metacognitive and critical thinking skills through the use of discovery learning method.

Thus, the result of individual test on the independent and dependent variables (test of between-subject effect MANOVA) by the use of MANOVA is presented on the following table:

Table 10.

Result of Tests of Between-Subjects Effects

Tests of Between-Subjects Effects						
Source	Dependence Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Critical Thinking	4580.802[a]	3	1526.934	82.108	.000
	Metacognitive	13166.976[b]	3	4388.992	163.812	.000
Intercept	Critical Thinking	943059.721	1	943059.721	50711.402	.000
	Metacognitive	5641410.110	1	5641410.110	210556.706	.000
Method	Critical Thinking	3841.962	1	3841.962	206.595	.000
	Metacognitive	11768.794	1	11768.794	439.252	.000
GK	Critical Thinking	429.924	1	429.924	23.118	.000
	Metacognitive	450.969	1	450.969	16.832	.000
Method * GK	Critical Thinking	219.109	1	219.109	11.782	.001
	Metacognitive	314.020	1	314.020	11.720	.001
Error	Critical Thinking	2603.524	140	18.597		
	Metacognitive	3750.996	140	26.793		
Total	Critical Thinking	1102521.000	144			
	Metacognitive	6520268.000	144			
Corrected Total	Critical Thinking	7184.326	143			
	Metacognitive	16917.972	143			
a. R Squared =.911 (Adjusted R Squared =.909)						
b. R Squared =.884 (Adjusted R Squared =.881)						

Based on the calculation result on Table 10 Test of Between-Subject Effects, it can be inferred that the metacognitive skill scored an F value of 439.252 with a significant level of 0.000 which is below alpha 0.05. Hence, H0 is rejected, meaning that there is a significant difference on the students' metacognitive skill learning outcomes by the use of discovery learning and discussion methods. Next, on the Test of Between-Subject Effects table above, it can be drawn that critical thinking skill scored an F value of 206.595 with a significant level of 0.000, which is below alpha 0.05. Hence, the H0 is also rejected, meaning that there is a significant difference in the learning outcomes of critical thinking skill for pre-service elementary school teachers who had undergone the discovery learning and discussion methods.

On the calculation result of Test of Between-Subject Effects above, it is noted that the metacognitive skill test obtained an F value of 16.832 with the significant level of 0.000, which is below alpha 0.05. Thus, H0 is rejected, meaning that there is

a significant difference on the metacognitive learning outcomes for pre-service elementary school teachers who have field independence and field dependence cognitive styles. By analyzing the table, it can also be inferred that critical thinking skill test obtained an F value of 23.118 with the significance level of 0.000 which is below alpha 0.05. In another words, the H0 is rejected, meaning that there is a significant difference between the critical thinking learning outcomes of pre-service elementary school teachers who have field dependence and field independence cognitive styles.

Based on the calculation result on Table 10 Test of Between-Subjects Effects, the metacognitive skill test obtained an F value of 11.720 with the significance level if 0.001 which is below alpha 0.05. Hence, the H0 is rejected, meaning there is a significant interaction impact between the use of discovery learning and discussion methods with the field independence and field dependence cognitive styles on metacognitive learning. Simply put, pre-service elementary school teachers who are taught by discussion and discovery learning methods by also integrating field independence and field dependence cognitive styles acquire a quite different score in metacognitive skill. On another side, the result of Test of Between-Subject Effects show that critical thinking test scored an F value of 11.782 with the significance level of 0.001, which is below alpha 0.05. Therefore, H0 is rejected, meaning that there is a significant impact in the interaction of discovery learning and discussion methods with the field independence and field dependence cognitive styles on critical thinking skill learning. Otherwise stated, pre-service elementary school teachers who are taught using discussion and discovery learning methods integrated with field independence and field dependence cognitive styles have a far different critical thinking value.

Discussion and Conclusion

This research aims to examine the effect of discovery learning method and cognitive styles on the metacognitive and critical thinking skills of pre-service elementary school teachers. The research found that discovery learning method used has significantly affected the scores of pre-service elementary school teachers on both metacognitive and critical thinking skills. The research also discovered that there is a significant difference in the metacognitive and critical thinking skills between pre-service elementary school teachers who have field independence cognitive style and those of field dependence cognitive style. Moreover, the research also identified an interaction between discovery learning method and discussion method with cognitive styles on the metacognitive and critical thinking pre-service elementary school teachers.

Research results show that there is an impact between discovery learning method on metacognitive and critical thinking skills, in line with a research conducted by Chich (2016), in China, where he claimed that discovery learning has a significant

effect in improving one's creativity, flexibility and developments. The experimented group which had integrated the use of discovery learning within their study would also effect on their academic achievement and learning retention. A similar study was carried by Ucar (2018) in Turkey, and he stated that metacognitive skill developed well when exposed to discovery learning method. The ability to think critically is a higher order thinking skill obtained from learning on the second stage of learning, which means that thinking critically is also included in domain cognitive learning outcomes, and therefore, the development of critical thinking skills is highly required for pre-service elementary school teachers (Fitzpatrick & Schulz, 2015).

The result of the hypothesis test in seeing the impact of field independence and field dependence cognitive styles show that there is a significant difference in metacognitive and critical thinking skill learning for pre-service elementary school teachers who develop field independence cognitive style. In a study conducted by Vendiagrys, L., Junaedi, I., & Masrukan (2015), it is concluded that cognitive styles hold a very essential role in problem solving or metacognitive skill. As aligned with that study, several studies stated that there is a positive interaction between cognitive styles and metacognitive skill (Jena, 2014; Argaw, Haile, Ayalew, & Kuma, 2016). Jena also added that cognitive styles have a significant impact on selecting the most appropriate learning strategies for pre-service elementary school teachers. Therefore, in order to develop metacognitive skills on elementary students, lecturers must be able to recognize each of the cognitive style of pre-service elementary school teachers and search for the most appropriate and competitive learning models as according with their learning styles in order to reach the learning outcomes.

The result of the hypothesis test shows that there is a great impact on the interaction between different learning methods and cognitive styles on the metacognitive and critical thinking skills. This interaction impact strengthens the first and second hypotheses which believed that the effect of the main variable on the dependent variables would be very strong. This is also relevant with the analysis of factorial variants, where if each of the independent and moderator variable has an effect of the variable dependent, then the impact on the interaction will be strong and significant. Based on the overall research result, discovery learning is proved to have impacted the metacognitive and critical thinking skills, as the field independence cognitive style has also significantly impacted the metacognitive and critical thinking skills. The research also shows an impact on real interaction between discovery learning method and discussion method by the use of field independence and field dependence cognitive styles on metacognitive and critical thinking skills.

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