PAPER • OPEN ACCESS

The analysis of the implementation of research-based learning to improve students' critical thinking skills based on their cognitive style

View the article online for updates and enhancements.

IOP ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

The analysis of the implementation of research-based learning to improve students' critical thinking skills based on their cognitive style

L P I Budayawati[1,2], V Jovanka[2], S. Fitriyah[1,5], Z. Finali[1,3]

[1] CEREBEL, University of Jember, Kalimantan Street 37, Jember, Indonesia

[2] Departement of Early Childhood Edu. Program. University of Jember, Kalimantan Street 37, Jember, Indonesia

[3] Departement of Primary Education. University of Jember, Kalimantan Street 37, Jember, Indonesia

[4] Departement of English Education. University of Jember, Kalimantan Street 37, Jember, Indonesia

[5] Departement of Postgraduate Math. Education, University of Jember. Kalimantan Street 37, Jember, Indonesia

*indahbudyawati.fkip@unej.ac.id

Abstract. This study aimed to analyze the effect of the implementation of research-based learning models based on their cognitive style on the improvement of students' critical thinking skills. This study employed Mix Method analysis with the 2x2 factorial design. 124 students who took Play and Game courses in the Teacher Education of Early Childhood Education Study Program. They were selected randomly using the multistage random sampling method. The results of this study indicated that: (1) students' critical thinking abilities with research-based learning models are higher than cooperative learning models. (2) there was a significant interaction between learning models and cognitive styles on students' critical thinking abilities. (3) for groups of students with a field dependent cognitive style, students' critical thinking abilities with research-based learning models are higher than those with cooperative learning models. (4) for groups of students with independent field cognitive style, critical thinking abilities of students who learnt by research - based learning models are higher than those who were learned by cooperative learning models. The results of this study show that research-based learning models can improve students' critical thinking skills based on their cognitive skills in Play and Game modules.

1. Introduction

Education quality is a compilation of the comprehensive arrangement of educational components. Education that is carried out comprehensively and in quality is guaranteed to be able to produce high education. High education quality will surely produce quality human resources and can educate the nation's life which is one of the goals of national education.

Early Childhood Education Teacher Education (PG PAUD) is one of the relatively new study programs at the Teacher Training and Education Faculty of Jember University. The profile of graduates targeted by PG PAUD study programs includes PAUD Educators, PAUD Managers and PAUD Supervisors. In order to equip PG PAUD students so that graduates have the intended competencies, the PG PAUD study program students are required to take several courses with a total SKS of approximately 144. All courses offered are support and provision for them to have competence as PAUD educators, PAUD Managers and PAUD Supervisor.

Children's play and games are one of the compulsory courses offered to PAUD students whose aim is that students gain knowledge about the concepts of play and games in early childhood education and have the ability to plan, implement and evaluate play programs and also make game tools that are in accordance with playing philosophy and early childhood games. The main material in this lecture includes: 1) the basic concepts of early childhood play and game theory, 2) the concept of play and early childhood development, 3) characteristics and stages of early childhood play, 4) types and forms of play and games for children early, 5) the concept of learning in play (playing for the optimization of early childhood development), 6) the nature of educational game tools, 7) preparation of educational game tools, 8) learning through play strategies, 9) teacher roles and responsibilities in playing and early childhood games, and 10) evaluation of play programs and early childhood games.

According to Vigotsky play and activities that are concrete can provide natural momentum for children to learn something that is in accordance with the stages of development of their age and needs. Playing as an implementation of learning in early childhood provides various benefits to develop all potential development of children. As stated by Freeman and Munandar in Ismail [1] the benefits obtained from playing are a) as a distributor of excess energy that children have, b) as a means to prepare their lives later in life, c) as a continuation of humanity's image, d) to build lost energy, e) to get compensation for things that are not obtained, f) play allows the child to let go of his feelings or emotions, and g) give a stimulus to his personal formation.

Given the importance of playing and games for early childhood as stated, educators, especially graduates of PG PAUD study programs, must master the theory and practice of the basic concepts of play and early childhood games so that they can guide and direct each play activity so that what is the goal learning can be achieved. In fact, there are still many students who have embraced this course that are still not optimal, especially in compiling educational game tools that are suitable for children's development. Less optimal ability possessed by students who have taken this course is due to the use of learning models in lectures that are not yet in accordance with the characteristics of courses that require a lot of competence in it and the minimum availability of learning facilities that can support students in the practice of making educational games. During this time students only wait for the material prepared by the lecturer, make a paper based on the material presented by the lecturer then work in groups to compile the paper and then be presented by the group and conduct discussion questions and answers [12].

Therefore, an innovative approach, strategy, model or method is needed so as to create collaborative, interactive and contextual learning activities. The learning model that was developed as an effort to create a learning process that leads to analysis, synthesis, and evaluation activities as well as improving the ability of students and lecturers in terms of assimilation and application of knowledge is Research Based Learning (PBR) [8]. According to Roach M in Widayati, *et al* [2], Research-Based Learning is a learning method that uses authentic learning, problem solving, cooperative learning, contextual (hands on & minds on, and inquiry discovery approach guided by constructivism philosophy. Research-Based Learning provides opportunities to students to find information, compile hypotheses, collect data, analyze data, and make conclusions on data that has been arranged, in this activity applies learning with the approach of "learning by doing." Research-Based Learning can also help students develop critical thinking skills [9].

Critical thinking ability, according to Ennis [3], is a mental activity that is reflective and based on reasoning that is focused on determining what to believe and do. The ability to think critically is the basic thinking process to understand and analyze a problem around it by looking at various points of view.

There are 12 indicators of critical thinking skills according to Ennis [4], namely: focus the question, 2) analyze the argument, 3) ask and answer the question, 4) consider whether the source can be trusted or not, 5) observe and consider the observation report, 6) deduce and consider the results of deduction, 7) induce and consider the results of induction , 8) make and determine the results of consideration, 9) define terms and consider a definition, 10) identify assumptions, 11) determine an action, and 12) interact with others.

The indicators of critical thinking skills can be developed in research-based learning. In research-based learning, students identify or formulate questions that might come from the surrounding environment [10]. Students must also consider the possibility of answers to be answered so that the

answers can be accepted by the community. After focusing the questions, students begin to identify questions or arguments that arise from the surrounding environment and students make a solution that can handle a problem that is not appropriate to be given and then given a treatment. When students have known the problems, students can ask the supervisor about the case studies they will examine. Students must be able to answer questions from lecturers, because in conducting research, lecturers only guide and activities focused on students. So, students need to answer questions from fact-based lecturers that exist along with simple examples.

In research-based learning, students also need to know the theories that exist. Students must be able to consider the sources they can, according to the research they do and students are expected to be able to provide the right reasons according to the source they have been looking for. After students know the theories and problems that exist, students begin to carry out preliminary observations, see the actual events in the field. Students must be able to report observations based on what they have examined in the field by attaching some evidence in the form of photos, videos, or other supporting evidence. After making observations, students are expected to be able to condition the logic in considering the results of deduction with supporting evidence, and students can state the interpretation of the results of the research that has been done. From the results of preliminary observations made by students, students can design an experiment as a remedy for solving problems in the field. From these results, students can draw conclusions according to the facts they can in the field.

After carrying out preliminary observations and designing an experimental activity, students make and determine the results of consideration of the various facts they have gotten from the observations they have made [11]. When students make and determine the results of consideration, students are also required to think about what consequences or events might occur from the experimental activities they provide. Before students give a handling of the results of their initial observations or experiments, students must first understand the definition of terms about what they will do. Then, students begin to identify and construct various arguments from the group regarding the facts they have gotten in the field.

Students express any problems that occur in the field. If the results of the initial experiments have not been successful, students must repeat the experiment by providing an alternative solution so that the problems in the field can be overcome. Students explain the results of the experiments they have done to others, both teachers and parents using good logic and rhetoric so that what the students have conveyed can be well received by the community.

Students' critical thinking skills can be developed through research-based learning. According to Roach M in Widayati, et al [2] Research-Based Learning is a learning method that uses authentic learning, problem-solving, cooperative learning, contextual (hands on & minds on, and inquiry discovery approach that is guided by constructivism philosophy. Research-Based Learning is learning that can build understanding students through real experience, because this learning uses a learning by doing approach and students can be skilled at solving problems that exist in the surrounding environment and provide solutions that can be applied to the community.

The implementation of Research-Based Learning can be carried out in several learning models developed in accordance with the characteristics of the study of science and the conditions of the facilities available in the education unit concerned [10]. The strategy for implementing Research-Based Learning should be thoroughly considered so that the implementation of effective Research-Based Learning and the objectives of Research-Based Learning are achieved. Here are some strategies for integrating empirical learning and research developed at Griffith University [4]: 1) Enriching teaching materials with the results of lecturers' research. Lecturers can explain the results of related research in lectures which are expected to function to help students understand research ideas, concepts, and theories; 2) Use the latest research findings and track the history of the discovery of the latest developments. Recent discoveries are discussed in lectures to support the appropriate subject matter. Thus students can have an understanding that current policies and practices can be carried out and developed at this time, because of the policies and practices that have been developed previously. This all constitutes a unity of dynamics in the development of science. 3) Enrich learning activities with contemporary research issues. Students are asked to submit research issues related to the subject matter and then asked to discuss the application of

the research issue to resolve real problems in life; 4) Teaching material on research methodology in the learning process. It is expected that by teaching research methodology in the learning process, students are able to do research in small scale to solve a problem related to the subject matter; 5) Enrich the learning process with small-scale research activities. Students are given assignments in groups to conduct research on a small scale, thus students can improve the skills and knowledge of these activities. With this activity the research culture can be more developed compared to if the research is held individually; 6) Enrich the learning process by involving students in institutional research activities. Lecturers together with students conduct umbrella research, where students are given research assignments which are part of the research conducted by lecturers; 7) Enriching the learning process by encouraging students to feel part of the research culture at the faculty / department. Encourage students to take part in research seminars, either as participants, paper presenters, or as seminar organizers. 8) Enriching the learning process with values that must be possessed by researchers. The values that must be possessed by researchers should need to be understood by students. These values include: objectivity, appreciation of research findings, respect for other views, tolerance for uncertainty, and analytical skills.

In research-based learning, students certainly need help from friends formed in a team. According to Solihatin Cooperative learning is cooperative learning is a shared attitude or behavior in working or helping among others in the structure of regular cooperation in groups, which consists of two or more where work success is strongly influenced by the involvement of each group member own. The purpose of cooperative learning is to create a situation where individual success is determined or influenced by the success of the group, Slavin. It was concluded that cooperative learning is learning carried out in groups in understanding material, solving or discussing a problem, and usually in one group consists of several students who have different abilities and learning styles. Some students have independent field cognitive styles and some use field dependent cognitive styles.

Cognitive style is related to the way a person faces cognitive tasks, especially in problem solving. Blacman and Goldstain. suggest that cognitive style is related to how one thinks. Woolfolk [5] argues that cognitive style is how one receives and organizes information from the surrounding world. In this study, what is meant by cognitive style is a typical way of learning in children, both related to the way of receiving and processing information, attitudes towards information, and habits related to the learning environment.

According to Winkel [6] that the characteristics of children who have an independent field of cognitive style are likely to pay more attention to parts and components in a pattern and are often more oriented towards the completion of tasks rather than agile social relations. While the field dependent according to Winkel[7] describes the characteristics of people who have a cognitive field dependent style is likely to view a pattern as a whole and often oriented to fellow humans and social relations.

According to O'Brien in Suryanti [7] there are differences in the characteristics of field dependent and independent fields, including the following: (1) individuals who have a field dependent style are more holistic and global in processing perceptions and information so commonly called "Global thinkers", individuals with cognitive field dependent tend to memorize what has been said or presented, (2) individuals with independent fields have a higher level of analysis in receiving information, and individuals with field independent styles tend to like to use problem solving techniques, analysis, organization, and structuring when they are working or studying.

In research-based learning in play and game courses, students with field-dependent cognitive styles can easily do research in the community and work together in teams. Students with a cognitive field independent style do not mean that they cannot carry out research activities in the field, they can carry out research activities by analyzing activities in the field less or without help from teammates. It can be concluded that students with field independent cognitive styles are less able to use cooperative learning models.

Data collection techniques in this study must pay attention to 12 indicators of critical thinking. In addition, things that must be considered in data collection techniques are cognitive style instruments, including; 1) conceptual, 2) operational, and 3) instrument grid. Conceptual definition, namely cognitive style is a typical way for children to learn, both related to the way of receiving and processing

information, attitudes towards information, and habits related to the learning environment. While the operational definition is, cognitive style is a typical way of learning in children, both related to the way of receiving and processing information, attitudes towards information, and habits related to the learning environment expressed in the form of cognitive style scores. And the instrument grid is the test instrument used to determine the type of cognitive style, namely field independent cognitive style and cognitive field dependent style is the Group Embedded Figure Test (GEFT).

2. Method

The study was conducted by using an experimental method using factorial design 2 x 2 design. It is a square experimental design which can be described as follow.

Table 1. Matrix of factorial design 2 x 2 square

Method	Research Based Learning	Cooperative Learning
Cognitive Style	A1	A2
Field Independent B1	A1B1	A2B1
Field Dependent B2	A1B2	A2B2

In this study, the target population was all FKIP PG PAUD of Jember University students. Affordable population is students in semester 3 of odd semester 2018/2019 in FKIP PG PAUD of Jember University. For sampling in this study carried out with a multi stage random sampling technique.

Table 2. Distribution of Samples in Research Design

Method Cognitive Style	A1	A2	∑row
B1	62	62	124
B2	62	62	124
∑column	124	124	248

The data analysis technique in this study used descriptive analysis to describe the raw data in the form of a frequency distribution table and visualization with a histogram graphic image. Testing the analysis requirements was carried out by normality and homogeneity tests between groups, and inferential analysis using analysis of two-way variance (ANAVA) and further testing with the Turkey test because this study was an experimental study with the design of Factorial Design 2x2.
The statistical hypotheses to be tested are as follows:

Hypothesis 1: H0: $\mu A1 \leq \mu A2$ **Hypothesis 3:** H0: $\mu A1B1 \leq \mu A2B1$
                 H1: $\mu A1 > \mu A2$ H1: $\mu A1B1 > \mu A2B1$
Hypothesis 2: H0: Int A x B = 0   **Hypothesis 4:** H0: $\mu A1B2 \geq \mu A2B2$
                 H1: Int A x B $\neq$ 0   H1: $\mu A1B2 < \mu A2B2$

3. Results and Discussion

Tabulation of research data is grouped into eight data groups, namely: (1) groups of children who use research-based learning methods (A1), (2) groups of children who use cooperative learning methods (A2), (3) groups of children who have cognitive style field independent (B1), (4) groups of children who have a field dependent cognitive style (B2), (5) groups of children who use research-based learning methods and have independent cognitive field styles (A1B1), (6) groups of children using the method research-based learning and having a field dependent cognitive style (A1B2), (7) groups of children using cooperative

learning methods and having an independent field cognitive style (A2B1), and (8) groups of children using cooperative learning methods and having field dependent cognitive styles (A2B2).

The description of the eight groups of data is completely presented with mean, median, mode, standard deviation, and variance values can be seen in the following table:

Table. 3. Description of Distribution of Student Critical Thinking Ability Scores

Variable	Average	Modus	Median	Standard Deviation	Variance
A1	9.14	8	9.5	1.69	2.87
A2	5.31	5	5	1.31	1.70
B1	8.31	6	6	1.94	3.75
B2	6.14	8	6	1.69	2.87
A1B1	10.67	10	11	0.69	0.47
A1B2	7.61	8	8	0.70	0.49
A2B1	5.94	6	6	1.35	1.82
A2B2	4.67	5	5	0.91	0.82

Testing the analysis requirements using the normality test and homogeneity test. The normality test based on the calculation of normality of the data with the Liliefors Test in all study groups is known that L_{count} for all groups is smaller than L_{table}, this implies that in all study groups came from the population with normal distribution. While the homogeneity test based on calculations obtained the value of $x^2_{count} = 0.21$, while x^2_{tabel} for the significance level $\alpha = 0.05$ with the number of groups 4 - 1 = 3 is 7.82 this means $x^2_{count}(0.21) < x^2_{tabel(0.05:3)}(7.82)$ means that the variance of the four groups is homogeneous.

In general, the average score of the critical thinking skills of children in each research group can be described in the variance test table with ANAVA, the following two lines:

Table 4. Difference Test Using ANAVA

COGNITIVE STYLE \ METHODE	Research Based Learning (A1)		Cooperative Learning (A2)		Total	
Field Independent (B1)	n_1	18	n_2	18	n_{b_1}	36
	$\sum Y_1$	192	$\sum Y_2$	107	$\sum Y_{b_1}$	299
	$\sum Y_1^2$	2056	$\sum Y_2^2$	667	$\sum Y_{b_1}^2$	2723
	$\sum y_1^2$	8.00	$\sum y_1^2$	30.94	$\sum y_1^2$	38.94
	x_1	**10.67**	x_2	5.94	x_{b_1}	**8.30**
Field Dependent (B2)	n_3	18	n_4	18	n_{b_2}	36
	$\sum Y_3$	137	$\sum Y_4$	84	$\sum Y_{b_2}$	221
	$\sum Y_3^2$	1051	$\sum Y_4^2$	406	$\sum Y_{b_2}^2$	1457
	$\sum$	8.277	$\sum$	14	$\sum$	22.2

	y_1^2	8	y_1^2		y_1^2		8
	x_3	7.61	x_4	4.67	$\frac{x}{b_2}$		6.14
	$\frac{n}{k_1}$	36	$\frac{n}{k_2}$	36	$\frac{N}{t}$		72
Total	$\sum Yk_1$	329	$\sum Yk_2$	191	$\sum Yt$		520
	$\sum Yk_1^2$	3107	$\sum Yk_2^2$	1073	$\sum Yt^2$		4180
	$\sum y_1^2$	16.28	$\sum y_1^2$	44.94	$\sum y_1^2$		61.2 / 2
	$\frac{x}{k_1}$	9.14	$\frac{x}{k_2}$	5.31	Xt		7.22

Note that: A1 = groups of children who use research-based learning methods, A2 = groups of children who use cooperative learning methods, B1 = groups of children who have a cognitive field independent style, B2 = a group of children who have a field dependent cognitive style, A1B1 = a group of children who use research-based learning methods and have a cognitive field independent style, A1B2 = a group of children who use research-based learning methods and have a field dependent cognitive style, A2B1 = groups of children who use cooperative learning methods and have cognitive field independent styles, A2B2 = a group of children who use cooperative learning methods and have a field dependent cognitive style.

From the ANAVA table above, it can be explained that the average of A1B1 is 10.67 (SD = 0.69), while the average of A1B2 is 7.61 (SD = 0.70). It can be concluded that the group of students using research-based learning methods that have field independent cognitive styles have higher critical thinking skills than students who have field dependent cognitive styles. In addition, explained the averages of A2B1 are 5.94 (SD = 1.35) and A2B2 is 4.67 (SD = 0.91). From the data above the group of students who used cooperative learning methods with field independent cognitive styles were higher than students who had field dependent cognitive styles. From the data presented above, it can be concluded that learning using research-based learning is more effective than cooperative learning.

Based on the research data, the calculation is done manually, using two-way ANOVA analysis results as in table 05 and further testing using the Tukey Test in Table 6 below.

Table 5. Variant Analysis Results Using Two Path ANAVA

VARIANT	JK	Db	RJK	F*o*
Between A	264.50	1	264.50	293.78**
Between B	84.50	1	84.50	93.85**
Interaction AB	3769.78	1	3769.78	4187.12**
Within (D)	61.22	68	0.90	
Total (T)	424.44	71		

From Table 5, it is explained that the average of A is 264.50 and Fo is 293.78 which states that it is very significant. While the average of B is 84.50 and F_o is 93.58 which states that it is very significant. The mean of interactions A and B are 3769.78 and F_o is 4187.12 which states that there is a very significant interaction. From the information above, it can be concluded that there are significant differences between A and B.

Table 6. Results of Advanced Calculations with the Tukey Formulation

GROUP	N	K	Dk (k:n)	q	q_{table}	
					$\alpha = 0.05$	$\alpha = 0.01$
A1B1 with A2B1	18	4	3:68	6.80**	3.44	3.37
A2B2 with A1B2	18			0.86ns		
A1B1 with A1B2	18			6.36**		
A2B2 with A2B1	18			1.29ns		

*Description: +, **: very significant, ns: non significant*

Based on calculations using the Tukey test obtained Q_{count} (6.80) <Q_{table} (3.44) at a significant level α = 0.05. meaning there is a significant difference between A1B1 and A2B1. In A2B2 and A1B2 it can be seen that Q_{count} (0.86) <Q_{table} (3.44) at a significant level α = 0.05 means that there is no significant difference between the two. Between A1B1 and A1B2, Q_{count} (6.36) <Q_{table} (3.44) was obtained at a significant level α = 0.05 which states that there is a significant level between the two. Whereas in A2B2 and A2B1, Q_{count} (1.29) <Q_{table} (344) at a significant level α = 0.05 which states that there is no significant difference between the two.

From the data analysis above, the discussion of the research results is as follows: Research-based learning is very helpful for students in developing their critical thinking skills. Because, in research-based learning, students go directly to the field to find information about any problems that exist in the PAUD environment. Then, students begin to compile hypotheses, collect data, analyze data, and make conclusions from data that has been arranged. After all the data is collected, students begin to design an activity that can help overcome the problems that exist in the PAUD environment.

The high absorption of students using research-based learning methods in solving problems is encourage by: (1) Research-based learning builds students' understanding through real experience, because this learning engages a learning by doing approach, (2) Students can be skilled in solving problems in the surrounding environment and provide solutions that can be applied to the community. Through research-based learning that uses a learning by doing approach students can compare existing theories with reality in the field. Students in the research-based learning model are given the opportunity to develop their critical thinking skills through various problems in the environment that must be properly resolved. Research-based learning can also help students develop 12 indicators of critical thinking [13]. The 12 indicators of critical thinking according to Ennis, namely; 1) focus the question, 2) analyze the argument, 3) ask and answer the question, 4) consider whether the source can be trusted or not, 5) observe and consider the observation report, 6) deduce and consider the results of deduction, 7) induce and consider the results of induction , 8) make and determine the results of consideration, 9) define terms and consider a definition, 10) identify assumptions, 11) determine an action, and 12) interact with others.

Dissimilar of research-based learning, cooperative learning is a learning process carried out in groups in understanding material, solving or discussing a problem. In cooperative learning, students have only been waiting for the material prepared by the lecturer, making papers based on the material presented by the lecturer, then working in groups to compile the paper and then presented by the group and conducting question and answer discussions. Cooperative learning can be said to be successful if one group of members has understood the material that has been studied together, and said it has not succeeded if there are still group members who do not understand what they have learned.

Such learning models have not been effective enough to be able to achieve learning goals that achieve student achievement, because it is caused by: (1) In cooperative learning students usually share material with friends in a group to be summarized and then put together in a paper, this causes no all students understand the overall material given by the lecturer, (2) Not all students can work together in learning, sometimes there are still students who are reluctant to work on and submit group assignments to friends who are considered more able to do the work. Students are less able to develop their critical thinking skills if they are just waiting for material from the lecturer for what will later be presented. In this learning model, most students depend on friends who are considered capable, so the lack of effort from students to develop their critical thinking skills.

Interaction means that there is cooperation between two or more independent variables in influencing the dependent variable. The significance of this interaction will have implications for the form of interaction that occurs. This means that the influence of interactions will have important meaning if testing on simple effects of each level of treatment. This means that students' critical thinking skills are determined by differences in the level of learning methods with the level of cognitive style. Because there are significant interactions, to see the magnitude of the difference in contribution in each experimental group towards the dependent variable, a further test with the Tukey formulation was carried out which aimed to see the simple effect of each treatment class.

The research hypothesis states that there is a significant interaction between learning models and cognitive styles on students' critical thinking abilities. Lecturers must be able to determine and provide learning models that can develop students' critical thinking skills. Research-based learning models and cooperative learning models can influence students' critical thinking skills because students are required to complete a case study. What distinguishes the two learning models is that students who are given research-based learning are better able to solve problems that are happening in their environment than students who are given cooperative learning who are only given case studies by lecturers.

The research hypothesis states that the critical thinking ability of students with cognitive field independent style with research-based learning models is higher than the group that uses cooperative learning models. The success of student groups that use research-based learning methods, related to the conditions of learning that can support students have a field independent cognitive style for maximum learning, including: 1) learning that provides an individual or independent learning environment, 2) provided more opportunities for learn and find a concept or principle for yourself, 3) more resources and learning materials are provided, 4) learning that provides little guidance and purpose, and 5) prioritizes instruction and goals individually.

Students with a field independent cognitive style are students who receive and process information, attitudes towards information obtained in their learning activities are less or not even influenced by their environment. Students can solve their own problems without guidance. Students can easily take a decision or action because they have clear and structured goals. This is what can develop students' critical thinking skills. Because, students identify their own problems based on what they have met in the field and also students with cognitive field independent styles are not affected by criticism from the surrounding environment.

The research hypothesis states that critical thinking skills of groups of students with cognitive field dependent styles with research-based learning models are higher than groups that use cooperative learning models. Students with a field dependent cognitive style are students who receive and process information, attitudes toward information obtained in learning activities are influenced by the environment or depend on the environment. Students' critical thinking skills with field dependent styles can be developed in research-based learning, because in research-based learning students interact directly with others.

Students with a field dependent cognitive style may be easily affected by criticism from the surrounding environment when carrying out research-based learning. However, criticism from the student environment can help students identify and construct various arguments. Thus, any criticism or argument can help students in determining an action. This can help students develop their critical thinking skills.

This is rarely found if students use cooperative learning models. Because, not all students understand the material given by the lecturers and also not all students participate in cooperative learning. In cooperative learning, students' critical thinking skills may only be obtained by a group of students who truly understand the material provided by the lecturer.

4. Conclusion

Based on the results of data analysis and discussion, conclusions can be drawn as follows: (1) There are differences in students' critical thinking skills with research-based learning models with cooperative learning models, (2) There are significant differences in interaction between learning models and cognitive styles of critical thinking, (3) There are differences in students 'critical thinking skills with research-based and cooperative learning-based learning models in field independent cognitive style, and

(4) There are differences in students' critical thinking abilities with research-based learning and cooperative learning with field dependent cognitive styles.

Acknowledgement

References

[1]   Andang Ismail 2006 *Pilar Media* Yogyakarta, Indonesia
[2]   Widayawati 2010 LP2M UGM Yogyakarta, Indonesia
[3]   Sunardjo, R. Nugrahenny. Yudhianto, Suroso Adi. Rahman, Taufik 2016 *Journal of Education* Vol 13 (**1**), 133-144.
[4]   Griffith Institute for Higher Education 2008 *University of Griffith*
[5]   Woolfolk, Anita 1993, *New Jersey: Allyn and Bacon A Division of Simon and Schuster, Inc.*
[6]   Winkel, W.S. 1996 Psikologi Pengajaran *Gramedia Widiasarana* Indonesia,.
[7]   Suryanti, Nunuk 2014 *Pancaran Pendidikan 1*. Vol. 4. No. 1, pp. 45-51
[8]   Tohir, M. Abidin, Z. Dafik. Hobri. 2018 *Journal of Physics: Conf. Series* 1008 (2018) 012072
[9]   Sanit Srikoon, Tassanee Bunterm, Jakkrit Samranjai, JintanapornWattanathorn, 2014 *Procedia-Social and Behavioral Sciences* 116, 913-917
[10]   Suntusia, Dafik, Hobri, 2019 *International Journal of Instruction*, **12** (1), pp. 33-52
[11]   Hobri. Dafik. Hossain 2018 *International Journal of Instruction* **11** (2), pp. 483-496
[12]   Sutarto. Nusantara, T. Subanji. Hastuti, I. Dafik. 2016. *J. Phys*.: Conf. Ser. 1008 012060
[13]   Mohammad Mukhlis, Dafik, Hobri 2018 *IJAERS* Vol-5, Issue-4