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Differences in Critical Thinking Skills through Group Discovery Learning (GDL)

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ABSTRACT

Critical thinking skills include the ability to reason, analyze, make decisions, assess, explain, and self-regulate. This study was to determine the effect of Group Discovery Learning (GDL) on students' critical thinking skills in terms of academic abilities. This was a quasi-experimental research design using a post-test only with a non-equivalent control group design. The population was students of class X MIPA SMA Negeri 1 Sukoharjo. The subjects were taken using simple random sampling which met the normality and homogeneity tests. The sample was class X MIPA 5 as the control class and X MIPA 2 as the experimental class. Data were collected using essay tests, documentation, and observation. The hypothesis was tested with two-way ANOVA followed by the LSD test. The results show that: (1). Students' critical thinking skills were affected by the group discovery learning model. (2). There is a significant difference between students' academic abilities on critical thinking skills between control and experiment classes. These results can be used for further research in building active and innovative learning models and strategies.

Keywords: Group Discovery learning, student critical thinking, student academic ability, quasi experiment

Introduction

Rapid changes in science and technology encourage every country to improve the quality of human resources to face the progress. According to Nisa, Koestiari, Habibbulloh, and Jatmiko (2018), technological and scientific advances need to be balanced with improving the quality of human resources. Quality human resources are obtained through a quality education process (Kusumaningrum & Djukri, 2016).

The development of students' is aimed to develop students' High Order Thinking Skills (HOTS). One of the HOTS to empower is critical thinking skills. According to Kaufman (2013), Critical thinking skills can improve intellectual abilities through cognitive activities. Critical thinking is a skill to think based on truth through the observing, analyzing, and evaluating information (Damayanti et al., 2019). According to Eklof (2005), Critical thinking skills are habits and intellectual skills are guided in deep understanding. Critical thinking skills are important to solve a problem, helping students be independent, flexible, and creative inside and outside of school. According to Zivkovic (2016), critical thinking is an important attribute in success. Critical thinking encourages students to make the best decisions and gain knowledge quickly (Lau, 2011).

According to Facione (2015), critical thinking skills have six aspects, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation. These six aspects are used to develop and practice critical thinking skills in seeking truth, thinking openly, analyzing problems, thinking systematically, expressing opinions and reasons, curiosity, and making decisions. Interpretation aspect is a skill in understanding and expressing data. Analysis is a skill for analyzing. Evaluation is an assessment of credibility. Inference is the identification, collecting data, making hypotheses and relevant conclusions. Explanation is a reasonable and coherent presentation. Self-Regulation is self-reflection (Facione, 2015).

Puteh & Hamid (2014) stated that critical thinking skills need to be developed. Critical thinking skills can be optimally empowered in learning activities. Teachers can plan learning strategies by involving active learning (Damayanti et al., 2019). Learning strategies are adjusted to the level of skill and the topics.

Critical thinking skills can be developed and trained through active learning involving higher-order thinking especially with learning that requires deep understanding. According to (Sudarisman, 2015), biology learning requires higher-order thinking skills to build an in-depth understanding of scientific concepts, theories, and principles. Suharsaputra (2014) stated that learning not only focuses on knowing the concept but also understanding the concept.

Arsy et al., (2018), stated that the low level of students' critical thinking is caused by teacher-centered learning. This method makes students tend to be passive (Fuad et al., 2015), thus makes students become less critical and lack of flexibility.

Critical thinking skills can be developed with a group discovery learning (GDL) learning model. In this learning, students learn in groups and expected to interact, communicate, and cooperate in building concepts and knowledge. GDL integrating the Discovery Learning model with Group Investigation (cooperative learning) that complements each other's shortcomings and advantages (Prasetyana et al., 2015).

According (Genovese, 2003), the cooperative model emphasizes the group interaction that is structured in cooperation with each other and supports contextual learning activities (Raelin et al., 2014). One of the cooperative learning is the group discovery learning (GDL) with an emphasis on student participation and activities in building information and concepts. GDL fosters thinking skills by empowering students' active participation in learning activity. GDL has investigation process that can be combined with the discovery process in groups. GDL has the syntaxes of grouping, orientation, hypothesis generation, hypothesis testing, conclusion, presenting, and evaluating (Prasetyana et al., 2015). The orientation has activities

of identifying, clarifying, exploring, and formulating problems that train students to interpret. Hypothesis generation includes creating, sorting, and selecting hypotheses that train students to interpret. Hypothesis testing includes designing, experimenting, collecting, interpreting, analyzing data to prove hypotheses that train students for analysis and evaluation. Conclusion includes making conclusions, verifying, testing hypotheses that train students in analysis and inference. The presenting is explaining, presenting, evaluating, clarifying, and asking questions that train students to explanation, analysis, and inference. The evaluation includes process of evaluation activities, self-evaluation, conducting assessments that train students evaluation and self-regulation.

GDL is expected to not only improve student skills and achievements but also create a conducive learning environment in achieving learning objectives. According to Nasution (2013), academic ability is categorized into lower, medium, and upper academic abilities.Those descriptions underline the need for proper leaning method to improve students' critical thinking skills. One of the potential solutions is the Group Discovery Learning (GDL).

Methods

This was a quasi-experiment with the Posttest-Only Nonequivalent Control Group Design. Data were collected with questionnaires and tests. The research was carried out in one public high school in Sukoharjo. The subject was divided into experimental classes and control classes. The experimental class use GDL model and the control class uses a discovery learning model. The assessment is carried out to obtain the value of students' critical thinking skills with Facione aspect indicators, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2015). The instrument was six essay questions that adjusted to the aspects of critical thinking skills. The hypothesis is that there are differences in the application of Group Discovery Learning (GDL) and Discovery Learning to students' critical thinking ability in terms of academic ability. Statistical test was done using two-way ANOVA.

Results and Discussion

Critical thinking is the ability to think based on observing, evaluating, and analyzing information in making accepted or rejected decisions (Damayanti et al., 2019). Critical thinking focuses on how to make educated decisions from problem recognition activities to evidentiary plans (Ennis, 2015). According to Ennis (2015), expressing the essential elements of critical thinking is tendencies (attitudes) and abilities (skills). Attitudes and skills to cover the examination of evidence, reasons, statements supporting various conclusions.

Research using critical thinking skills assessment Facione (2015) with aspects of interpretation, analysis, inference, evaluation, explanation, and self-regulation. These six aspects have the objective of measuring a person's critical thinking skills that involve curiosity, open-mindedness, systematic thinking, analyzing problems, expressing arguments and reasons, and making conclusions. Students' critical thinking skills were assessed based on criteria from Facione (2015) and adapted to the topic of environmental changes. The results can be seen in Table 1 and Figure 1.

Table 1. Students' Scores on Aspects of Critical Thinking Skills During Posttest

Aspects	Averages	
	Control	Experiment
Interpretation	2.694	3
Analyze	2.778	3.028
Inference	2.5	2.694
Evaluation	2.306	2.694
Explanation	2.167	2.444
Self-Regulation	2.056	2.333

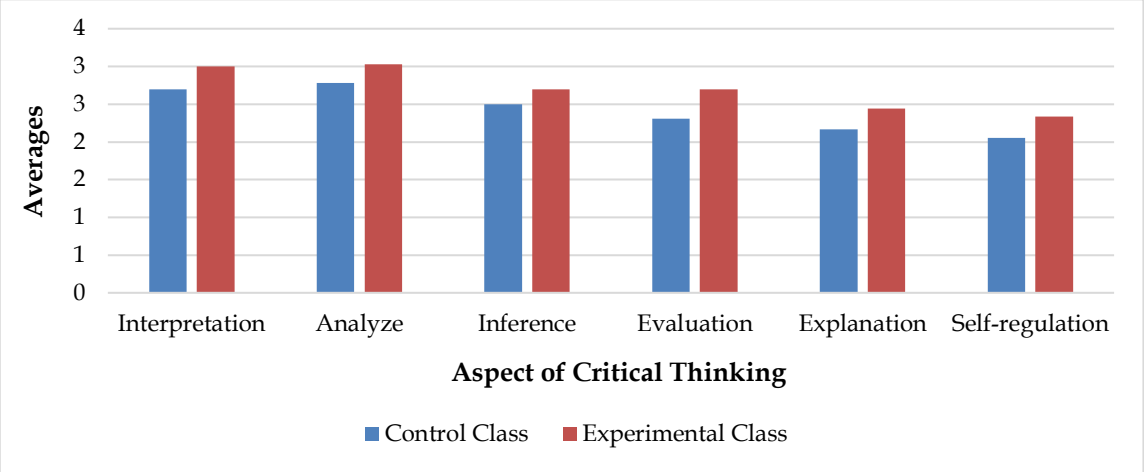

Figure 1. Histogram of Every Aspect of Critical Thinking

Table 1 and Figure 1 show that the average score of students' thinking skill differs in each aspect. Differences can also be seen from the averages between experimental class and the control. Explanation of each aspect as follows.

The interpretation is the ability to express and understand the meaning of data, events, and experiences (Facione, 2015). The results show that the interpretation score of the experiment class has a higher value compared to the control class. These differences occurred due to differences in students' skills in interpreting, looking for references, and students' conceptual understanding. GDL can optimize students' interpretation abilities through orientation and hypothesis generation syntaxes.

The analytical skills are the ability to identifying data, concepts, and statements in actual terms to be used as material for decision consideration (Facione, 2015). The experiment class has higher scores compared to control class. These differences occurred due to differences in analytical skills, experiences, and ideas. GDL can optimize students' analytical ability through hypothesis testing, conclusion, and presenting syntax. The inference is the ability to make conclusions that are relevant to the elements, data, and supporting evidence (Facione, 2015) This occurred due to differences in students' ability to make conclusions based on arguments and evidence. GDL can optimize students' inference ability through conclusion and presenting syntaxes.

Evaluation is the ability to assess the credibility of a statement, judgment, decision, experience, and perception by considering its strengths and weaknesses (Facione, 2015). The results show that experiment class has a higher score compared to the control class. These differences occurred because differences in students' evaluation metacognition ability. GDL can optimize students' evaluation ability through hypothesis testing and evaluation syntaxes. The explanation is the ability to present information factually, conceptually, and procedurally. The results show that the experiment class has higher scores compared to control class. These differences occurred due to differences in levels of students' experience, confidence. GDL can optimize students' explanatory abilities through presenting.

The self-regulation is self-reflection and self-monitoring after implementing activities and evaluation before making decisions. The results show that the experiment class has higher scores compared to control class. It occurred because of differences in students' evaluation skill. GDL can optimize students' self-regulation ability through evaluation syntax.

The scores then analyzed using ANOVA test. The results of the two-way ANOVA test can be seen in Table 2.

Table 2. ANOVA Test Results on Students' Critical Thinking Skills Bade on Learning Models

	Source	Sig.	Criteria	Verdict
KBK	Learning Model	0.001	Sig. <0.05	H_0 is rejected

The two-way ANOVA test shows a signification value of 0.001; thus H0 is rejected and H1 being accepted. It means that there are effect of learning models to students' critical thinking skills. The sig value is smaller than 0.05 so there was a difference between the group discovery learning model and the students' critical thinking skills.

The average score of the experimental class was 68,997 while the average score control class was 58,982. The difference occurs because the experimental class uses GDL that provides opportunities for students to play an active role in learning and exchanging information. Learning using discovery learning has not fully encouraged students to think critically because it only emphasizes students to build knowledge with.

Critical thinking skills can be improved through scientific work. A learning that allows students to learn from each other, exchange information, and scaffolding will optimize their critical thinking understanding (Sulistijo et al., 2017). Prayitno et al., (2013) stated that group learning encourages students to take responsibility for each other while studying and teach to achieve maximum learning outcomes.

Radulović & Stančić (2017) stated students' critical thinking can be developed using more discursive and argumentative teaching and assessment methods. GDL provides students to play an active role in conducting discussions, and involve students actively conducting experimental activities. Critical thinking can be optimized by conducting trainings and experiments through observing, analyzing, finding solutions, and implementing decisions.

Group discovery is contextual learning that involves interaction activities between students, conducting discussions, and expressing opinions in a group collaboration. Groups as a forum for exchanging information, knowledge, and experiences help solve problems effectively and efficiently. Cooperative learning develops potential problems-solving skill assisted by teacher guidance and peer cooperation. Students obtain information and knowledge through interpersonal activities (Goodyear, 2017). The improvement of critical thinking is not only from the differences in learning models but rather there are other factors that influence the higher-level thinking processes of students.

The analysis shows that there are differences in students' critical thinking skills between experimental classes and control classes. GDL is more effective to help students develop their critical thinking skills compared to discovery learning models. GDL syntax stimulates every aspect of critical thinking and thus shows better results compared to DL.

Students' critical thinking skills were assessed based on criteria from Facione (2015). The students' academic level were grouped based on the frequencies of distribution patterns. The students were divided into three groups which can be seen in Table 3 and Figure 2.

Table 3. Aspects of Students' Critical Thinking Skills Seen from Students' Academic Levels

Aspects of Critical Thinking	**Academic Skill**		
	Low	**Mid**	**High**
Interpretation	2.33	2.84	3.4
Analyze	2.57	2.94	3.2
Inference	2.24	2.55	3.05
Evaluation	2.14	2.45	2.99
Explanation	1.90	2.26	2.8
Self-Regulation	1.96	2.13	2.55

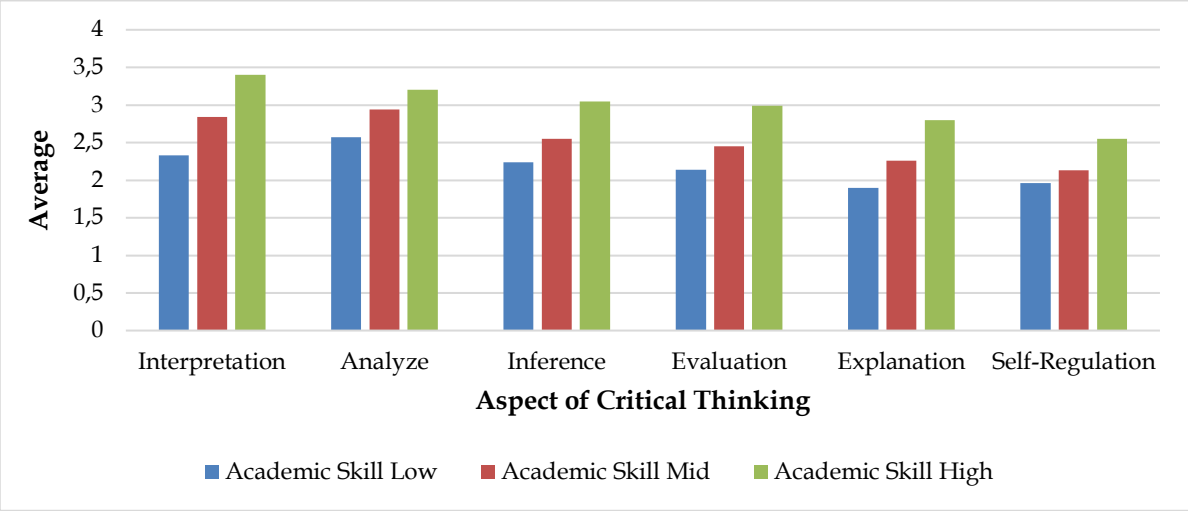

Figure 2. Aspects of Students' Critical Thinking Skills Seen from Students' Academic Levels

High academic ability (HA) students have the potential to improve their critical thinking skills better (Changwong, et.al., 2018; Mamu, 2014). According to Fong (2017), there is correlation between academic ability and critical thinking skills. Students who have high cognitive skill gain more optimal improvement in their higher-order thinking skills. The results also show significant difference between the value of aspects of interpretation, analysis, evaluation, inference, explanation, and self-regulation in terms of students' academic abilities.

The critical thinking has six aspects. The first aspect is the interpretation, which is the ability to express meaning, understand, and express the meaning of data, events, and experiences. Figure 2 show Low academic (LA) students have the lowest score, Mid Academic (MA) students have moderate grades, and KAT (High Academic) students have the highest scores. The differences in grades occurred due to differences in students' ability and understanding in interpreting, the higher their academic ability, the higher their critical thinking skills. HA students usually have high reasoning ability (Nurmaliah, 2013).

The second aspect is the analyze, the skills to process and identify data, concepts, and statements in actual terms to be used for decision consideration. The lowest scores were obtained by LA students, MA students got moderate results, and HA students got the highest scores. The difference in grades occurs due to differences in the level of analytical ability, the higher the academic ability, the higher the critical thinking skills. As stated by Karakoc (2016), that HA students have high metacognition in learning. Metacognition is awareness in understanding, controlling, manipulating cognitive processes and thinking.

The third aspect is inference, the skills to make conclusions relevant to the elements, data, and supporting evidence. The lowest scores were obtained by LA students, MA students got moderate scores, and HA students got the highest scores. The differences occur due to differences in the students' skill. Changwong (2018), stated that HA students have the potential to improve their critical thinking skills better. Critical thinkers think analytically, openly, and speak based on the correct facts in making decisions.

The fourth aspect is evaluation, the skills to assess the credibility of a statement, judgment, decision, experience, and perception by considering its strengths and weaknesses. The lowest scores were obtained by LA students, MA students got moderate results, and HA students got the highest scores. The difference in grades occurs due to differences in the level of analytical ability, the higher the academic ability, the higher the critical thinking skills. As stated by Karakoc (2016), that HA students have high metacognition in learning. Metacognition is awareness in understanding, controlling, manipulating cognitive processes and thinking.

The fifth aspect is explanation, the skills to present information factually, conceptually, and procedurally. The lowest scores were obtained by LA students, MA students got moderate

results, and HA students got the highest scores. As stated by Orgad (2014), critical thinking can be trained by problem-solving activities.

The sixth aspect is self-regulation, the self-reflection and self-monitoring after implementing analyst activities and evaluation before making decisions. The lowest scores were obtained by LA students, MA students got moderate results, and HA students got the highest scores. These differences occurred due to differences in the level of students' metacognition, especially the self-regulation. Shoval et.al., (2013) argued that self-regulation is related to self-understanding, self-potential, and self-confidence.

The difference in the critical thinking skills improvements are not only affected by academic ability but also from external factors such as learning models. Other factors also influence critical thinking skills such as psychic fitness, intellectual characteristics, interest in learning and the learning environment (Budsankom et.al., 2015).

The two-way ANOVA shows a signification value of 0.000. It means H0 is rejected and H1 is accepted. Thus, that there are differences in students' critical thinking skills due to different learning models. The sig value is smaller than 0.05, so there is a difference in the students' critical thinking skills between students with group discovery learning and the students with discovery learning.

The LA students have the lowest average score (52.917) followed by MA students (64.69) and the highest was HA students (74.583). These show that differences in students' academic abilities affect students' critical thinking skills.

Table 4. Two-Way ANOVA Test on the Interaction of Learning Models and Academic Ability toward Students' Critical Thinking

	Sources	**Sig.**	**Criteria**	**Verdict**
KBK	Learning Models and Academic Abilities	0.835	Sig.> 0.05	H_0 is accepted, no interaction

The two-way ANOVA shows a signification or greater than 0.05, thus H0 is accepted. It means that there is no interaction between the learning model and academic abilities towards students' critical thinking skills. The linkage chart can be seen from Figure 4.

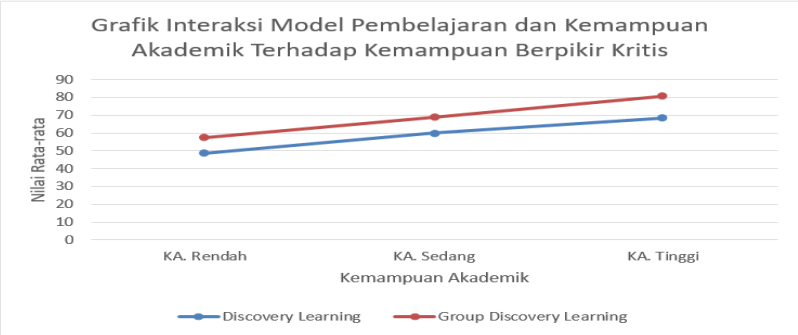

Figure 4. The Interaction Between Learning Models and Students' Academic Abilities toward Students' Critical Thinking Skills

There is an influence of learning models toward thinking and students' academic abilities toward critical thinking but they are not interrelated and mutually free. The learning model becomes an external factor that affects students' critical thinking skills, while academic ability is the internal factor. Other factors include psychic condition, intellectual characteristics, interest in learning, and learning environment (Budsankom et al., 2015).

Conclusion

The results show significant differences in students' critical thinking skills between experiment and control classes. The findings can be used for further research in building active and innovative learning models and strategies to improve students' critical thinking skills.

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