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The Implementation of Collaborative-Based Guided Discovery Reviewed from Students' Analytical Thinking Skills and Social Skills

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Abstract

This study aimed to determine the effectiveness of collaborative based Guided Discovery in empowering critical thinking skills and social skills of students in High Plant Systematics Course. It was a quasi-experimental study with One Group Pretest-Posttest Design using one class as an experiment (pretest and posttest). The subjects of the study were 26 students of the fourth semester of Department of Biology Education, Universitas Bangun Nusantara Sukoharjo Academic Year 2015/2016. Data collection techniques were done with tests to measure analytical thinking skills and observation to measure social skills. Data analysis of the result of analytical thinking skills was quantitative descriptive using paired sample t-test, while the result of social skill observation was qualitative descriptive. Paired sample t-test resulted in a significant difference of pretest and posttest value of analytical thinking skill. The result of social skill score was nine students with very good category and seventeen students with a good category. The conclusion of the study was that collaborative based Guided Discovery effectively empowers the student's analytical thinking and social skills.

Keywords: guided discovery, collaborative, analytical thinking, social skills

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INTRODUCTION

In the 21st century, it is required for the human to have skills to adapt with the changing and developing of the era. Ledward and Hirata (2011) state that the skills needed in the 21st century are Life and Career skills, Information, Media, and Technology skills, and Critical Learning and Innovation skills which cover the analytical thinking skills. Sexton (2013) explains that the analytical thinking skills is the ability to store information, identify a case, correlate and combine the data from a various source, and identify cause and effect pattern of a relationship, and draw a conclusion.

Bloom divides analysis aspects into three categories, they are: (1) element analysis, like fact formation, defined element, argument, axiom (assumption), argumentation, hypothesis, and conclusion, (2) relationship analysis, like correlating between elements of a math structure/system, (3) analysis, like knowing the elements and its relationship with the organized structure. The explanation of those three categories according to Suharsimi involves many skills. They are specifying, describing diagram, differentiating, identifying, illustrating, concluding, showing, and dividing (Anderson & Krathwohl).

The analytical thinking skills of students in Indonesia can be seen from the research conducted by TIMSS (Trends in International Mathematics and Science Study) in Biology learning. TIMSS is a four-year international study conducted by IEA (International Evaluation for the Evaluation of Educational Achievement). The research shows that the average achievement score of students in the domain of biological content in Indonesia ranks 38th out of 40 countries. This achievement proves that the average students in Indonesia have

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not mastered the biology materials completely (Mullis, Martin, Foy, & Arora, 2012).

Thinking ability is an important aspect of mental activity like solving problems, making the decision, persuading, analyzing assumption, and doing research (Johnson, 2007). The analytical thinking of students can be seen from the observation to students of Department of Biology Education, the academic year 2014, in the course of Invertebrate System II using classical learning model like lecturing and group presentation. The result of students' analytical thinking test using multiple choices of 20 numbers with four variations shows that the average score of students' analytical thinking is 69,35 (total score of 100). The analytical thinking ability (C4) is one of the aspects of cognitive learning outcomes. To get the high cognitive learning outcomes, one of the supporting factors is by improving analytical thinking skill. The analytical thinking ability can be improved through standard and assessment, curriculum and instructions, developing lecturers' professionalism, and learning environment, which arranged in a learning process.

In some courses learning of students of the academic year 2014, the cooperation of students in a group or extra group is still poor/ weak. This problem can be seen through the discussion, and some of the egoist students do not participate in it. The students make a group based on their academic achievement/ ability. Students with the high academic/cognitive ability are in groups with students with the same ability and the other way. This condition creates the real academic discrepancy which can be seen in the result of students' analytical thinking test that six students get the high score (>80) and fourteen students get the low score (<70). Merrel (2008) explains social skill as a specific, initiative behavior which aimed at the expected social result as a form of human behavior. The development of students' behavior is influenced/ affected by their environment, parents, friends, and their surrounding community. If the condition and the social environment can facilitate or to give chances to the development of students positively, then they will have better social skills.

The social skills of students must be improved so there will be a way to meet the students with the high academic score and the students with the lower score. Therefore, the academic discrepancy can be minimized. The analytical thinking skill and social skill can be improved through education. Education has a strategic role in forming the students as the generation who possess skills needed in the 21st century. The process of forming students to be the generation who possess skills needed in the 21st century cannot be separated from the learning process during the class.

The learning process in a university is listed in Permendikbud of 2013 about National Standards of Higher Education. It states that the learning process should be interactive, inspiring, fun, challenging, and motivating to students to actively participate and to give a chance to be initiative, creative, and independently based on their talent, interest, and physical and psychological development. The lecturer as the educator has the important role to manage the learning process in the class. Rustaman et al. (2005) state that to run his role in managing the learning process, the lecture should master some competencies to plan, conduct, and evaluate the learning. In science learning, especially Biology, it has specific characteristics so the lecture should choose the learning strategy which is appropriate to Biology characteristics.

Warianto (2011) states that Biology is a science related to the way to know, to understand universe systematically, objective, universal, analytical, and verifying so Biology is not only about the mastery of facts of knowledge, concepts, or principals, but also a process of discovery (constructivism).

Kim (2005) and Demirci (2009) states that constructive learning gives chances to students to think about their experience and analyze it, to solve problems by using knowledge, to collect and develop ideas, to give explanation and solution, and to take action and make a decision. One of the learning models of constructivism is guided discovery. Discovery, according to Sumiati (2009), is a learning process that emphasizes on the discovery of the students and the lecture manages the learning process in a way that students gain the knowledge not through notification/ lecturing, but through the discovery of the whole or part of the knowledge by themselves. Guided discovery learning, which is constructivism-based, is potential to improve students thinking ability because many phenomena around can be analyzed by using the five-sense. In this way, constructivism develops higher thinking ability like analytical thinking, critical thinking, research, communication and collaboration (Gazi, 2009). The benefit of guided discovery

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learning, which is the discovery process, will improve students' concept of understanding and problem solving (Saptono & Senen, 2009; Sulistyowati, Widodo & Sumarni, 2012).

Guided discovery learning should be integrated with collaborative learning to optimize students' social skill. In collaborative learning, students are grouped or paired, and they do not learn by themselves (Barkley, Cros, & Major, 2014). Cruickshank, Jenkins, & Metcalf (2005) states that collaborative learning is a learning procedure that in this case students learned together in groups and guided to achieve the objective collectively. Collaborative-based guided discovery learning gives chances to students to discover their knowledge independently or in groups through the series of learning activities. Students in the group will get the roles and duties of their group.

Collaborative-based Guided discovery learning is applied in the course which is appropriate for its characteristics, that is in High Plants Systematics course. It is expected that this implementation will empower students' analytical thinking and social skills in Department of Biology Education, Faculty of Education, Universitas Veteran Bangun Nusantara Sukoharjo.

METHOD

It was a quasi-experimental research since the variables cannot be controlled strictly. The design of this research was one group pretest-posttest design. The implementation of collaborative based guided discovery was through pretest and posttest in a group of students of an experimental class (Sugiyono, 2015). The design of this research is presented in Table 1 and Figure 1.

Table 1. One Group Pretest-Posttest Research Design

Group	*Pretest*	*Posttest*
Experiment	O_1	O_2

Notes:

O_1: Pretest of analytical thinking ability given to the experimental group.

O_2: Posttest of analytical thinking ability given to the experimental group.

	X: Treatment of learning implementation.
0_1 X 0_2	0_1: Pretest of analytical thinking ability
	0_2: Posttest of analytical thinking ability

Figure 1. One Group Pretest-Posttest Design

Social skill was measured during the learning process, and the score and category of each student would be gained. The subject of this research were 26 students in the fourth-semester academic year 2014/2015 of Biology Education study program, Universitas Veteran Bangun Nusantara Sukoharjo. The data gained in this research was in the form of quantitative data which involved the score of analytical thinking ability and social skill observation. The data sources of this research were students who study the course of High Plants Systematics in the fourth semester and a team of lecturers as the observer.

The instruments of the data were the test and observation sheets. The test was applied to measure the analytical thinking ability of students. The observation was conducted to observe students' social skills during the learning process of High Plants Systematics course. The data analysis was gained from the score of pretest and posttest of analytical thinking ability in the form of multiple choices test of 30 numbers.

The enhancement score of pretest and posttest of analytical thinking ability can be seen from the test of Normalized N-Gain. Students' analytical thinking ability before and after the implementation of collaborative based guided discovery can be measured through this following formula:

$$g = \frac{S_{post} - S_{pre}}{S_{\max} - S_{pre}}$$

The counting result is categorized by using Normalized Gain based on Meltzer classification as presented in Table 2.

Table. 2 Gain Level Criteria

g	Notes
0,7<g<1	High
0,3≤g≤0,7	Medium
0≤g<0,3	Low

The previous Gain equation is one of the indicators of the research success. The research can be successful if the gain score of pretest and posttest is at the medium level for at least. In another way, it can be said that there is an enhancement result of the research if the gain level is more than 0.3.

If it does not happen, it means that there is no score enhancement of students' analytical thinking ability in this research.

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The result of pretest and posttest of analytical thinking ability was also tested through parametric statistics T-test (paired sample) which was preceded by the prerequisite test of homogeneity and normality. Social skills data were analyzed through descriptive qualitative way with the category of very good, good, fair, and poor.

RESULT AND DISCUSSION

This research is aimed at defining the effectiveness of collaborative-based guided discovery learning implemented in High Plants Systematics course toward the students' analytical thinking and social skills. Guided discovery learning with the collaborative approach is implemented in High Plants Systematics course with the time allocation of three times meeting (each meeting lasts for 4 x 50 minutes).

Before the collaborative-based guided discovery learning is conducted, 26 students must do the pretest first to know their early ability of analytical thinking. After the pretest, the collaborative-based guided discovery learning is implemented in High Plants Systematics course. During the learning process, students complete the worksheet arranged by the lecturer (LKM).

Collaborative-based Guided discovery learning is implemented in High Plants Systematics course with the time allocation of three times meeting (each meeting lasts for 4 x 50 minutes). The subject of this research is students of the fourth semester of Biology Education, Faculty of Education, University of Veteran Bangun Nusantara Sukohajo academic year 2015/2016. The research is started with the pretest of students' analytical thinking. The test consists of 30 numbers multiple choices of *Phanerogamae* family materials. During the learning process, students also complete the worksheet arranged by the lecturer. The characteristics of collaborative-based guided discovery learning applied in High Plants Systematics is that the students are grouped into six group-discussion, and the member of the groups are students with the heterogeneous cognitive ability. Besides that, each group has the responsibility to do the presentation in the class based on the selected-materials. The collaborative learning is applied through the discussion among the students in a group, extra-groups, and to the lecturer.

The first meeting was conducted on February ^{29th}, 2016 in the laboratory room II with the theme of *Gramineae, Asteraceae,* and *Araceae* family. Before the learning process, students are already grouped based on the previous distribution. The first step of the collaborative-based guided discovery learning is the simulation. The lecture presents the problem about high plants diversity of *sunflowers, King's salad, billy goat-weed, grass, Japanese grass, and Aglonema or Chinese evergreen*. Students observe the similarity and difference of those plants on their flower, fruit, leave, stem, root, and the contained substance. The second step is the problem statement. Students classify the plants into three families based on their characteristics. Before doing the observation, students write the references and the steps of observation/ investigation. The third step is data collecting. Students collect the data by identifying the details of various plants. Besides observing the plants directly, students are also discussing with the groups and the lecture or finding the sources on the internet or books.

The fourth step is data processing. Students try to analyze the data identified from various plants to define the families of the group of plants. After that, students answer the questions in the worksheets which help them to analyze the data and define the appropriate families of the observed plants. The defined families are *Gramineae, Asteraceae, and Araceae*. The fifth step is verification. It is conducted by comparing the result of identification to the references in the books to make sure that the identification is correct. The six-step is the generalization. Students conclude the result of the identification that is *Gramineae, Asteraceae, and Araceae* families. The result of the identification is then presented in the class. The first presenters in the first meeting are the first group and second group. After the presentation ends, students of other groups may ask questions to the presenters. At the end of the learning process, the lecturer clarifies and adds the materials of *Gramineae, Asteraceae, and Araceae* families.

The second meeting was conducted on March 16th, 2016 in laboratory room II with the theme *Cyperaceae*, *Solanaceae,* and *Papilionaceae*. Before the learning process, students are already grouped based on the prior distribution. The first step of the collaborative-based guided discovery learning is the simulation. The lecture presents the problem about high plants diversity of *Java grass, nut grass, legumes, chilies, tomatoes, cape gooseberries,*

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and eggplants. Students observe the similarity and difference of those plants on their flower, fruit, leave, stem, root, and the contained substance. The second step is the problem statement. Students classify the plants into three families based on their characteristics. Before doing the observation, students write the references and the steps of observation/ investigation. The third step is data collecting. Students collect the data by identifying the details of various plants. Besides observing the plants directly, students are also discussing with the groups and the lecture or finding the sources on the internet or books.

The fourth step is data processing. Students try to analyze the data identified from various plants to define the families of the group of plants. After that, students answer the questions in the worksheets which help them to analyze the data and define the appropriate families of the observed plants. The families are *Cyperaceae*, *Solanaceae,* and *Papilionaceae*. The fifth step is verification. It is conducted by comparing the result of identification to the references in the books to make sure that the identification is correct. The six-step is the generalization. Students conclude the result of the identification that is *Cyperaceae*, *Solanaceae,* and *Papilionaceae* families. The result of the identification is then presented in the class. The second presenters in the second meeting are the third group and fourth group. After the presentation ends, students of other groups may ask questions to the presenters. At the end of the learning process, the lecturer clarifies and adds the materials of *Cyperaceae*, *Solanaceae,* and *Papilionaceae* families.

The third meeting was conducted on April 6th, 2016 in the laboratory room II with the theme *Annonaceae, Euphorbiaceae, Mimosaceae, and Orchidaceae*. Before the learning process, students are already grouped based on the previous distribution. The first step of the collaborative-based guided discovery learning is the simulation. The lecture presents the problem about high plants diversity of *sugar-apples, soursops, sensitive plants, Euphorbia mili, Euphorbia hirta, hyacinth orchid, and moon orchid.* Students observe the similarity and difference of those plants on their flower, fruit, leave, stem, root, and the contained substance. The second step is the problem statement. Students classify the plants into three families based on their characteristics. Before doing the observation, students write the references and the steps of observation/ investigation. The third step is data collecting. Students collect the data by identifying the details of various plants. Besides observing the plants directly, students are also discussing with the groups and the lecture or finding the sources on the internet or books.

The fourth step is data processing. Students try to analyze the data identified from various plants to define the families of the group of plants. After that, students answer the questions in the worksheets which help them to analyze the data and define the appropriate families of the observed plants. The families are *Annonaceae, Euphorbiaceae, Mimosaceae, and Orchidaceae*. The fifth step is verification. It is conducted by comparing the result of identification to the references in the books to make sure that the identification is correct. The six-step is the generalization. Students conclude the result of the identification that are *Annonaceae, Euphorbiaceae, Mimosaceae, and Orchidaceae* families. The result of the identification is then presented in the class. The third presenters in the third meeting are the fourth group and the sixth group. After the presentation ends, students of other groups may ask questions to the presenters. At the end of the learning process, the lecturer clarifies and adds the materials of *Annonaceae, Euphorbiaceae, Mimosaceae, and Orchidaceae* families.

During the learning process, the students' social skills are observed through observation sheet. The collaborative-based guided discovery learning is ended by the activity of posttest and making herbarium. The herbarium making is focused at the plants discussed previously except for the family of *Gramineae.* Each group collects three families of plants for the herbarium. The posttest is conducted to measure the effectiveness of collaborative-based discovery learning to students' analytical thinking skills.

Analytical Thinking Skills

The data histogram of analytical thinking can be seen in Figure 2. The data shows that the average pretest score of students' analytical thinking ability is 36,42 with the standard deviation of 9,72, the minimum score is 20, and the maximum score is 56,70. After the collaborative-based guided discovery learning is implemented in the High Plants Systematics course, the average posttest score of students' analytical thinking is 69,62 with the deviation

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standard of 15,18, the minimum score is 33,30, and the maximum score is 69,62.

The enhancement of students' analytical thinking based on the pretest and posttest score can be analyzed by using N-Gain normalized test. (Hake, 1998; Subekti & Ariswan, 2016). N-Gain Test can be seen in the Table 3.

Table 3. *N-Gain* Students' Analytical Thinking Ability

N-Gain	Category	N-Gain	Numbers
0,7<g<1	High	0,72-1	11 students
0,3≤g≤0,7	Medium	0,30-0,70	11 students
0<g<0,3	Low	0,00-0,10	4 students

Table 4. Data Description of Social Skills Score

Interval	Category	Final Score	Numbers of people
3,33 < final score ≤ 4,00	Very good	3,4-3,6	9 people
2,33 < final score ≤ 3,33	Good	2,4-3,2	17 people
1,33 < final score ≤ 2,33	Fair	-	none
Final score ≤ 1,33	Poor	-	none

Based on Table 3, students' analytical ability improvement is tested through N-Gain. There are eleven students with the N-Gain of 0,72-1 who achieve the high category, and eleven students with the N-Gain of 0,30-0,70 who achieve the medium category, and four students with the N-Gain of 0,00-0,10 who achieve low category. The average score of students' analytical thinking ability in the pretest and posttest are then compared through a statistical test to know the effectiveness of collaborative-based guided discovery learning. Before the statistics test is conducted, the prerequisite test is tested first through normality and homogeneity test.

Based on the result of the prerequisite test, it can be concluded that the normality test with the Kolmogorov Smirnov of the pretest value is gained significance of 0,173. It means that its significance value is more than 0,05. Therefore, Ho is accepted. In shorts, the pretest value is normally distributed. In the posttest value, it is gained the significance of 0,136 which means that its significance value is more than 0,05 and therefore Ho is accepted. In conclusion, the posttest value is also distributed normally. Based on the Levene statistics, it is gained the significance of 0,065 which means that its significance value is more than 0,05. Therefore Ho is accepted, and the variation of the data is homogenous. The known data of pretest and posttest are normally distributed and homogenous. Next, the data is tested through parametric test since the data passed the prerequisite test. The next test is paired sample t-test for two dependent groups or paired sample for pretest and posttest data. The data processing is by using IBM SPSS Statistics 20 program. The hypothesis of this test is:

Ho: there is no significant difference between pretest and posttest value before and after the collaborative-based guided discovery learning

Hi: there is a significant difference between pretest and posttest value before and after the collaborative-based guided discovery learning.

Based on the paired sample t-test, it is gained Asymp. Sig. Value (2-tailed) of 0.00 which is under 0.05, therefore Ho is rejected. This means that there is a significant difference of analytical thinking ability value before and after the collaborative-based guided discovery learning applied in High Plants Systematics course.

Social Skills

This is the description of the data of students' social skills scores gained from the learning observation using collaborative-based guided discovery.

Based on the table of social skill data distribution, there are nine students who get the final score of 3,4-3,6 with the very good category. There are seventeen students who get the final score of 2,4-3,2 with the good category, and there is no student who gets the score under 2,4.

The collaborative-based guided discovery learning which is applied in High Plants Systematics course can improve students' analytical thinking and social skills. In this kind of learning, students are asked to analyze and discuss the unknown family of plants. Learning by using discovery process will improve students' concept of understanding and problem solving (Saptono & Senen, 2009, Sulistyowati et al., 2012).

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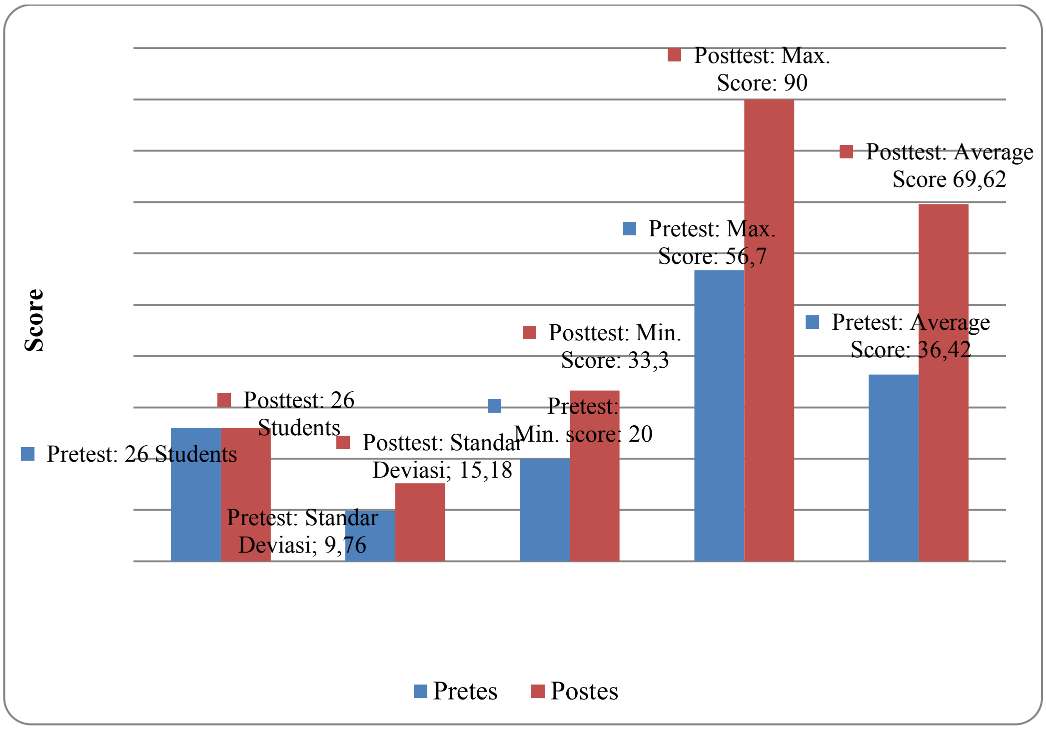

Figure 2. Description of Histogram Data of Students' Analytical Thinking Skills

The first step of collaborative-based discovery learning is the simulation. The simulation is conducted by observing the plants. The observation presented in the form of the real plants which stimulate students to think before doing observation or investigation. Students are asked to observe and analyze the plants based on their similarities and differences. The object of the real plants gives the stimulus to students to be interested and motivated to learn more. Lavine (2005) in his research states that simulation before observation will help students to build concepts and produce the better learning outcomes which directly also improve the better analytical thinking skills.

The second step of collaborative-based guided discovery learning is problem statement. Students classify the plants into three groups based on their similarities. Besides that, students also ask questions about problems during observation. Students' analytical thinking ability to ask questions in this level is formed since the students analyze the problems first before asking questions. The questions are formulated by the students with the guidance of the lecturer.

The next step is data collecting. The students conduct an investigation based on their plans. During the investigation, students use the information in the form of data, facts, observation, and experiment. This information stimulates them to think analytically. According to Dumitrascu (2009) by trying to solve problems, the students can get the experience to prove something, and they will understand the learning materials. The students get the experience by proving something through experiment which stimulates them to have analytical thinking to analyze their experiment. The result of the investigation is in the form of data and information.

After the students conduct the investigation, they have a group discussion. During the discussion, the students interact with the members of the intra-group and extra-group and also with the lecturer. The collaborative learning with the ideal number of groups will help students to improve their communication ability and knowledge to collaborate with other groups (Newman, 2005). The collaborative process is formed during the process of investigation and data analysis. Cruickshank, Jenkins, and Metcalf (2005) state that collaborative learning is a learning procedure which in this case students learn together in groups and are guided to achieve the purpose collectively. Guided discovery learning give chances to students to discuss since during the guided discovery learning process students learn in groups.

Students in groups will learn how to anticipate, prevent, solve, and deal with the problems during the learning process. Daniel, (2013) and Akanmu & Fajemidagba (2013)

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states that the learning in groups produces more effective learning outcomes than the individual learning does. Lord (2001) also explains the benefit of learning in groups or work in groups can improve students' interest in the learning materials since the students also get more influence and interaction from their friends and the environment (Lord, 2001). Akanmu & Fejimadagba (2013) states that the learning conducted in groups produces more effective learning outcomes than the individual learning does. Jantti (2003) states that the collaborative learning stresses more on the interaction among the members of a small group to complete the task by the guidance of the lecture. The job description for the students in the group will create their interdependency one another.

Based on the theory of Piaget about the active learning, the students are better in learning when they discuss in groups and present it in the class. Piaget also argues that if there is one active group, the group will stimulate other groups to discuss together and the learning process becomes more interesting (Smith et al., 1992).

Based on Shulman and Keisler as recited by Mayer (2004) that the guided discovery learning is more effective than the pure discovery learning. Some students do not understand the rules and principals in the pure discovery learning, but through guided discovery learning, they do better. Guided discovery learning model is more appropriate to be implemented in Science since it helps students to meet the two important criteria of active learning, that is building knowledge to create understanding based on new information and integrating new information until it is found the right knowledge.

Developing students' analytical thinking skill through guided discovery learning will guide the students to find the concepts independently, therefore they can develop their positive attitude in learning and improve their learning outcomes (Akinbobola & Afolabi, 2009). The process of constructivism in guided discovery learning will give impact to students' ability to dig information independently through the various thinking process. This is appropriate to the research by Abbot and Fouts (2003) which states that the constructive learning implementation has a positive correlation towards students' learning outcomes.

CONCLUSION

The conclusion gained from collaborative-based guided discovery learning is that it effectively improve students' analytical thinking skills in the fourth semester of Department of Biology Education, Faculty of Education, Universitas Veteran Bangun Nusantara Sukoharjo. In the paired sample t-test, it is gained the Asymp. Sig (2-tailed) of 0.000 which is under 0.05. Therefore, there is a significant difference of students' analytical thinking value before and after the implementation of collaborative-based guided discovery learning in High Plants Systematics course. The collaborative-based guided discovery learning also improves students' social skills effectively. The result of social skill score shows that there are nine students in the very good category and seventeen students in the good one.

The suggestion given to this research is that it needs a module for the learning materials and students better use the plants in the surrounded campus.

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