Improving Student' Understanding of Basic Biology Concepts through Argument-Driven Inquiry with Scaffolding

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Abstract: Some teachers usually have the problem of an underdeveloped discourse of argumentation in the Argument-Driven Inquiry (ADI) learning model. The students' diversity of academic ability needs to be seriously considered to form high-quality arguments. ADI can be integrated with Scaffolding to improve students' conceptual understanding. The current research aimed to determine the difference of conceptual understanding between students with low and high academic abilities. The treatment was conducted through three different science learning models i.e., ADI, ADI integrated with Scaffolding (ADIS), and the conventional. This research was quasi-experimental research, which used a nonequivalent pre-test post-test control group design. The subjects were 180 students of the Mathematics and Science Education Department of the Faculty of Teacher Training and Education, Lampung University, Indonesia. The data of students' conceptual understanding were collected through an essay test on the natural science competence, taking the form of Bloom's dimension of cognitive processes. The results showed that the highest conceptual understanding scores were exhibited by the students taught using the ADIS model. The students with high academic ability had conceptual understanding higher than those with a low academic ability. This suggests that the students with high academic ability were found it easier to capture, understand, and to remember lessons than those with the low academic ability.

Keywords: *argument-driven inqury,scaffolding,conceptual understanding, academic ability*

1. Introduction

Many advances in agriculture, health, and environmental control, on the one hand, bring us all closer to an understanding of how the human mind works, how to produce multiple cells from a single cell, and how such diverse lives are formed from only one cell resembling a virus. However, on the other hands, the explosions of information in so many discoveries can make it difficult for people who study them. Most students have not gotten a good way of utilizing biology concepts to sort through and give meaning to new things in their thinking (Campbell et al., 2010). Students are still difficult to internalize the concepts obtained as a basis for thinking. Therefore, biology should be taught by an approach which experienced by researchers or scientists as they develop the knowledge itself (Hasnunidah, 2016). Include when the scientists defend theories and explanations by offering evidence and arguments, this is what is called argumentation.

There are two literatures that provide the definitions of argumentation and argument. Duschl & Osborne (2002) states "argumentation" as the process of building arguments and "arguments" as references for the content of arguments. Meanwhile, Sampson & Clark (2008) use the term "argument" for the work of students in articulating and justifying claims or explanations, and "argumentation " for complex processes in producing arguments. Keraf (2007) has provided a comprehensive definition of argumentation as a form of rhetoric to influence the attitudes and opinions of others, to believe and act according to what the speaker wants. Through the author's argument or the speaker assembles the facts to show whether an opinion or a particular thing is true or not.

Argumentation is considered to be a major component of science education (National Research Council, 2012). Aufschnaiter et al. (2007) proposed three important reasons for the inclusion of argumentation in science education. The first, scientists use argumentation in developing and enhancing scientific knowledge. The second, people use arguments in scientific debates, and students need argumentation in learning to strengthen understanding. The last, argumentation as a structural element of scientific language is an important cog in both conducting science and communicating scientifically.

Several studies have examined the relationship between argumentation and conceptual understanding. These studies can be conceptualized into two lines of research, there are: (1) investigated the impact of argumentative activities on students' conceptual understanding: Riemeier (2010) states that student involvement in argumentation contributes to improving the understanding of the concept. Arguments can provide a strong foundation in understanding a concept as a whole and right (Cross et al. 2008). The goal of the thinking process in argumentation is the truth about the subject being argued (Keraf, 2007). Through argumentation, one can show statements (theories) that are expressed correctly or not referring to the facts and evidences (Aufschnaiter et al. 2008), (2) the effect of content of knowledge on the argumentation. Students' understanding of a concept may influence the quality and quantity of argumentation they construct (Sadler & Fowler 2006).

The conceptual understanding based on the dimensions of cognitive processes by Bloom's which revised by Anderson & Krathwohl (2001) is a cognitive process for reading and understanding images, reports, tables, diagrams, directives, and regulations. A student has an understanding when faced with something that must be communicated, it is estimated to know what must be communicated, and can use the idea verbally or in writing or in verbal and symbolic forms. In other words, understanding is the ability to communicate ideas into various forms of communication. There are five indicators of conceptual understanding: (1)Interpreting, change from one form of representation; (2) Exemplifying, find specific examples or illustrations of a concept or principle; (3) Classifying, determine something to have a category; (4) Summarizing, abstract general themes or main points; (5) Inferring, draw logical conclusions from the information presented; (6) Comparing, detects conformity between two ideas, objects, and the like; (7) Explaining, build a causal model of a system. Understanding of the concept is the ability to absorb material meaning or an abstraction that describes the general characteristics of a group of objects, events or other phenomena studied. The study of understanding important concepts is done to determine to understand and develop appropriate material (Kibar & Ayas, 2010). Meaningful understanding of students about science concepts and topics is useful so that science education programs can achieve their goals (Kılıça & Saglamb, 2009).

Based on the results of a preliminary study in science learning, it was revealed that understanding of biology concepts in students in The Basic Biology course from The Mathematics and Science Education Department of The Faculty of Teacher Training and Education of Lampung University in Lampung, Indonesia were still low. Hasnunidah (2016) stated that the results of the analysis of the lecturer questionnaire indicate that conceptual understanding of students on natural science concepts has not been comprehensive or is still separate from each other, in line with the learning process by the lecturers presented in the textbooks are separate topics per topic. The impact of this is the low cognitive learning outcomes of students in the Basic Biology course in the last 3 years from the 2015/2016 Academic Year to 2017/2018 show an average of 65.45 which is converted into grade to C+. Meanwhile, according to Kılıça & Saglamb (2009), one of the objectives of science education is to ensure a comprehensive and accurate understanding of students' concepts of science.

Students' conceptual understanding which is different from one another requires a learning condition involving a learning experience so that the potential of argumentation skill can be developed (Hasnunidah, 2016). Argumentation skill can be incorporated into learning by teachers, so teachers should be able to carry out the mandate of developing students' argumentation skills. This is in accordance with the opinions of Sampson & Gerbino (2010) who stated that through the application of argument-based learning models, students showed an increase in terms of understanding concepts about biology. Students need to learn how to construct an argument, choose supporting evidence, and learn how to compile a rebuttal. Suhandi (2012) stated that through argument-based learning models for students is based on the theoretical concepts that education aims to facilitate students to achieve an understanding that can be expressed verbally, numerically, and in a frame of mind. In addition, conceptual understanding is a mental process of adaptation and transformation of science. Conceptual understanding is a representation of learning outcomes. Thus, argumentation skills need to be trained through learning to improving learning outcomes, especially in science learning.

Various advantages have been found in the use of the ADI learning model to improve students' knowledge and skills through their participation in scientific arguments through inquiry activities (Clark & Sampson, 2007; Erduran Simon & Osborne. 2004; Sampson & Gleim, 2009; Simon, Erduran, & Osborne, 2006; Clark et al., 2009; Cavagnetto, 2010, Çetin, 2014). There are few studies about argumentation-driven inquiry particularly in Indonesia (Hasnunidah, 2015; Andriani and Riandi, 2015). However, facing the problem of underdeveloped discourse of argumentation among students, then practicing oral and written argumentation skills from each individual student through investigation are a very difficult job.

Some researchers also explained the difficulties in using the ADI learning model: (1) Some of the students had difficulties in discussing various ideas in participating in scientific arguments and many of them did not use scientific explanations as a tool to solve problems or to evaluate claims (VE Sampson, Grooms, & Walker, 2011), (2) Students tend to use the minimum evidence needed to describe their conclusions (Walker, 2011.), (3) Students abled to provide arguments with accurate claims and strong evidence but still did not use relevant rationale (scientific theories, models, or laws) (Sampson, et al., 2012). This reflects on condition that although ADI is believed to be a model that can evoke argumentation through the investigation process, there were still many students who could not construct high-quality arguments and participated productively in scientific arguments. So that, this study can be considered as one of the first attempt in development and implementation ADI instructional model with Scaffolding (ADIS) in Indonesia. It is supported by opinions by Cho & Jonassen (2002), who states that a lecturer needs to develop scaffolding for his students to develop their argumentation skills.

ADIS is a modification usage of the Argument-Driven Inquiry (ADI) learning model by a guidance of tiered arguments which begins with a standpoint at each level (Hasnunidah, 2016). Standpoint is the principle of someone which must be compared and assessed. Standpoint plays an important role in initiating classical dialectics especially in the argumentation practise (Eemeren, Grootendors & Henkemans, 2002). Arguments can be intended in order to defend or refute the standpoint in a debate. According to Walker (2011), educators need to create debate among students explicitly to build arguments which are complete with claims, evidence, and rationale. Debates can be created, one of it, is by the argument or resistance argument. Erduran (2004) emphasized that, the quality of arguments can be determined by the presence or absence of objections or arguments against the argumentation discourse. Arguments with refutation are an important element of a quality arguments and show a high level of an argumentation ability. Furthermore, refutation can also be considered as a measure of conversation involvement, because it can involve students in dialogical conversations where they not only can prove their claims, but also reject other people's claims with evidence. The presence of disclaimers in conversation can act as a continuous indicator of student involvement in the argumentation discourse.

The ADIS learning model which isused in this research, was be underlined and categorized to allows students in constructing their own knowledges through an active involvement in the activities of inquiring, argumentating, writing, and reviewing which are trained from the levels of class, group, and individual. Tiered guidance in ADIS learning model includes on three phase, they are including: 1) initiation phase, students are divided into two large groups, with mutual claims, whether to approve or refute the standpoint. Through this large group discussions, students practice in developing the evidence and justification to support the claim and basic reasons and also develop refutation of claims or the basic reasons of the opponents group; 2) the development phase, a small group of 4-5 people, is given a freedom to determine their group's claim in order to approve or refute the standpoint. Through discussions in groups of 4-5 people, students practice to develop the evidence and justification to support claims, basic reasons, and also to develop refutation; 3) strengthening phase, students have been named by the individuals, whether to approve or refute the standpoint. Individually, students were practicing to develop the evidence and justification to support claims and basic reason and also to develop objections (Hasnunidah, 2015). Stages of learning in learning activities with the ADIS model in detail are explained in Table 1.

Table 1. Stages of Learning in the Model Argument-Driven Inquiry with Scaffolding (ADIS)

Syntax	Lecturer Activity	Student Activity
The Initiation Phase		
Stage 1. Development of Class Standpoint	1. Explaining the learning model, logistics and how to implement it. 2. Deliver the learning objectives. 3. Propose the phenomena related to the emergence of class standpoints. 4. Encourage students to develop their class claims whether to approve or refute the class standpoint. 5. Guide students to take up research assignments in the student worksheet.	1. Pay attention and record learning objectives. 2. Develop the class claims that approve or resent the class standpoint. 3. Observe the research tasks in the student worksheet.
Stage 2. Collectingthe data class	1. Organizing the student's groups into two camps as the camp that agreed to the standpoint and the camp which denied the standpoint. 2. Guiding students in laboratory investigations to look for evidence and a sound basis for supporting claims that approve or refute the standpoint.	1. Conditioning yourself bythe camp that approves or refutes the standpoint. 2. Conducting an investigation to look for evidence and a sound basis for supporting claims that approve or refute the standpoint according to the student worksheet.
Stage 3. Production of tentative class argument	1. Guiding students in case to process and analyze collected data. 2. Facilitating students to build arguments and writing them down in argumentation schemes.	1. Analyze and analyze the obtained data from research process. 2. Produce works in the form of argumentation schemes written in the student worksheet and blackboard.

Syntax	Lecturer Activity	Student Activity
Stage 4. The interactive session of class argument	Guide debates to criticizethe arguments and refine the rationale between agreeing fortresses and opposing standpoints.	Debate to criticize arguments and improve the basic reason between the two camps that approve or refute the standpoints.
Stage 5. a Written investigation of class report	1. Helping students to plan and prepare the investigation reports as directed in the student worksheet. 2. Assigning students to compile an investigation report.	Compile individual research reports which explain the investigation purpose and steps, and also provide sound arguments.
Stage 6. Peer-review of class report	Guiding students to evaluate the investigation reports qualitythrough review sheets.	Evaluate the investigation reports by using the review sheet.
Stage 7. Revisioning the process of class report	Encourage students to revise the investigation report.	Revise the report based on the peer review results.
Stage 8. Reflective discussion	Helping students to reflect on the investigation process and results.	Reflecting the research process and results.
The Development Phase		
Stage 1. Development of group standpoint	1. Deliver the learning objectives. 2. Propose the phenomena related to the emergence of group standpoints. 3. Encourage students to develop their class claims whether to approve or refute the group standpoint. 4. Guide students to take up research assignments in the student worksheet.	1. Pay attention and record the learning goals. 2. Develop the group claims into the group of approving or refuting the standpoint. 3. Observe the research tasks in the student worksheet.
Stage 2. Collect and analyze the group data	1. Organizing groups of students into groups that approve the standpoint or refute the standpoint. 2. Guiding students in laboratory investigations to look for evidence and a sound basis for supporting claims that approve or refute the standpoint.	1. Conditioning yourself in a group to approves or refutes the standpoint. 1. Conducting group investigations to look for evidence and a sound basis for supporting claims that approve or refute the standpoint according to thestudent worksheet.
Stage 3. Production of group tentative argument	1. Guiding students to process and analyze the collected data. 2. Facilitating students to build arguments and write them on in argumentation's schemes.	3. Analyze and analyze data obtained from the research process. 4. Produce works in the form of argumentation schemes written in thestudent worksheetand blackboards.
Stage 4. The interactive session of the group arguments	Guide debates to criticize arguments and improve the basic reason between the agreed groups and camps that refute the standpoint.	Debate to criticize arguments and improve the basic reason between groups which is approve or refute the standpoint.
Stage 5. reflective discussion	Helping students reflect on the investigation process and results.	Reflecting on the investigation process and results.
The Reinforcement Phase		
Stage 1. The development of individual standpoint	1. Deliver the learning objectives. 2. Propose the phenomena related to the emergence of individual standpoints. 3. Encourage students to develop their class claims whether to approve or refute the individual standpoint. 4. Guide students to take up research	1. Pay attention and record learning objectives. 2. Develop the class claims that approve or resent the individual standpoint. 3. Observe the research tasks in the student worksheet

Syntax	Lecturer Activity	Student Activity
	assignments in the student worksheet.	
Stage 2. Collect and analyze of individual data	Facilitating individual students in laboratory investigations to look for evidence and a sound basis for supporting claims that approve or refute the standpoint.	Conduct individual investigations to look for evidence and a sound basis for supporting claims that approve or refute the standpoint according to the student worksheet.
Stage 2. Production of individual tentative argument	Facilitating individual students to build student arguments according to data and results of data analysis.	Produce works in the form of argumentation schemes written in thestudent worksheet according to data and results of data analysis.
Stage 17. The interactive session of theindividual arguments	Guide debates to critique arguments and refine the rationale between agreeing individuals and strongholds that oppose standpoints.	Debate to criticize arguments and improve the basis of reason between individuals who approve or refute the standpoint.
Tahap 18. Reflective discussion	Helping students reflect on the process and results of the investigation.	Reflecting on the research process and results.

Source: Hasnunidah (2016: 80-84)

Learning using the ADIS model is expected to help those low academic students to improve their learning quality and improve their thinking abilities, especially their argumentation skills. Moreover, the gaps between the high and low academic ability students can be minimized, and conceptual understanding of science can increase. The results of this research are expected to be taken into considerations by teachers to implement ADIS learning model to improve the learning results of the low academic students. Students' academic abilities affect their ability to participate in learning activities. Academic ability is an illustration of ability that can be used as a provision and capital to obtain broader and more complex knowledge. The polarization of students having high academic ability or low academic ability in a particular school will have an impact on different learning patterns. This condition related to the numerous differences found on the students having high academic ability and those having low academic ability. Students having high academic ability have better initial condition than students low ability, have a high confidence and learning habits (Heltemes, 2009; Bashir & Mattoo, 2012), as well as show a better performance in completing problem solving tasks and consequence test (Suman & Umapathy, 2003; Ford & Moore, 2013). Meanwhile, the students of low academic ability are often associated with failure in education (Carroll et al., 2006).

If students' differences are studied and used appropriately, their speed and success in learning can be fostered. There is a significant difference between students who have high academic abilities and those who have low academic abilities show a gap between them. Corebima (2005) argues that lecturers must be able to innovate on learning models to help or empower students with academic abilities to achieve higher academic improvement. Thus, the distance or distance between students' upper and lower academic abilities can be minimized. Therefore, efforts to minimize gaps between students based on academic ability need to be done to improve the quality of learning and improve students' conceptual understanding. Based on the explanation above, the urgency in this research is to examine the influence of the use of ADIS learning model and academic ability on conceptual understanding of students of Mathematics and Science Education Department, Faculty of Teacher Training and Education, University of Lampung.

3. Method

In this study, pretest-posttest non-equivalent control group design was used which is a type of quasi-experimental design. One of the classes was randomly assigned as an ADIS group and the other as ADIS group and Conventional group. Table 2 shows the design of the study.

Table 2. Quasi-experimental Research Design

Pretes	Group	Postest
O_1	X_1A_1	O_2
O_1	X_1A_2	O_2
O_1	X_2A_1	O_2
O_1	X_2A_1	O2
O_1	CA_1	O2
O_1	CA_2	O2

X_1 = ADI, X_2 = ADIS, A_1 = Low Academic Ability, A_2 = High Academic Ability, C = Conventional, O1= Pretest score, O2 = posttest score

A total of 160 (521 male and 95 female) students in Mathematics and Science Education Department participated in the present study. The students were recruited from 4 (four) study program, they are: biology education, chemistry education, physics education, and mathematics education that was taught by the same instructor in the first semester of the 2014/ 2015 academic year. The students' ages ranged from 18 to 21 years. The classes were randomly assigned as the ADIS groups (60 students), ADI groups (60 students) and conventional groups (60 students). Third of the groups were taught by the same instructor, who is the author of this research. There were 220-minute sessions per week for thirdly of the groups and the treatment was conducted over sixteen weeks. During the intervention, the experimental and control groups covered the same subject matters and used the same textbook. The topics covered were the structure and function of plantations and animals, living things reproduction, metabolism, Mendel Law and human nature inheritance, organisms' interaction to environment, and evolution.

The data were collected through The Concept Understanding Test (CUT). The CUT developed from Bloom's cognitive level of thought that has been revised by Anderson & Krathwohl (2001). The original form of the essay test included 28 items taken from several existing instruments (Campbell, 2010; The College Board AP, 2010) and items written by the authors. Most of the questions required students to interpret diagrams or observations to measures 6 (six) cognitive level, namely: remembering, understanding, applying, analyzing, and create. The scoring rubric of CUT was adapted from Hart (1994) with 0-4 range score. Table 3 presents examples of the scoring rubric for the students' understanding of basic biology concept.

Table 2. The examples of Scoring Rubric Used to Score the Students' Understanding of Organisms' Interaction to Environment Concepts

Question Item	Process Category	Score	Descriptor
Certain species of bright yellow beetles are dominant in bright-sandy soil habitats, and dark brown are dominant in dark-clay soil habitats. The experiment was designed to determine the survival rates of light yellow and dark brown beetles in different habitats. 500 bright yellow beetles and 500 dark brown beetles were released in 4 habitat types. Each beetle was marked with a red dot on the abdomen before being released. One week after the beetle was released, some marked beetles could be found and captured. The results are presented in the table below, assuming that the difference in the	Applying	4	Write the answers correctly and express the correct way of thinking to get the answers given. The correct answer, for example: predation by insectivorous birds that occurs in habitat 4 results in the number of bright yellow beetles being captured is less than that of dark brown beetles. With a light colored body in dark habitat causes the

<table>
<tr><td>Question Item</td><td>Process Category</td><td>Score</td><td>Descriptor</td></tr>
<tr><td rowspan="5">number of beetles that are recaptured is directly related to differences in survival rates.

<table>
<tr><td></td><td colspan="2">Habitat 1
Sandy soil, no insectivorous birds present</td><td colspan="2">Habitat 2
Sandy soil, insectivorous birds present</td><td colspan="2">Habitat 3
Loam soil, no insectivorous birds present</td><td colspan="2">Habitat 4
Loam soil, insectivorous birds present</td></tr>
<tr><td>Color of Beetle</td><td>Light tan</td><td>Dark brown</td><td>Light tan</td><td>Dark brown</td><td>Light tan</td><td>Dark brown</td><td>Light tan</td><td>Dark brown</td></tr>
<tr><td>Number Released</td><td>500</td><td>500</td><td>500</td><td>500</td><td>500</td><td>500</td><td>500</td><td>500</td></tr>
<tr><td>Number Recaptured</td><td>130</td><td>114</td><td>123</td><td>88</td><td>65</td><td>74</td><td>13</td><td>87</td></tr>
</table>

What events might occur to explain why the number of bright yellow beetles captured in habitat 4 is less than that of dark brown beetles?</td><td rowspan="5"></td><td></td><td>beetle to be easily seen by its prey.</td></tr>
<tr><td>3</td><td>Write the answer correctly and express the correct way of thinking to get the answer given, but the argument given is not right.</td></tr>
<tr><td>2</td><td>Write the answers correctly and express the correct way of thinking to get the answers given, but not the arguments put forward.</td></tr>
<tr><td>1</td><td>Indicates an attempt to answer the question but the answer is wrong.</td></tr>
<tr><td>0</td><td>Does not indicate an attempt to answer or no answer.</td></tr>
<tr><td rowspan="5">If all remaining insectivorous beetles and beetles are removed from habitat 2. Then add 500 dark brown beetles and 500 bright yellow beetles to the habitat 2. How can the expected number of dark brown beetles be recaptured in habitat 2 after one week later compared to the number bright yellow beetle? Why is that?</td><td rowspan="5">Analyzing</td><td>4</td><td>Write the answers correctly and express the correct way of thinking to get the answers given. The correct answer, for example: the number of dark brown beetles that can be recaptured in habitat 2 after one week later is almost the same as the number of bright yellow beetles. The survival rate of each beetle is equally high, due to the absence of predators.</td></tr>
<tr><td>3</td><td>Write the answer correctly and express the correct way of thinking to get the answer given, but the argument given is not right.</td></tr>
<tr><td>2</td><td>Write the answers correctly and express the correct way of thinking to get the answers given, but not the arguments put forward.</td></tr>
<tr><td>1</td><td>Indicates an attempt to answer the question but the answer is wrong.</td></tr>
<tr><td>0</td><td>Does not indicate an attempt to answer or no answer.</td></tr>
<tr><td>What conclusions can you draw from the data in the table above?</td><td>Create</td><td>4</td><td>The conclusions are clearly stated in complete statement sentences, showing the concordance between the data and conclusions. The correct answer, for example: Based on</td></tr>
</table>

Question Item	Process Category	Score	Descriptor
			the data it is known that the ground beetle with a body color that matches its habitat can protect itself from its predators (insectivorous birds) so that its survival rate is high. The conclusion is that the survival rate is determined by the ability of living things to adapt to a place of life to protect themselves from enemies.
		3	The conclusions are clearly stated in the complete statement sentence, but do not indicate the discrepancy between the data and the conclusions.
		2	The conclusions are stated ambiguously and there is little consistency between the data and the conclusions.
		1	Indicates an attempt to answer the question but the answer is wrong.
		0	Does not indicate an attempt to answer or no answer.

The CUT was submitted for biology education expert review who identified some errors and inconsistencies the instructional objectives with the questions. Then, the original form of the test was applied to 59 students as a pilot test to evaluate reliability and validity aspects of this test during the even semester of 2013-2014. The Cronbach α of the CUT was 0.83, so it can be stated that the reliability of these test questions is very high in category. Moreover, the results of the emphirical validity showed that the Pearson Correlation of CUT for each item (from items 1 to 28) is greater than r_{table} (0.254 for $\alpha = 0.05$ or 0.330 for $\alpha = 0.01$) with N = 59. Therefore, all test items are valid. With respect to the instructional objectives of the lesson, 20 of the test questions were used in the present study. The CUT was administered as a pretest and a posttest in all learning models.

In the present study, the researcher considered this activity (inquiry, argumentation, writing, and reviewing) in designing the learning environment. During the implementation, the students in ADI group actively participated in the eight activities (Sampson, Grooms, & Walker, 2011; Walker et al., 2011), namely: 1) identification of a research question, 2) generation of data through systematic observation or experimentation, 3) production of tentative arguments, 4) argumentation session, 5) creation of a written investigation report, 6) double blind peer-review, 7) revision of the report based on the peer review, and 8) reflective discussion. The participants were asked to choose among alternative theories to explain a phenomenon, to discuss and write science, to distinguish good from poor arguments, to discuss and communicate their perspectives, and to critique others' claims with appropriately supported arguments. Moreover, the role of the teacher was to support students in justifying their knowledge claims, to provide criteria for evaluating the quality of the arguments produced by the students, to encourage students to use evidence and to reflect on their positions.

Meanwhile, the students in ADIS group actively participated in 3 stage, namely initiation, development, and reinforcement (Hasnunidah, 2015). Student activities in the ADIS group can be seen in full in Table 1. In the conventional group, traditionally designed basic biology instruction was used. This type of instruction is primarily based on lecturing, discussion, and practicum. The instructor explained the topic and wrote the key concepts on the board, each group of students is given the task to make a paper about this conceps. In each meeting there is a group of students who present papers that have been prepared, and each person in class discussion can ask questions to students who present their papers. This discussion model is theoretical, not a matter that must be debated. Practicum activities are not in the form of inquiry, but only to prove or test the theory presented in the lecture theory and the textbook used. Students are only required to be orderly to follow the steps in guided book, but are not trained to formulate problems, form hypotheses, and plan experiments.

The software of SPSS was used for the data obtained through pre-CUT and post-CUT. The gathered data from this test were entered into Microsoft Excel. Then, each student's score from these tests were computed and then the scores were converted to the SPSS. Moreover, other variables which are students' academic abilities were also entered to this SPSS file. The descriptive statistics was conducted for each variable and presented as scores of ADI, ADIS and conventional groups' mean, standard deviation, skewness, kurtosis, minimum, and maximum values. For the inferential statistics, analysis of covariance (ANCOVA) was conducted with one dependent variables, which was Post-CUT mean scores; two independent variables, which were learning model and students' academic abilities; and one covariate, which was Pre-CUT mean scores. The Least Significance Difference (LSD) test used if there is a significant mean differences of the post-CUT mean scores were found between the treatment groups. Since the aim of this study was to generalize results obtained from the sample to the population, ANCOVA and LSD test with significant value 5% was also appropriate. Before conducting ANCOVA, all variables were checked for assumptions of ANCOVA, which were normality and homogeneity of variances and all assumptions was met.

4. Result

To investigate the effect of ADIS learning model, academic ability, and interaction between learning model and academic ability on the students' conceptual understanding, the students' answers to the CUT were analyzed. The results of ANCOVA are given in Table 3. In this table, ANCOVA analysis indicates that there is a significant mean difference ($F = 24.266$; $p = 0.000$) between ADI, ADIS, and Conventional learning model on the collective dependent variables of the post-CUT between groups when the pre-CUT was controlled.

Table 3. ANCOVA Test Results on The Effect between Subject

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	10731.505[a]	6	1788.584	20.822	0.000	0.419	124.931	1.000
Intercept	59911.456	1	59911.456	697.459	0.000	0.801	697. 459	1.000
Pretest Conceptual Understanding	2720.616	1	2720.616	31.672	0.000	0.155	31.672	1.000
Learning Models	4168.844	2	2084.422	24.266	0.000	0.219	48.532	1.000
Academic Ability	1302.708	1	1302.708	15.165	0.000	0.081	15.165	0.972
Learning Models*Academic Ability	262.070	2	131.035	1.525	0.220	0.017	3.051	0.321
Error	14860.627	173	85.900					
Total	910787.020	180						
Corrected Total	25592.132	179						

The results LSD test as seen from Table 4. In this table, LSD analysis indicates that there is no significant difference between mean corrected students who thought by ADI and ADIS learning model. However, LSD analysis showed that is any statistically significant mean corrected difference between ADI and Conventional learning model. Similarly, between ADIS and conventional learning model. In other words, there was a statistically significant difference between ADI and ADIS learning model on the collective dependent variable in favour of the Conventional group. All of these results indicated that ADIS learning model was as effective as ADI learning model in improving the students' understanding concepts of the structure and function of plantations and animals, living things reproduction, metabolism, Mendel Law and human nature inheritance, organism's interaction to environment, and evolution than conventional learning model.

Table 4.Comparison of Mean Corrected Student's Conceptual Understanding beetwen Three Models

Learning Model	Pretest	Postest	Difference	Corrected Mean	Notation
Argument-Driven Inquiry (ADI)	20.44	74.97	54.53	74.30	a
Argument-Driven Inquiry with Scaffolding (ADIS)	20.19	72.36	52.17	72.14	a
Conventional	19.29	63.05	43.76	63.94	b

For the academic ability variables, ANCOVA results (Table 3) showed that there is significant mean difference ($F = 15.165$; $p = 0{,}000$) between students' with high and low academic abilities in terms of post-CUT scores. This result showed that student's with high and low academic abilities had different understanding of basic biology concepts regardless treatment. The LSD test seen from Table 5. In this table, LSD analysis showed that mean corrected of the high academic ability students is higher than the low academic ability students. This result showed that achievement of the high academic ability students is higher than the low academic ability students.

Table 5.Comparison of Mean Corrected Understanding of Basic biology Concepts beetwen Two Academic Ability

Academic Ability	Pretest	Postest	Difference	Corrected Mean	Notation
High	22.11	74.22	52.11	72.93	a
Low	17.83	66.03	48.20	67.32	b

According to the results of ANCOVA, as seen from Table 3 above, there was no significant interaction between the learning model and academic ability on the post-CUT mean scores ($F = 1{,}525$; $p = 0{,}220$). This result indicates that ADI, ADIS, and Conventional learning model did not make any difference in students' understanding of basic biology concepts between high and low academic ability. The mean scores of students in ADIS, ADI, and Conventional Group are summarized in Table 6.

Table 6. The Summary of the ADIS, ADI, and Conventional Group Student Scores for the Pre- and Post-CUT

Descriptor	Learning Strategy	Academic Ability	N	Min	Max	Mean	SD	Skewness	Kurtosis
Pretest	ADI	High	30	14	35	22,69	5,44	0,615	-0,369
		Low	30	7	38	18,61	7,40	0,64	0,097
	ADIS	High	30	8	37	22,84	8,41	0,05	-0,984
		Low	30	9	33	17,55	5,33	0,755	0,846
	Conventional	High	30	7	43	20,82	8,09	0,504	0,341
		Low	30	10	27	17,76	4,45	0,274	-0,592
	Total	High	30	10	38	22,12	7,31	0,390	-0,337
		Low	30	9	33	17,97	5,73	0,556	0,117
Posttest	ADI	High	30	59	93	77,45	9,44	-0,247	-0,775
		Low	30	45	90	72,90	10,30	0,686	0,633
	ADIS	High	30	58	94	77,85	8,77	-0,402	-0,166

	Low	30	43	81	66,88	8,87	-0,912	0,824
	High	30	44	82	67,37	10,33	-0,816	-0,051
Conventional	Low	30	30	80	58,72	12,2	-0,152	-0,18
	High	30	54	90	74,22	9,51	-0,488	-0,331
Total	Low	30	39	84	66,17	10,46	-0,126	0,426

Based on data are presented in Table 5, it can be seen the mean scores of the ADI group in post-CUT between two academic abilities (high = 77.45; low = 72.90) is higher than the conventional group (high = 67.37; low = 58.72). Similarly, the mean post-CUT scores of the ADIS group between two academic abilities (high = 77.85; low = 66.88) is higher than the conventional group. Meanwhile, the mean scores of student with high academic ability of the ADIS group in post-CUT (77.85) is higher than the ADI group (77.45). Conversely, the mean scores of student with low academic ability of the ADI group in post-CUT (72.90) is higher than the ADIS group (66.88). While the mean scores of ADI and ADIS in post-CUT between two academic abilities (high and low) is higher than the ones in pre-CUT scores, the amount of raise in ADI and ADIS is much higher than the conventional group. That also shows us that the Argument-Driven Inquiry with Scaffolding learning model works well for the benefit of the students.

5. Discussion

The result of the study indicates that the learning model has a significant effect on the students' conceptual understanding. The students in ADIS group had significant mean scores equal to the ADI group in terms of the understanding of basic biology concepts, but both are higher than Conventional group students. This results are similar with a number of studies focusing on the effects of argumentation-based instruction using pretest-posttest design and documented that students who were learning with argumentation-based instruction developed better conceptual understanding than those in the traditional instruction (Aydeniz et al., 2012; Jimenez-Aleixandre et al., 2000; Kaya, Erduran & Cetin, 2010; Venville & Davson, 2010; Zohar & Nemet, 2002).

The ADIS learning model is as effective as the ADI learning model in improving the understanding of the concept, but both of them are more effective than conventional learning models. This is a very possible thing, because both of these models facilitate the realization of student involvement in the activities of investigation, argumentation, writing in science, and engage in peer review. The student's involvement in the investigation activities in the ADI and ADIS models is believed playing a major role in increasing the higher conceptual understanding achievement than the conventional model. Learning using both models had provided an opportunity for students to construct the concepts independently through laboratory investigation to produce data or to test the questions. According to Anderson (2009), based on a constructivist perspective, knowledge is should actively built by students and not only absorbed from textbooks and lectures. In another word, the students in ADI and ADIS class gain a concept based on direct experience and they learn to be able to apply the concept in other situations or in situations related to daily life. This is in line with Prince & Felder's (2006) opinion that inductive learning such as inquiry-based models usually presents new information in the context of situations and problems related to everyday life, so there is an opportunity that new information can be linked to the cognitive structure which has existed. According to Syah (2003) without a cognitive domain, it is difficult to imagine a student can think. Furthermore, without the ability to think, it is impossible that the student can understand and believe in the benefits of learning materials he learned.

Lecturers must be able to make biology relevant to a student's life. In the identification task stage of the ADI learning model and standpoint development stage of the ADIS learning model, the student is given open-ended problems. Giving problems like this is believed able to arouse student curiosity and motivate them to be able to solve problems so that their concept mastery will also increase. This is in line with Tan's (2003) opinion that problem-based learning can improve the concepts transfer to a new situation, concept integration, interest intrinsic learning, and learning skill, thus can help students to construct knowledge and reasoning skills compared to traditional teaching approach.

Learning with ADI and ADIS in this study also provides opportunities for students to communicate their result investigations to be criticized, debated, and revised through argumentation activities. The student's involvement in the argumentation activities through learning with the ADI and ADIS models is believed plays a major role in the increase of conceptual understanding achievement higher than the conventional model. This study results are in accordance with the previous relevant research, i.e: Cross et al. (2008) concluded that students who took biology courses and also argued with the Toulmin model, could improve their science concept understanding; Riemeier's research (2010) showed that the student involvement in argumentation has to do with their concepts understanding. Students who are actively arguing turned out to have a good understanding of a concept. The need to understand concepts in better, encourages students to make an argue; Jimenez-Aleixandre & Erduran (2008) and Cavagnetto (2010) stated that the involvement in the argumentation process, develop students' conceptual understanding, ability and cognitive intelligence, metacognitive, communication, and also critical thinking skills, which furthermore, fosters scientific literacy.

Students have a responsibility in learning when they are being given the opportunity to communicate. Students who use the ADI and ADIS models are being given the opportunity to communicate both verbally and writing through "argumentation sessions". Through this activity, cooperation between students in groups is related so that it enables them to influence and learn from each other. Reconstructing the concept in a small group is believed greatly in strengthening the learning process. This is supported by the Brown's opinion (2003), that students can show their knowledge about an object as they listening, observing, and studying from other students in their group, based on the modification of their own results understanding. Argumentation discourse is suggested as a way to get learners involved in a community of practice that mimics the way scientists' reason and evaluate data and as a way to get students to evaluate their existing scientific knowledge by constructing new knowledge from the understandings of their peers. In other to, students also have the opportunity to change or improve on their first ideas or methods. It also gives teachers a chance to consider students' ideas and to encourage them to think about concerns that may have been ignored (Walker, 2011). Communication is essential to this argumentation discourse. In this way, students gain new ideas that can broaden their knowledge, put meaning on existing information, and use that information for a particular purpose. According to Schunk (2008) understanding of the concept involves elaboration and adding new knowledge with armed with prior knowledge, where the new information is elaborated into the organizational structure that already exists in memory. The process of constructing knowledge through social interaction with other friends is the potential to enrich the intellectual development of the students (Ibrahim and Nur, 2004).

Basic Biology lecture by ADI and ADIS learning models in this study is believed could enable students to learn to write in science and to help them better understand the content. Students are required to produce a report that answers three basic questions: What were you trying to do and why? What did you do and why? What is your argument? The aim of this report is to understand the goal of the investigation and learn to write in science. According to Sampson et al. (2011), writing activities in the ADI model, teach students the importance in sharing the research results through writing, reading, understanding other people's writings, and evolving their values. This activity could help students to understand the topic and develop a better understanding of how to write scientific arguments. Wallace et al. (2004) stated that the writing process encourages metacognition and improve student understanding of the content and develop a conceptual understanding of scientific inquiry. Meanwhile, the ADI and ADIS learning models also involve students actively in reviewing that ensures the quality of these reports. With the aim of engagement in the evaluation process inserted in the models, students assess the other groups' reports with a peer review sheet as a part of double-blind peer review.

Sampson et al. (2011) state that the double-blind peer-review is expected to improve students' metacognition, critical thinking skills, argumentation skills, and conceptual understanding.

The results analysis of student response in the application of the three learning models that have been carried out showed that the student percentage in ADIS and ADI classes has more believe that lectures can add clarity in basic biology subjects than Conventional classes. Students' confidence in the increasing clarity in the lecture material which has learned, showed the success of the ADI and ADIS models in learning basic biology. According to Amin (1987), a student is said to have the concept understanding whereas he was able to define concepts, identify concepts, and give examples from the concepts or not so that with this ability, he could bring a different concept to another from a textbook. Demircioglu et al. (2001, in Kibar & Ayas, 2010) argue that improving the study of student concepts understanding is important to determine the students understanding itself and develop appropriate material. The meaningful of students understanding about science concepts and topics is useful in case that science education programs could achieve the goals (Kılıça & Saglamb, 2009).

The factors that cause the low of the students' conceptual understanding who undergo learning with conventional models were the lack of empowering students to study optimally. According to researchers, students have been 'cultured' to receive the transfer of knowledge from the lecturer, work on the assignment (if any), then examine the questions when the exam is near. In other words, the mindset and learning style of students, both inside and outside the lecture, have not involved high mental activities. Meanwhile, understanding concepts is a key aspect of learning. One of the importance of learning goal is to help students understand the main concepts in a subject, not just remembering the separate facts. The integrity of understanding allows students to learn more meaningfully than just repetitive memorization without meaning, next, they can apply it in daily life and carry out higher mental processes (Santrock, 2007).

Furthermore, the low posttest means a score of the conventional group students in terms of the understanding of basic biology concepts showed in this study might be caused by the lack of activities on the investigation. The type of experimental activity is only to prove or test the theory presented in theoretical lecture activities or in textbooks used. Besides that, the discussion questions in the practicum guide are dominated by the only memory questions, not the questions in the form of challenging to debate issues. It can be seen that the interaction between students which should lead to the formation of together concepts, becomes just only a division of task in case of completing the lab works more quickly or copying the data as soon as possible. This situation occurs because of practicum activities are just only a complement of the lecture. Thus, the acquisition of concepts is not through practical activities but tends from what the lecturers directly convey (lectures). In other words, students are more likely to use cognitive structures that have been filled from lectures concept (theory). Students are not accustomed to achieving a concept understanding from a process and apply the theory to the reality found in nature. These opinions support the findings of the previous studies such as Domin (1999) stated that characteristic of the traditional laboratory activities is to use "cookbook" that emphasizes the adherence of students in following procedures for the benefit of data collection. Almost no attention is given to planning investigations or for interpreting results. This kind of activity has been criticized for having little emphasis on thought, is not very effective for conceptual change, and unrealistic in the depiction of scientific experiments. In other words, students' mindsets and learning styles in the conventional group have not involved high mental activity; Suwondo & Wulandari (2013) stated that practicum activities do not always succeed in involving students to find their own concepts, but it will succeed if the activities inside it have a clear thinking processes and objectives. Meanwhile, Santrock (2007) stated that conceptual understanding is a key aspect of learning. One of the important learning objectives is to increase students' understanding of the main concepts in a subject, rather than merely remembering fragmentary facts. The integrity of comprehension allows students to learn more meaningfully than simply memorize over and over without meaning, then can apply it in everyday life and can perform higher mental processes.

Based on the study results analysis, it is also known that academic ability had significant effects on students' conceptual understanding. Students with high academic ability had a significantly better acquisition of the understanding of the basic biology concepts when compared with students with low academic ability. These references illustrate that through ADI and ADIS learning models, students with high academic ability can optimally improve their thinking process through investigation, argumentation, writing, and review activities that are carried out in stages from class level to individual level. Thus, students with high academic ability tend to have better control their cognitive processes, have a better starting point and have more confidence than the students with low academic ability thus they tend to be easier to understand the concepts. The results of this study opposite to the results of previous relevant research such as Prasinta (2018) in her research to examine the effect of ADI learning models, that the average value of N-Gain the students' understanding concept was using ADI learning model are higher than using conventional learning not only high academic ability but also low academic ability. The initial academic ability of student has a great influence on the ability of students to take part in lecture activities. This initial academic ability must be empowered, especially for students who have low initial academic abilities, to get the same results as another group with different initial abilities. This showed that the grouping of student abilities based on academic ability is very important to educate a large group of students with different backgrounds and abilities (Corebima, 2006). Various factors that influence the learning achievement of students are lecturer and lecture environment, peers, family, and student's own roles. Lecturers and lecture environments play a role in stimulating active learning, developing thinking skills, creating effective learning zones, promoting success, providing effective feedback, enhancing motivation and accepting individual differences. Meanwhile, the factor of intelligence is one factor that is effective in influencing the success of learning. Smart students will be more successful in learning activities because it is easier to capture and understand the lesson and easier to remember it. This is different from students who are less intelligent or sluggish (Yahaya, 2003; Hamalik, 2004; Heltemes, 2009).

As the analysis results described above, it is known that there is no significant interaction effect between the learning model and academic ability on the conceptual understanding. This can be caused by no dominant influence of the learning model (ADI, ADIS, and Conventional) and academic ability on the conceptual understanding. Conversely, the influence of academic abilities is not more dominant through the learning model to conceptual understanding. This result is in line with previous relevant research such as Suprapto (2015) concluded that the no-interaction between learning models (Direct Contextual and Direct Learning) and achievement motivation on cognitive learning outcomes and motor skills, due to the strong influence of each learning model and achievement motivation variables to learning outcomes variables. In another word, no interactions between variables were caused when if two independent variables or more bring a very strong (significant) separately influences to the dependent (Hair, 2009).

Although the study results showed that there is no significant interaction effect between the learning model and academic ability on the students' conceptual understanding, the highest mean scores (posttest = 77.85 ± 8.77) was achieved by the students with high academic ability in the ADIS group, while the lowest mean score (posttest = 58.72 ± 12.2) was achieved by the lower academic students in the Conventional class. These results indicate that the ADIS model is more able to improve the students' conceptual understanding in student with high academic ability compared to students' with low academic students.

Result this study above illustrates that through the ADIS learning model, students with high academic abilities can optimally improve their thinking processes through investigation, argumentation, writing,

and reviewing on stage carried out from class level to individual level. Standpoint as a starting point in the development of argumentation and tiered guidance in the initiation, development, and strengthening phases in ADIS is effectively used as scaffolding for students to develop argumentative skills both classically, in class, groups, and individually. Standpoint plays a very important role in initiating a classical dialectic, especially in the practice of argumentation, because standpoint is a functional element of an argument (Eemeren et al., 2002; Ferreti et al., 2009).
Students who study with ADI without scaffolding produce argumentative discourse with a pattern of low-quality discourse. Discourse patterns with high scores are very low percentages. This means that very few students can submit their objections to the claims, data, warrant, or backing of other students so that the resulting claims and counterclaims are lacking. The quality of arguments can be determined by the presence or absence of rebuttal or resistance arguments in the discourse of argumentation (Erduran et al., 2004). Arguments with rebuttal are important elements of quality arguments and show a high level of argumentation ability. Furthermore, rebuttal can also be considered as a measure of conversation involvement, because it can involve students in dialogic conversations where they can not only prove their claims but also reject other people's claims with evidence. The presence of a rebuttal in a conversation can act as an ongoing indicator of student involvement in argumentation discourse. Students who actively participate in argumentation can improve their argumentation skills. Increasing student argumentation skills significantly increases understanding of the concept. Through the argument generating learning model, students are encouraged to develop the abilities and habits of thought to build and support scientific statements through arguments and to evaluate or compare them with statements or arguments of others. Thus students get help in understanding basic biology concepts well. Thus, there is a positive reciprocal relationship between the argumentation process and students' understanding of concepts.

Students in the ADI group in this study did not use scaffolding to develop their argumentation skills. They produce argumentation with a discourse pattern in low quality and students' with high-quality discourse pattern were very low percentages. This means that very few students can submit their rebuttal to the claims, data, warrant, or backing of other students so that the resulting counterclaims are lacking. The quality of arguments can be determined by the presence or absence of rebuttal or resistance arguments in the discourse of argumentation. Arguments with rebuttal are important elements of quality arguments and show a high level of argumentation ability. Furthermore, rebuttal can also be considered as a measure of conversation involvement, because it can involve students in dialogic conversations where they can not only prove their claims, but also reject other people's claims with evidence The presence of a rebuttal in a conversation can act as an ongoing indicator of student involvement in argumentation discourse (Erduran et al., 2004; Walker, 2011).

Students who actively participate in argumentation discourse can improve their argumentation skills. Increasing student's argumentation skills significantly increases understanding of the concept (Dawson & Venville, 2009). Through the ADIS learning model, students are encouraged to develop the abilities and habits of thought to build and support scientific statements through arguments and to evaluate or compare them with statements or arguments of others. Thus students get help in understanding basic biology concepts well. The students' argumentative discourse which highest quality in the ADIS group can be seen below.

Standpoint:
Evolutionary relationships between populations can be detected by comparing morphological features.

Counter Claim:
I disagree if the evolutionary relationship between the 6 lizard populations can only be detected by comparing the body size of its species, but also by comparing the amount of cytochrome B in the DNA strand.

Ground/Data:

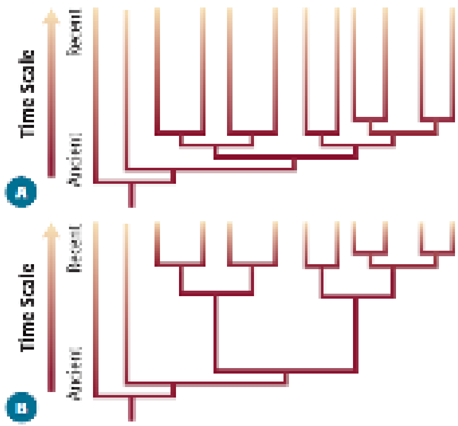
The data I got in Table 2 of the number of cytochrome b in DNA sequence among Gallotia lizard populations is Gallotia atlantica compared to Gallotia stehlini resulting in a difference of 36. G atlantica with G. galloti subspecies Tenerife at 21, with G. galloti subspecies Palma by 25, with G. galloti subspecies Gomera by 24, and with G. galloti subspecies Hiero by 28. Difference in the number of cytochrome b in the DNA sequence between G. Gallotia stehlini and G.galloti subspecies Hiero by 49. G.galloti subspecies Tenerife 40 , with G. galloti subspecies Hiero at 19 and G.galloti subspecies Palma compared to G.galloti subspecies Hiero at 19. G. galloti subspecies Gomera compared to G.galloti subspecies Hiero at 4.

Warrant:
I think that the evolutionary relationship among 6 lizard populations can be detected by comparing the number of cytochromes B in the DNA strand among the lizard populations, because the results showed that the closest kinship was between G.galloti subspecies Gomera and G.galloti subspecies Hiero. This can be clearly seen through the cladogram based on the order of the closest distance between G.galloti subspecies Gomera with G.galloti subspecies Hiero, then with G.galloti with G.galloti subspecies Palma. Then followed by G.galloti subspecies Hiero with G. Atlantica which is closer than G.stehlini. The figures in the table illustrate that genetic distance is determined from the DNA ratio of the species, the more similar the DNA the shorter the genetic distance. In the sequence shows G.galloti subspecies Hiero is closer related to G.galloti subspecies Gomera and continued with G.galloti subspecies Tenerife, G.galloti subspecies Palma, G. Atlantica, and G.stehlini.

Backing:
Based on the book I read, the comparison of nucleotides between DNA segments of different species in order has the potential to show us how much separation occurs in the evolution of two genes originating from the same ancestor. Identifying homologous nucleotide sequences, that is, the sequence of nucleotides found in two species that have the same pattern is important to find differences between the two species.

There is a positive reciprocal relationship between the argumentation process and students' conceptual understanding. Students who can compose high-quality argumentative discourse apparently score high conceptual understanding. Student answers that show a high level of conceptual understanding can be seen below.

Question:
The picture below illustrates the evolution of various modern fern plants. Researchers analyzed fossil evidence and DNA sequence data for ferns and they found that ferns have shown a higher diversity in the history of contemporary evolution. They concluded that the diversity of modern ferns developed after Angiosperms dominated the terrestrial ecosystem. Consider the two models that show the evolution of diversity in organisms. Which model best fits the researcher's conclusions as explained above? Why is that?



Answer:
I would argue that Model B best fits the researcher's conclusion. The data in the graph provided shows that the branching points in the phylogenetic tree in Model B are more numerous in the present than in the past. The earliest line of ferns separated in antiquity. The next branching point towards the top indicates a more recent separation by the two big groups. One of them consists of 10 species occur in the present.

The idea of increasing the student's understanding of basic biology concepts through the ADIS learning model in this study based on a theoretical conception that education aims to facilitate students to achieve an understanding that can be expressed verbally, numerically and frameworks. Concept understanding is a mental process of the adaptation and transformation of science. Understanding concepts is a representation of learning outcomes. Therefore, with ADIS learning that evokes arguments students will issue their opinions according to their knowledge and experience. This opinion will also help other students add knowledge that they do not know yet. The quality of argumentation or the strength of an argument (claim) is determined by understanding a concept supported by data/evidence, warrant, backing and how we construct these components so that they can convince others. Strong arguments have many relevant and specific justifications to support conclusions with accurate conceptual evidence. While the characteristics of weak argumentation are shown by the lack of scientific knowledge, inaccurate, not specific, and inaccurate (Jimenez-Aleixandre & Erduran, 2008).

3. Conclusions and Implication

The ADI and ADIS are learning models that can be used by science educators to promote deep conceptual engagement with scientific phenomena compared to the conventional models. The improvement of the students' conceptual understanding of the high academic students in the ADI and ADIS learning model is 8.3% higher than that of the low academic ability students. The lecturer can use these two models to develop students' conceptual understanding and give birth to scientific habits in the classroom environment. The inherent activities of these two learning models also seem to provide opportunities for student diversity in academic abilities to be active participants in the science process. The ADI and ADIS learning models provide opportunities for students to engage in a variety of activities, such as the generation of an argument, the discussion of findings, and the writing and editing of manuscripts in addition to experimental design and data analysis. It seems likely that more students would find several aspects of the process that they could participate in and feel successful. In this study, we can show that for students with high academic ability, this variety had a positive effect on their conceptual understanding.

The ADIS learning model is inclined to have the potential to improve the conceptual understanding of the high academic ability exceeding that of the high academic ability students. It is believe that ADIS learning model has appropriate learning stages needed by high and low academic ability students so that it enhances their achievement. The students who study in the ADIS learning model engaged in an investigation, argumentation, writing and review in three-phase, that is: initiation, development, and strengthening. In developing gradual scientific arguments from class, group and individual levels, ADIS was proven capable of training student skills in developing high-quality arguments and participating productively in tiered scientific argumentation. Being involved in argumentation and production of spoken and written argument in this study, the students are able to improve their conceptual understanding.

Although we did not find significant differences in conceptual understanding (measured by CUT) between the ADI and ADIS learning models, students in the ADIS group were found to be more disputed in their arguments. The use of viewpoints in ADIS is believed to be effective for submitting arguments for refutation or rejection. As such, extensive engagement with the debate, in the context of ADIS, seems to promote conceptual understanding along with additional positive results that are not realized by the ADI learning model. However, there is an inevitable limitation of this study, namely that with a small population size it is very possible that the generalization of findings is limited. Therefore, it would be better to conduct research with a larger group.

Although we did not find a significant difference in conceptual understanding (as measured with the CUT) between the ADI and ADIS learning models, students in the ADIS group were found raised more rebuttal in their arguments. The use of standpoints in ADIS is believed to be effective to raise a rebuttal or resistance arguments. Thus, extended engagement with debate, in the context of ADIS, seems to promote conceptual understanding along with additional positive results which are not realized by the ADI learning model. However, there are certain inevitable limitations of this study, namely that with a small population size; it is very possible that the generalization of findings is limited. Therefore, it would be better to conduct research with a larger group.

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