Improving Critical Thinking Skills To Learn Heredity With Discovery Based Unity of Sciences (DBUS) Model

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Abstract. The Background of this research is the study of the integration of science and religion in science learning in Islamic Higher Education. The study discusses how to teach biology with Discovery Based Unity of Sciences (DBUS) model to improve students' critical thinking skill. Observation of research at UIN Walisongo and UIN Sunan Kalijaga. Classroom learning uses a discovery based Unity of sciences (DBUS) model. Samples in the study were 96 students of UIN Walisongo and 94 students of UIN Sunan Kalijaga in first year 2017/2018 and 2018/2019. The research used experimental method with T test pretest posttest experiment. The N-gain obtained by the experimental class is 0.23 is greater than the control group of 0.09 in UIN Walisongo. The gain obtained from the experimental class is 0.54 greater than the control group 0.16 in Sunan Kalijaga UIN. The results of the DBUS model study are feasible to improve critical thinking skills of heredity learning. Content validity between 0.75 to 1.00. Construct validity using structural equation model (SEM) method with lisserel analysis 8.7 with loading factor value of all critical thinking skill 0.575 and T-value of DBUS model> 1.96. The effectiveness of DBUS model with statistical test at UIN Walisongo Semarang by value of t value = 9,326 with sig 0,000 <0,05 and UIN Sunan Kalijaga obtained t value = 25,582 with sig value 0,000 <0,05.

1. Introduction

Critical thinking is a character (disposition) and skill (ability). Character and skill are two separate things within a person [1,2,3]. From the perspective of developmental psychology, character and skills are mutually reinforcing, therefore both must be explicitly taught together. The human character (disposition) is a consistent internal motivation within a person to act, respond to a person, event, or ordinary situation. Experiences reinforce a human character (disposition) characterized by apparent tendencies, which can be easily described, evaluated, and compared by themselves and others. Knowing one's character (disposition) allows us to predict how one tends to act or react in various situations [4,5].

Skill is manifested in deeds. A person with good skills tends to show a little mistake in doing tasks while less skilled people make more mistakes when given a number of similar tasks [1,6]. The results of educational research show that critical thinking is able to prepare learners to think in various disciplines, and can be used to fill the intellectual needs and the development of potential learners, to live their career and life [7,8]. Learning learners with critical thinking skills can influence the lives of learners to analyze some of the problems they encounter in everyday life [9,10]. Critical thinking skills can provide information can be used more productively, i.e by making decisions and problem solving. The importance of trained critical thinking skills in learning
provides students with the ability to develop strategies and tactics for success in future global competition. Through critical thinking skills, learners are invited to participate actively and effectively to build their knowledge [9]. Critical thinking is included in high-level thinking skills, along with creative thinking, problem solving, and decision-making which are all high-thinking skills that include analytical, synthesis, and evaluation skills [10,11]. According to Facione, there are six major skills of critical thinking skills involved in the critical thinking process. These skills are interpretation, analysis, evaluation, inference, explanation and self-regulation [1,2].

The education system in Indonesia is still focused on the delivery of information rather than the development of thinking skills of learners. The knowledge information provided to learners has not become knowledgeable until analyze, applying, synthesizing, evaluating and integrating into life. Educators should pay attention to critical thinking skills during learning because of the learners who have [12,13].

The need for learning models that can empower critical thinking skills. Discovery model based on unity of sciences is one model that can be applied in learning in class [14]. The DBUS (Discovery Based Unity of Sciences) model is a form of discovery model development by incorporating elements of regional culture and Islamic values. Stages DBUS model consists of; 1) Stimulation using local wisdom 2) Problem statement 3) Observation and data collection 4) Data processing 5) Verification based on religion 6) Generalization and awareness [15,16].

1.1 Heredity

Genes are the unit of inheritance of properties for living organisms or substances of heredity which are chemical compounds containing information and may duplicate themselves at the time of mitosis. The physical form is a sequence of DNA encoding a protein, polypeptide, or a RNA that has a function for the organism that has it. Genes cultivate and organize various types of characters in the body both physical and psychic [19,20]. Setting these characteristics through protein synthesis processes such as; the skin is formed by keratin, the muscle of actin and myosin, the blood of (Hb, globulin, and fibrinogen), the binding tissue of (collagen and elastin), bones of Osteocytes, cartilage of chondrocytes. Genes as hereditary factors are stored in chromosomes, which are inside beads called chromosome or nuclei of chromosomes [21,22].

In chromosomes there is 35% DNA of the entire chromosome. DNA is a living molecule and can replicate. DNA is a reservoir of genetic information to be inherited to these guidelines, show the best layout for your paper using Microsoft Word. If you don’t wish to use the Word template provided, please use the following page setup measurements.

Figure 1. Chromosome (http://www.aktifbelajar.com/2015/10/pewarisan-sifat-istilah-istilah-dalam.html)

In the body of the organism there are different chromosome numbers. In humans every somatic cell counts 46 chromosomes (except sperm and ovum cells, because it has a single set of chromosomes) or 23 pairs. 46 chromosomes are two sets of chromosomes consisting of each of the 23 chromosomes, a maternal set (from the mother) and a paternal set (from the father).

In Organism there are two kinds of chromosomes, namely: Sex chromosomes that determine the sex and chromosomes of the body (autosomes) of 23 pairs of chromosomes, 22 pairs of which are autosomes and 1 pair of gen that determine the sex [20,22].
### 1.2 Learning Heredity With the DBUS Model

The DBUS model is an integrative model of discovery based on Islamic values and values of society. In learning, students are invited to explore the noble cultural values of the concept of heredity. In addition, the value of religion became the basis in the implementation of the concept of heredity.

Achievement of learning is expected to explain the concept of heredity with the basis of the Qur'an, Sunnah and cultural values that exist in society. Indicators in learning include:

- a. Students understand and explain the basic concepts of heredity and utilization
- b. Students can implement basic concepts of heredity in the community.

Students are expected to be more critical in learning heredity by using the DBUS model. In classroom learning, students observed students' critical thinking skills. The indicator of critical thinking skills can be seen in table 1.

#### Table 1. Critical thinking skills indicator

| No. | Indicator | Operational Indicator | No Butir |
|-----|-----------|-----------------------|----------|
| 1   | Interpretation | Revealing experiences | 1        |
|     |           | Bring up data | 2        |
|     |           | Telling the situation and events | 3        |
|     |           | Bring out rules and procedures | 4        |
| 2   | Analyzation | Linking statements with confidence | 5        |
|     |           | Describe experiences, reasons, and opinions | 6        |
|     |           | Identify questions to disclose information, opinions and reasons | 7        |
|     |           | Linking concepts in the form of reason and opinion | 8        |
| 3   | Evaluation | Giving statements from other people's perceptions | 9        |
|     |           | Giving opinions from others' experiences | 10       |
|     |           | Assess the strength of the relationship between questions and statements | 11       |
|     |           | Distinguish information and opinions | 12       |
| 4   | Inference | Collect data and facts to draw temporary conclusions | 13       |
|     |           | Make a hypothesis of information, facts and data available | 14       |
|     |           | identify the elements needed to draw conclusions | 15       |
|     |           | Consider relevant information from the data | 16       |
| 5   | Explain   | Gives reason in the form of a convincing argument | 17       |
|     |           | Provide evidence in the form of a convincing argument | 18       |
|     |           | Provide methodology to convince arguments | 19       |
|     |           | Providing contextual considerations in convincing arguments | 20       |
| 6   | self-regulation | Conducting cognitive activities | 21       |
|     |           | Apply the concept in activities | 22       |
|     |           | Apply learning outcomes in skills and analysis | 23       |
|     |           | Provide assessment with questions, confirmation and validation | 24       |
2. Methods
The population in this study were Biology Education students UIN Walisongo (96 people) and UIN Sunan Kalijaga (94 people) in the first year of 2017/2018. This study is a population study, meaning that all populations are sampled in the study [23,24]. This type of research is experimental with DBUS learning model as independent variable in research for experimental class and direct learning model for control class. The dependent variable is students' critical thinking skills.

The research instrument consists of learning tools, namely: Semester learning plan (RPS) and observation sheet of critical thinking skill. Learning devices are used in the implementation of learning, while the instrument of data collection as a means of data retrieval research results. The research data consist of observation of critical thinking skill of students obtained from observation done in class. All instruments are tested for validity before use. RPS and student observation sheets are tested for validity of experts in their field (judgment experts).

Instrument of observation of students' thinking skill as 24 indicator of critical thinking skill. The research data is the value of students' critical thinking skill. Data were analyze by descriptive statistic and T test. Descriptive analysis is used to describe the critical thinking skills of the learning model. Test T Test to test the hypothesis that has been formulated at 5% significance level.

The use of the DBUS model in empowering critical thinking skills is reviewed based on the comparison of normalized gain (N-gain) values, between the experimental and control groups. The normalized gain (N-gain) can be calculated by the equation [24,25,26] by the formula:

\[ g = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maximum}} - S_{\text{pretest}}} \]

After the normality test, the homogeneity test of variance is performed before the T Test. Normal distributed data and homogeneous variance are obtained. Hypothesis of this research, that is: there is difference of critical thinking skill between student using DBUS model with student using conventional model. The hypothesis was tested with SPSS 18 program based on Test of Between-Subject Effects in SPSS output.

3. Results and Discussion
Here it is explained that $g$ is the normalized gain (N-gain) of both models, the maximum $S$ is the ideal score of the initial and final tests, $S_{\text{posttest}}$ is the final test score, whereas $S_{\text{pretest}}$ is the initial test score. The normalized low gain (N-gain) can be classified as follows:
- if the resulting $g \geq 0.7$ N-gain belongs to the high category
- if $0.7 > g \geq 0.3$, the resulting N-gain belongs to the moderate category
- if $g < 0.3$, the resulting N-gain belongs to the low category [24,25].

Tables 1 and 2 respectively demonstrate the scores and results of critical thinking skills analysis of experimental class and control class students on the concepts of heredity before and after the lecture. The table contains the average score of pre-test and post-test of students' critical thinking skills for each experimental class and control class.

Table 2. Score and analysis results critical thinking skills UIN Walisongo student

| No | Concept | Experiment Class | Control class |
|----|---------|-----------------|--------------|
|    |         | n Pre test | Post test | N-gain | N Pre test | Post test | N-gain |
| 1  | Heredity| 96  2.4583 | 7,4167 | 0,23 | 101 3,1683 | 5,0792 | 0,09 |
Based on Tables 2 and 3, it appears that the N-gain difference between the experimental and control groups when learning the Basic of Inheritance of Nature and Biotechnology with the DBUS model. The gain of the experimental class of 0.23 is greater than that of the control group of 0.09, so it generally illustrates the effectiveness of the application of the DBUS model in teaching the concept of heredity.

Table 3. Score and results of analysis of critical thinking skills
UIN student Sunan Kalijaga

| No | Concept | Experiment class | Control class |
|----|---------|------------------|---------------|
|    |         | N Pre test | Post test | N-gain | N Pre test | Post test | N-gain |
| 1  | Heredity| 94   | 7.1702 | 16.3511 | 0.54  | 48   | 5.0417 | 8.0625 | 0.16  |

Based on Table 2 and 3 it appears that the difference in N-gain between the experimental and control groups. If we review more generally, the N-gain obtained by the experimental class is 0.54 times greater than that of the control group 0.16, thus generally illustrating the effectiveness of the application of the DBUS model in heredity.

Described comparison between the experimental class (DBUS model) and the learning model class in the control group (discussion), in terms of empowering students' critical thinking skills. The comparison of these two models is done by comparing the gain of normalized (N-gain) experimental class and control class for critical thinking skills.

3.1 Effectiveness of DBUS model judging from obtaining score of critical thinking skill
To compare DBUS model classes and regular learning model classes, in terms of empowering students' critical thinking skills on the concept of heredity, a normalized score comparison test (g) of these skills is performed between the experimental and control classes (regular). This comparison is done by statistical test that is t test for normal distributed data. Table 2 and 3 show the data analysis of scores normalized students' critical thinking skills.

Table 4. Test of UIN Walisongo experimental t-test

| Paired Samples Statistics | Mean | N  | Std. Deviation | Std. Error Mean |
|---------------------------|------|----|----------------|----------------|
| Pair 1 Post test          | 7.4167 | 96 | 4.92398       | .50255          |
| Pair 1 Pre test           | 2.4583 | 96 | 1.88018       | .19190          |

| Paired Samples Correlations | N  | Correlation | Sig. |
|-----------------------------|----|-------------|------|
| Pair 1 Post test & pre test | 96 | .035        | .736 |

| Paired Samples Test | Paired Differences | 95% Confidence Interval of the Difference | Sig. (2-tailed) |
|---------------------|--------------------|------------------------------------------|----------------|
| Mean                | Std. Deviation     | Std. Error Mean                          | df             |
| Lower               | Upper              | T                                         |                |
Paired Samples Statistics

|       | Mean | N  | Std. Deviation | Std. Error Mean |
|-------|------|----|----------------|-----------------|
| Pair 1 Post test | 7.4167 | 96 | 4.92398        | .50255           |
| Pre test | 2.4583 | 96 | 1.88018        | .19190           |

Paired Samples Correlations

|       | N  | Correlation | Sig. |
|-------|----|-------------|------|
| Pair 1 Post test – pre test | 4.95833 | 5.20914 | .53166 | 3.90286 | 6.01380 | 9.326 | 95 | .000 |

The result of statistical test in table 4.1 paired sample test statistic obtained pre test average value is 2.45 while average post test value of 7.4167 is correlation between pre test data and post test data is 0.035 with probability 0.035 <5%, it shows that the increase in student value from pre test to post test is evenly distributed in other words pre test data has a significant relationship with post test data. In table 4.14 paired sample test obtained account = 9,326 with sig value 0.000 <0,05 thus there is difference of pre test average value and mean value of post test. Because the mean value of post test is higher than the pre test average value, it can be said that the average value of post test is better than the average value of pre test. The magnitude of the percentage increase in the pre test value to the post test is:

\[
(7.4167 - 2.45) / 2.45 \times 100\% = 202.722\%.
\]

There was an increase of more than 200% critical thinking skills to UIN Walisongo students from the observation of learning activities using DBUS model. Increases in almost every indicator of critical thinking skills include: interpreting, analyzing, evaluating, inference, explaining and self regulation [2]

Table 5. T-test experiment control class UIN Sunan Kalijaga

Paired Samples Statistics

|       | Mean | N  | Std. Deviation | Std. Error Mean |
|-------|------|----|----------------|-----------------|
| Pair 1 Post test | 16.3511 | 94 | 3.05050        | .31463           |
| Pre test | 7.1702 | 94 | 1.90437        | .19642           |

Paired Samples Correlations

|       | N  | Correlation | Sig. |
|-------|----|-------------|------|
| Pair 1 Post test & pretest | 94 | .071        | .496 |

Paired Samples Test

|       | Paired Differences | 95% Confidence Interval of the Difference | Sig. (2-tailed) |
|-------|--------------------|----------------------------------------|----------------|
|       | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | t    | df   |
| Pair 1 Post test pre test | 9.18085 | 3.47947 | .35888 | 8.46819 | 9.89352 | 25.582 | 93 | .000 |

The result of statistic test on paired table of statistic samples obtained pre test average value is 7.1702 while the average value of post test 16.3511 is correlation between pre test data and post test
data is 0.071 with probability 0.496 > 5%, it shows that improvement of critical thinking skill UIN student Sunan Kalijaga from pre test to post test is evenly distributed in other words pre test data has a significant relationship with post test data. On paired table sample test obtained \( t \) value = 25.582 with sig value 0.000 < 0.05 thus there is difference of pre test average value and mean value of post test. Because the mean value of post test is higher than the pre test average value, it can be said that the average value of post test is better than the average value of pre test. The magnitude of the percentage increase in the pre test value to the post test is \((16.3511 - 7.71702) / 7.71702 \times 100\% = 111.88\%\).

There is an increase of more than 100% critical thinking skills in UIN Sunan Kalijaga students from the observation of learning activities using DBUS model. The increase of almost every indicator of critical thinking skill includes: interpreting, analyzing, evaluating, inference, explaining and self regulation [1,3,6].

Parameter effect size in this study is to test the correlation coefficient then the effect size is determined by how big the difference. The way to calculate the effect size in this study was to use an average of Cohen. According to Cohen, the average effect size is the mean difference expressed in standard deviation units [24,26].

**Effect size d Cohen = \(\frac{\text{mean difference}}{\text{standard deviation}}\)**

So the result of effect size in this research are: Effect size d Cohen Result from UIN Walisongo

a. Effect size d Cohen Result from UIN Walisongo

| Mean size | Std. Deviation |
|-----------|----------------|
| 4.95833   | 5.2814         |

The Result effect size Model DBUS di UIN Walisongo
d = 4.95833/5.2814 = 0.9388287

b. Effect size d Cohen Result UIN Sunan Kalijaga

| Mean size | Std. Deviation |
|-----------|----------------|
| 9.18085   | 3.47947        |

The result of measure size of DBUS model size in UIN Sunan Kalijaga is
d = 9.18085/3.47949 = 2.63857714

Based on Cohen’s effect size criteria proposed by Cohen on the size of the effect are as follows:

- \(0 < d < 0.2\) Small effect (average difference of less than 0.2 standard deviation)
- \(0.2 < d < 0.8\) Medium effect (average difference of about 0.5 standard deviation)
- \(d > 0.8\) Large effect (average difference of more than 0.8 standardized deviation) [21].

So it can be concluded that the effect size of the DBUS model both in UIN Walisongo and UIN Sunan Kalijaga in the class of great effect because it has a value \(d > 0.8\) ie 0.93 in UIN walisongo and 2.63 from UIN Sunan Kalijaga.

4. **Conclusion**

The value of \(N\)-gain in UIN Walisongo obtained the experimental class of 0.23 is greater than the control group of 0.09, so the general application of the DBUS model in the General Biology lecture is effective. The effectiveness of the DBUS model implemented in UIN Sunan Kalijaga viewed \(N\)-gain obtained by experimental class of 0.54 is greater than the control group of 0.16, so it generally illustrates the effectiveness of the application of DBUS model in Biology lectures.
The results of statistical tests at UIN Walisongo Semarang obtained the average value of pre-test is 2.45 and the average value of post-test is 7.4167. The correlation between pre-test post-test is 0.035 <5% with t test value = 9.326 with sig value 0.000 <0.05 thus the percentage of increase of pre test value to post test is: (7.4167 - 2.45) / 2.45 x100% = 202.722%.

The result of statistic test in UIN Sunan Kalijaga obtained the average value of pre-test is 7.1702 and the average value of post-test is 16.3511. The correlation between pre-test data and post-test data is 0.071 with probability 0.496 <5%, it indicates that improvement of students' critical thinking skill. In the paired table the test sample obtained t test = 25.582 with sig value 0.000 <0.05 thus the difference of pre-test average value and average value of post stest. (16.3511 - 7.71702) / 7.71702 x100% = 111.88%.

Effect size of the DBUS model both in UIN Walisongo and UIN Sunan Kalijaga in a large effect class because it has a value of d> 0.8 ie 0.93 in UIN Walisongo and 2.63 from UIN Sunan Kalijaga.

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