Analyzing Student Biology Education Misconception And Scientific Argumentation Ability Using Diagnostic Question Clusters (DQCs) Of Molecular Genetic Concept

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Abstract. The purpose of this research is to describe the profile of misconceptions and scientific argumentation ability using Diagnostic Question Cluster (DQCs) of molecular genetics concept. This research use descriptive research method and biology education students as a research subject. The Instrument that used in this research are DQCs, sheets interviews, observations, and field notes. The DQCs tested by writing and oral that used to analyze misconceptions and scientific argumentation ability. Sheets interviews, observations and field notes, are used to analyze the possible factors causing misconceptions and scientific argumentation ability. The results showed that misconception of molecular genetics are: DNA (23.75%), genes (18.75%) of chromosomes (15%) and protein synthesis (5.5%). The pattern of the highest misconceptions owned Misconception-Understand Partial. The average scientific argumentation ability is 55% and still categorized warrant (W). The pattern of the scientific argumentation abilities formed is level 2 to level 2 that consists of the arguments in the form of a claim with a counter claim that accompanied by data, collateral (warrant) or support (backing) but does not contain a disclaimer (rebutal).

1. Introduction

Biology is one of science subject matter that includes concepts that are concrete and abstract concepts. Biological materials abstract be one of the sources of difficulty in understanding the concepts students are causing misconceptions. One of biological materials that are difficult to understand by most students is the genetic material concept [1]. The misconception is not just happening in the students of primary and secondary school level, but the level of high school students until the students were told there students who experienced misconception especially for concepts that require deep understanding. Just as in biological materials, which have the abstract concepts that can’t be explained in real terms.

Based on the results of an initial interview with a lecturer of the course [2] note that the genetic material that is highly vulnerable to any misconceptions or fail to understand the concept is in subconcepts cell reproduction, genetic control (protein synthesis and gene expression), as well as the basic concepts of relationship genes, DNA and chromosomes. In addition, according [3] adds that the genetic material included in the material a tedious and tiring. It can happen one of them is that students tend to memorize concepts compared to apply concepts, besides genetics are biological materials that constitute the conceptual knowledge that contains some complex concepts [4]. The results of the research to the understanding of genetics concepts made by [5] suggests that approximately 15% of the students are unable to provide an explanation of the chromosomes, and 70% of students give
incorrect explanation of the process of mitosis and meiosis. In addition, based on research results [6] at the upper secondary level school students in the city of Palu in mind that students have misconceptions on the concept of chromosomes (76.1%), genes (75.0%) and DNA (76.5%) and protein synthesis (63.1%). Understanding the concept of the genetic material is essential as a basis for understanding other concepts in other biological concepts. It can be said that understanding the concept of genetics is a prerequisite for understanding other concepts such as biotechnology [7].

[8] suggest that the science learning should promote the teaching for understanding, but in reality their science lessons in college now synonymous with the provision of comprehensive science course content. Basically, the provision of comprehensive content in college is important to convey to the students, but to ensure that students understand the whole content should also be analyzed using the capabilities of higher order learning schemes include the ability of reasoning or in other words is the ability of the scientific argument. Over the last two decades the ability of argumentation becomes very interesting in science education in university education [9].

Based on the research results [10] argued that the ability of high school students in Bandung on learning biology is still not well developed. It can be seen from the percentage of the level of ability that decreases from the lowest to highest. Decrease in the ability of these arguments are influenced by the methods and strategies of teaching teachers. Through these studies it is known that high school students in the city of Bandung is still not able to develop the ability of the argument. So it is very interesting, especially what arguments the ability of students in college, whether the result will be the same as the argument ability of high school students or it will be better.

Based on the interview notes that the lecturer has struggled to develop questions or questions that can stimulate students to think of using the theory / concept of relevant science that can explain the data obtained as the basis for a claim scientific argument, so if the ability of this argument is not developed, the students' answers to the question is feared will have misconceptions. So that measure students' conceptual understanding has become increasingly important to the biology faculty members were involved in evaluating and improving departmental programs [11]. It needed the assessment tool to identify and detect the extent of scientific argumentation ability of students to questions about the concept of genetically so that it can detect the tendency of their misconceptions. Assessment tools that can be used as an alternative in identifying the ability of scientific arguments (scientific reasoning) and the tendency of their misconceptions include Diagnostic Question Clusters (DQCs).

Diagnostic Question Clusters (DQCs) is one concept conceptual inventory or assessment in biology [12]. According [13] that the diagnostic test is useful to know the learning difficulties faced by the students, including the misunderstanding of the concept. The results of the diagnostic tests provide information about the concepts that have not been understood and that was understood. Through the use of group diagnosis in a test question can provide the opportunity for students to be able to think like a scientist biology "thinking like a biologists'. The important aspect to think like scientists in biology is always apply the basic principles of scientific argument (reasoning). Besides this, there are several studies also use diagnostic tests to determine students' understanding of the molecular and cell biology [13]. Some diagnostic tests may be used to determine the understanding of concepts and misconceptions which are diagnostic question clusters (DQCs) and interviews.

According [14] that this type of test is used to reduce the student can guess the answer, because they are required to give arguments (reasoning) so it can know the extent of their understanding of a concept. In addition, based on research results Hartley et al (2011) also explained that the function of the Diagnostic Question Clusters (DQCs) is to measure comprehension through the ability of argumentation based on scientific principles, as an assessment tool that can inform learning difficulties students and their misconceptions learners to a concept.

Based on the background of the above problems, the authors are interested to do research with the title Analysis of misconception and Capabilities argument Student Science Biology Education by Using Diagnostic Question Clusters (DQCs) on the concept of Molecular Genetics with a problem of this research is "What is the profile of misconceptions and the ability of scientific argumentation biology education students using Diagnostic instrument Cluster Question (DQCs) on the concept of
molecular genetics?". The research objective to be achieved in general is to analyze misconceptions and scientific argumentation ability of biology education students using the instrument cluster diagnostic question (DQCs) on the concept of genetics. In particular the research objectives to be achieved are as follows: 1. Analyze misconceptions biology education students on the concept of genetics 2. Analyzing the ability of scientific arguments biology education students on the concept of genetics 3. Uncover the tendency pattern of misconceptions and scientific argumentation ability of biology education students on the concept of genetics.

The results of this study are expected to provide benefits as preliminary information for the lecturers of the misconceptions and the ability of scientific argumentation experienced by students of biology education who take courses in genetics, and as study materials to anticipate the possibility of misconceptions in students when the learning process and informing them of alternative instruments upon ability in analyzing the scientific arguments and misconceptions. Results are expected to be the basis for further research, especially in developing diagnostic question cluster (DQC) as an instrument in analyzing misconceptions and scientific argumentation ability of biology education students, as well as preliminary information on further action to anticipate any misconceptions in students.

2. Method

The method used descriptive research. This research method used to analyze the data in ways that describe or depict the data that has been collected by the instrument DQCs as it is. The population of this study were all students of biology in one of public university in Bandung who take the classes genetics academic year 2015/2016. The sampling technique used in this research is purposive sampling. This technique is a technique of sampling data source with a certain considerations. The sample of this research is a biology education students who follow courses of Genetics in the academic year 2014/2015 of 40 people. The independent variables in this study were analyzed misconceptions aspect of the students’ answers on DQCs given the lead to the genetic material and the use of assessment rubrics [16].

| Criteria             | Description                                                                 |
|----------------------|-----------------------------------------------------------------------------|
| Understand (U)       | The answer to each concept statement shows mastery of concepts               |
| Partial Understand (PU) | Answer demonstrate mastery of concepts that marked their partial (at least one) feature or element answers represent mastery of concepts |
| Partial Understand with Misconception (PUM) | Answers indicate that understood the concept but contains statements that misconception |
| Misconception (M)    | Answer that contains information that is not logical or appropriate          |
| Don’t understand (DU) | Answer indicate: (1) Repetition question / statement (2) The answer is of no relevance to the statement (3) The answer "I do not know / understand"; (4) No answer or not filled |

The ability of a scientific argument as independent variables in this study were analyzed based on the quality of student writing arguments. The dependent variable in this study is the Problem Question Diagnostic Clusters (DQCs).

Scientific Argument Ability in this study is a written response (claim, warrant, backing, and rebuttal) by [16] that is given by using questions DQC's developed into a two-tier DQC's type of test or multiple choice questions about the type of reasoned and essays. Observation sheet used as an instrument to measure the adherence to the learning process in the classroom during the study. This observation sheet aims to identify the learning process that occurs in the classroom so that it can support data capabilities misconceptions and scientific arguments that have been obtained. Notes field is used as a supporting instrument in this study in order to get the field data during the study process. Notes field will be obtained through field data collection tool such as stationery, recorders, cameras, and others.
3. Result And Discussion

3.1 Analysis misconception of genetic molecular concept

Conception is the ability to understand the concept of good obtained through interaction with the environment as well as from formal education [18]. A misconception is a conclusion that's wrong because it's based on faulty thinking or facts that are wrong about concept. Based on the result about written and oral conception, there is a data:

3.2.1 Written and oral conception. Most of the conception of the students were in the category of understanding of the concept. However, there are some students who still have misconceptions and did not even understand the concept. Based on the data it is known that sub highest concept is understood correctly by students is sub concept of chromosomal abnormalities by the number of students who correctly answered is 27 students or 68% of the total number of students. While the concept of the lowest sub misreading by the students is sub concept prokaryotic protein synthesis in the number of students who answered with these categories is 20 students or 50% of the overall student population. The sub concepts that led to a lot of misconceptions are sub concepts chemical structure of DNA by the number of students who have misconceptions are 9 people or 23% of the overall student population.

The average confidence level of all students answer is as much as 81.5%. It shows that a written test used may indicate a confidence level of students as much as 18.5% of the answers to questions that have been given through the provision of reasons.

![Figure 1. Written conception result graph](image)

Sub highest concept is understood correctly by students is sub concept of chromosomal abnormalities by the number of students who correctly answered is 25 students or 63% of the total number of students. While the concept of the lowest sub misreading by the students is sub concept prokaryotic protein synthesis in the number of students who answered with these categories is 15 students or 38% of the overall student population. The sub concepts that led to a lot of misconceptions are sub concepts chemical structure of DNA by the number of students who have misconceptions are 10 people or 25% of the overall student population.
The average confidence level of all students answer is as much as 82%. It shows that a written test used may indicate a confidence level of students as much as 12% of the answers to questions that have been given through the provision of reasons.

3.2.2 Misconception of genetic molecules

The results showed that misconceptions subconcepts highest in the chemical structure of DNA with a percentage of 23.75% of the total number of students. It shows that there is a misconception that occur and must be investigated causes of the misconceptions. The results showed that misconception of molecular genetics are: DNA (23.75%), genes (18.75%) of chromosomes (15%) and protein synthesis (5.5%).

Results of the analysis showed that most students still do not understand the true concept of the chemical structure of DNA and its characteristics. While the concept of differences in DNA and RNA that almost all students can understand. This is in contrast to the results of research which states that the concept of DNA better than other concepts in genetics.

3.2.3 Misconception pattern

The highest misconceptions pattern formed in a changing conception is Misconception (MC) – Understand Partially (UP) as much as 35% on the concept of DNA and RNA. While the pattern formed is the highest argument argumentation level 2 - level arguments 2. It shows that there is a change in the conception of the misconceptions students have come to understand the concept of majority. The pattern of the argument, unchanged. That means there is no credible form or the learning process to develop the student’s argument.
3.3 Analysis student scientific argumentation ability

3.3.1 Reality of student scientific argumentation. The ability of the scientific arguments in question in this research is the ability, based on the argument that Toulmin model of argumentation. Ability arguments are analyzed Claim (C), Warrant (W), Backing (B) and Rebuttal (R). The four categories are analyzed to produce scientific arguments profile capabilities biology education students who attended the lectures of genetics and cell biology. The results showed that the ability of written and oral arguments have different results.

The reality of general scientific argumentation abilities of students based on questions given in writing or orally in mind that the ability of the warrant (W) is the most prominent ability compared with the ability of other arguments in the following order: 50% of the students have the ability argumentation warrant categories; 22% only mengclaim; 18% appears categories backing and rebuttal as much as 3% of the total number of students. The facts are not in accordance with the theory of Inch and [18] states that a person who makes a claim is expected to provide support by using evidence and reason in accordance with the facts on the ground.

3.3.2 The Quality of Argumentations. As for the quality of the arguments that were analyzed using the argument Toulmin quality showed that the students were in the highest quality of written arguments on the quality of conceptual category descriptors I with an average percentage of 22% and the lowest in the category descriptors V with an average percentage of 18%. Similarly, the quality of the arguments orally or verbally with the highest percentage in the descriptor I with an average percentage of 25% and the lowest in the descriptor V with a percentage of 19%.

This shows that the quality of the arguments the highest student is at the level proposed claim causal framework theoretical specific and still low in unifying the proper reference when developing data. This is consistent with the results of [20] through the sheet questionnaires and interviews show that low descriptors V due to the difficulties faced by students in the argument is the ability to develop data / backing in support of their claim.

3.3.3 Level of Argumentation. In addition to quality-based argument is conceptually and epistemic, the quality of the arguments analyzed through arguments based on the level of [21]. The results showed that the level of argumentation students in writing and orally dominant sequence is the level of argument 2, 1, and 3, which means that the students are still at the level of argument in the form of a claim with a counter claim and be accompanied by the data, collateral (warrant) or support (backing) but little or no rebuttal. This is in contrast to the results of [20] which explains that the quality of the arguments of individual students are at level three.

3.3.4 Pattern of Argumentation. The pattern of argumentation abilities formed based on changes in the level of argument, based on the level of argumentation [23] Of the 25 possible patterns of argumentation is found that the highest argument is owned by the pattern of argumentation level 2 - level arguments 2. It shows that there is no change in the ability of argument are formed. This means that the ability of the student's argument remained at level 2 or argument in the form of a claim with kouterklaime containing the data, guarantees, and there is no objection. No changes in the ability of the argument can be caused by several factors, namely 1) there is no learning activities that develop student argumentation; 2) students have little opportunity to argue.
4. Conclusion
The concept of molecular genetics is one of the concepts in biology pembelajaran prone with their misconceptions. The misconception is to misunderstand the concept that a person either students or students. Miskonsepi research results of students on the concept of molecular genetics with DQCs shows that students still have misconceptions about the concept of molecular genetics. The subconcepts with the highest percentage rate misconception is on subconcepts DNA & RNA as much (23.75%), genes (18.75%), chromosomes (15%) and protein synthesis (5.5%). It shows that the concept of DNA has the highest level of vulnerability compared with other concepts of molecular genetics. In addition to the analysis of misconceptions, this study also analyzes the ability of the scientific arguments that are owned by students.

The ability of the scientific arguments that are owned by the student is still in the category of the warrant (W) as much as 50% of all students. While the quality of the argument is still dominated by the quality of the conceptual arguments that are in the first or lowest descriptors owned by the descriptor V on the quality of epistemic argument. As for the level of argumentation that is formed through written tests and oral tests known that argument level 2, 1, and 3 most prominent than the level of the other arguments. Ability argument dianalysis also form a pattern similar to the pattern of misconceptions.

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5. References
[1] Meilinda 2009 E-modul interaktif berbasis kontruktifisme pada materi Genetika untuk meningkatkan kompetensi guru Biologi SLTP (Tesis of Universitas Pendidikan Indonesia)
[2] Benabdallah N, Bhatia S, Williamson I and Bickmore W 2015 European J. of Genetics 23 1 Planary Lecture
[3] Venvile G, Gribble S and Donovan J 2002 Science Education 89 614–633
[4] Urey and Calik 2008 Asia pacific forum on science learning and teaching 9 2 12:1-15
[5] Infante, Malachias M E 2010 Electronic J. of Science Education 9 3 657-668
[6] Wangintowe T 2008 Miskonsepsi Siswa SMA pada Mata Pelajaran Biologi dan Faktor-faktor Penyebabnya. Dissertation of Universitas Negeri Malang
[7] Tekkaya 2006 J. of Hacetette University Education Faculty 23 259-266
[8] National Research Council 1996 National science education standards (Washington DC: National Academy Press)
[9] Kuhn D 2010 Science Education 94 810–824
[10] Kurniadi E 2015 J.Pendidikan 14 1-11
[11] Fisher K M, Williams K S and Lineback J E 2011 CBE-Life science education 10 418–429
[12] Suwirto 2013 Pengembangan Tes Diagnostik dalam Pembelajaran (Yogyakarta: Pustaka Palajaran)
[13] Shi D, Xu Y, Hopkinson B M, François M, and Morel M 2010 Science 327 5 February 2010
[14] Treagust D F 2007 J. of Research in Science Teaching 44 2 205–235
[15] Morgil, İnci and Nuray Y 2006 J. of Turkish Science Education 3 1
[16] Toulmin S 2003 The uses of argument, updated (Cambridge: Cambridge University Press)
[17] Suparno 2005 Filsafat Konstruktivisme dalam Pendidikan (Yogyakarta: Kanisius)
[18] Warnick B K, Thompson G W and Tarpley R S 2006 Proc. of the Thirty-third Annual National Agricultural Education Research Conference 33 601-603
[19] Erduran S and Maria P J 2004 Argumentation in science education (London: Springer)
[20] Herlanti Y 2012 J. Pendidikan IPA Indonesia 1 2 168-177
[21] Erduran S, Simon and Osborne J 2004 Science Education 88 915-933
