Identification of misconceptions in geography using the three-tier diagnostic test

M Desfandi, A W Abdi, A N Gadeng, and I Sofia

Department of Geography Education, Universitas Syiah Kuala, Banda Aceh

E-mail: mirza_des@unsyiah.ac.id

Abstract. Misconceptions can occur in all subjects, including in geography. Three-tier diagnostic test is an instrument that cannot only be used to determine the level of understanding of concepts, but also can identify misconceptions in geography on earth dynamics subject matter by using three-tier diagnostic test. The study uses a quantitative approach, with data analysis technique, with data analysis technique use descriptive statistic. The study was conducted in Madrasah Aliyah Negeri Model (Islamic Senior High School) Banda Aceh with the subject of study were 70 students of Social Sciences Class. Data collection is done through three-tier diagnostic test that has been tested for validity and reliability. The results showed that 30.5% of students did not understand the concept, 26.5% of students have misconception, and 5% of students give wrong answer. Based on study finding, it is suggested to the teacher to be able to prepare well the learning particularly on earth dynamics subject matter, such as by implementing learning methods that are suitable with characteristics of learning subject and by using learning media so that students’ understanding of concepts increases.

1. Introduction

Understanding is an advanced stage of knowledge after following the learning process. The newly acquired knowledge will be memorized and memorization is to take certain knowledge from long-term memory [1]. After memorizing well, knowledge will be understood. Understanding is constructing meaning from learning material including what is said, written and described by teacher [1]. Understanding is a level after knowing and memorizing about one thing which had been learned, one’s ability to understand something after it is known and memorized through learning process [2]. In cognitive domain, if it is arranged in stages, it starts from knowing (memorizing), understanding and applying, as stated in Dale’s Cone of Experience theory. Students are demanded to be able to understand a material which had been taught by their teacher through learning process, whether oral, written or graphical which is delivered through teaching, book or computer screen [1,3,16,19]. Student that has good understanding on the learning material if they can construct and deliver the meaning of the material by their own language. [2,17,18]. What should be understood well by students are various concepts contained in each learning material in certain subject. The emphasis on teaching and learning process will shape ability in understanding concept stated by teacher and can use the content and can communicate it well [4,18]. Student preparedness in receiving a material will intervene their level of understanding to the material, they will easily receive the material if they are ready to learn it. In contrary, they will hardly understand the material or worst – it creates the misconceptions of the material [5,20,21,22].
The phenomena occurred so far has many concepts not contained in learning material which cannot be understood by students. Students' lack of understanding toward material can be caused by various factors, one of them is misconception taught by teachers when learning process take place [6, 23,24]. Concept misunderstanding is well known with the term misconception. Misconception is error in defining, interpreting and translating a different concept and not as intended. Suparno mention that “misconception refer to a concept which is not suitable with definition accepted by the experts in that field” [7]. The form of misconception can be initial concept, the error in wrong relation among concepts, intuitive idea or naïve view. The cause of misconception in learning, particularly for primary level according to Driver namely: (1) because students tend to base their thinking in matters seen in a situation; (2) students only pay attention to certain aspects in a situation. It is because student tend to interpret a phenomena from absolute nature of objects, not from interaction aspect among elements of a system; (3) students tend to pay attention to the change of silent situation and tent to think by following linear causal order; (4) the idea possessed by students has various connotation in which their idea is more inclusive and global; (5) students often use different idea to interpret the situations as used by scientist [8,25].

One step in order to identity misconception is through diagnostic test, that is three-tier multiple choice. The use of three-tier multiple choice instrument can identify students’ concept understanding easily and efficient in time. Besides, it can also differentiate students who answer wrong because they have misconception or less understand the material [9,26]. Three-tier multiple choice diagnostic test is one form of tests containing multiple choice items which consist of three levels of question in it. In first level. It contains item (material), the second level question the reason of first level answer and the third level is in the form of confidence index [10]. Each level of test in a three-tier multiple choice aims to measure three levels concurrently easily without taking too much time, for example it can see concept understanding and also identify misconception occurs in students in learning process. Besides, it can differentiate between students who give wrong answer due to misconception and students who less understand the material [11].

The main foundation in choosing three-tier multiple choice instrument is some earlier studies such as in Chemistry subject. The result of study conducted which measure the level of concept understanding use three-tier multiple choice instrument in 11 indicators, showed that 14.60% students understand the concept, 22.27% students did not understand the concept and 63.13% students have misconception [12]. In addition, the study in Chemistry subject also who tested 6 indicators in colligative material solution use three-tier multiple choice diagnostic test instrument showed that 17.89% students did not understand the concept, 42.85% students had misconception and 5.96% students were error [13]. Based on result of literature study and some earlier studies, the researcher is interesting to identify misconception in Geography by using three-tier diagnostic test.

2. Method
This study uses quantitative approach, with data analysis technique used is descriptive statistic. This study was conducted in Madrasah Aliyah Negeri Model (Islamic Senior High School) Banda Aceh with subjects of study are 70 students of Study Social class. Data collection is done by three-tier diagnostic test whose validity and reliability have been tested. Data analysis technique used are: instrument validity test, instrument reliability test and answer combination analysis by using three-tier multiple choice.

3. Result and Discussion
This study is done in earth dynamic subject matter, precisely on students of class X Madrasah Aliyah Negeri 1, Banda Aceh City. The main reason of researcher to choose that material is because in this material contain many concept, from simple concept to more complex concept, so intelligence level can influence student in understanding the material which need ability in memorizing and understanding the concept. / The
instrument used in this study three-tier multiple choice which aims to know concept understanding level among students in earth dynamic subject matter. Item instrument is distributed to students who had learned earth dynamic subject matter.

Table 1. Recapitulation of Percentage of Concept Understanding Level on Earth Dynamics Subject Matter

| No | Indicator of Item                                           | Misconception |
|----|-------------------------------------------------------------|---------------|
| 1  | Understand the earth formation theory                       | 25%           |
| 2  | Identify the impact of earth rotation and revolution on life in earth | 27%           |
| 3  | Describe characteristic of earth layer                      | 20%           |
| 4  | Analyze the movement of continental plate                    | 16%           |
| 5  | Analyze geological periodic and history of life on earth     | 34%           |
| 6  | Evaluate earth appropriateness as the place to live          | 37%           |
|    | **Mean**                                                    | **26.5%**     |

Source: Data Processing, 2018

Based on the study result, it can be known that in indicator of first item “Understand earth formation theory, there is misconception of 25% in this indicator. It shows that many students who have misconception, the cause of high percentage of misconception level in this item indicator in students is wrong in giving reason from Kuiper theory, but many students who are correct in answering that Protoplanet theory is formed in Kuiper hypothesis. Another error also occur because student are not able to analyze correctly the picture which display the process of how the nebula theory was created. Many students who answer that the existing picture in item is process of Kuiper and Planetesimal theory, but when students answer the item of second level, the reason given by students shows that students do not understand the concept correctly. Students find difficulty in memorizing the theory but when analyzing the picture, students can understand process by process displayed in the picture. Students are not able to understand the which theory generated from the picture of process analyzed in that item. Lack of concept understanding among students is because the material is very difficult due to its broad scope [6]. The lack of concept understanding among students in first indicator is caused by some factors such as students’ difficulty in understanding the item, too much material, and students are wrong or less understand the concept.

Next, in second item indicator, namely “Identify the impact of earth rotation and revolution on life in earth”, there is misconception of 27% in this indicator. It shows that many students who have misconception, the cause of high percentage of misconception level in this indicator is because students are less able in distinguishing the movement of earth rotation and earth revolution so they are wrong in understanding the impact of earth rotation and revolution on life. Students think that day and night happen due to earth rotation but the reason given is wrong. Students give reason when the month rotate the earth, the earth area which is shaded by moonlight become day and the earth area which is not shaded by moonlight become night. Next, students think that part of earth which get much sunlight is desert area, with the reason that sun always moves from the east to the west, so it cause that area get much sunlight and student answer that item with confidence and very confident scale (CRI>2.5). It is misconception. Some factors which cause misconception among others are students are not able to apply the concepts they learn in solving a problem and relate it to each other [14].

Then, in third item indicator, namely “Describe the characteristic of earth layer”, there is misconception of 20% in this indicator. It shows that only few students who have misconception, many students who have knew and understood well about the material contained in item indicator of describing the characteristic of earth layer, even though there are students who are not able to implement the theory they have already knew, students know the definition of theory but they are not able to explain how the process of that theory is
created. For instance, many students give correct answer that valley and mountain are formed because earth contraction, but students are wrong in answering how the process of contraction theory in valley and mountain formation. Students give correct answer that continental floating theory is proposed for the first time by Alfred Wegener and the reason given also correct that in the past, there is only one very big continent in earth named Pangea, then that continent is divided and keep moving in equator direction. But the problem is in confidence level chosen that is, the scale under 2.5 (CRI <2.5) so students are thought do not understand the concept. Students who give correct answer and not confident for their answer doesn’t mean that they have misconception, but they are lack of knowledge or do not understand the concept [15].

In forth item indicator, namely “Analyzing the movement of continent plate”, there is misconception of 16% in this indicator. It shows that only few students who have misconception, many students who had knew and understood well and there is no problem in the material contained in the item indicator of analyzing the movement of continental plates.

The fifth item indicator “Analyzing geological periodic and history of life in earth”, there is misconception of 34% in this indicator. It shows that many students who have misconception, the cause of high percentage of misconception level in this indicator is most significant error in which students are correct in answering the second level item by giving the reason, but students are not able to answer the first level item and confidence level given by students is CRI<2.5. Student give correct answer in answering the characteristic of quarter era but they are wrong in understand the process of quarter era formation because they are not able to distinguish each period of geological periodic division so students are wrong in understanding the history of life in earth. The error occured also because students are wrong in answering the technique to measure rocks mass. Rock mass must be measured by using Geology Numeric technique, because students equate the item question with the choice of answer which has the same word. It can be seen from confidence scale given by students in which they guess in answering that item. If level of confidence is low (CRI 1-2), then it can be known that there is element of guessing in answering that question [13].

Lastly, in sixth item indicator “Evaluate the appropriateness of earth as a place to live”, there is misconception of 37% in this indicator. It shows that many students have misconception, the cause of high percentage of misconception level in this indicator is because students are wrong in understanding gravity force. Students think that gravity force is the force which rotate the sun and moon and orbit and rotate the earth so the balance of nature always protected. Actually, gravity force is not or biting the earth or moon, but gravity force can maintain earth balance because of attraction force among all particles exist in universe. It cause students wrong in interpret gravity force. Another misconception occurs because students are correct in answering the first level item, namely in answering the function of moon satellite. They answer that the function of moon satellite is to maintain sea water stability in order not freezing, but students do not understand the mechanism of that satellite. Besides, students are wrong in interpreting the function of atmosphere. Many students are distracted by almost similar answer but it is clearly differed from the actual answer.

4. Conclusion
Misconception refers to concepts that do not fit the definition accepted by experts in a particular field of science, so there is difference between the concept understood and the actual concept. One fourth of the students experience the misconception on earth dynamic subject. Based on this finding, the better teacher preparations were needed to be implemented to squeeze its number, such as by implementing learning method which is suitable with the characteristic of subject and by using learning media so students’ understanding of concept increase.
5. References

[1] Anderson W L dan Krathwohl R David 2015 *Kerangka Landasan Untuk Pembelajaran, Pengajaran dan Asesmen (Revisi Taksonomi Pendidikan Bloom)* (Yogyakarta: Pustaka Pelajar)

[2] Gadeng N A, Maryani E, and Ningrum E 2018 The Simulation of Smong in Geography Learning to Enhance Understanding of Disaster 2nd IGEOS: *International Geography Seminar 2018*, Universiti Pendidikan Sultan Idris, Malaysia

[3] Daryanto 2012 *Model Pembelajaran Inovatif* (Yogyakarta: Gava Media)

[4] Daryanto 2008 *Evaluasi Pendidikan* (Jakarta: Rineka Cipta)

[5] Marsita R 2010 Analisis Kesulitan Belajar Kimia SMA dalam memahami materi larutan Penyangga dengan menggunakan Two-tier Multiple Choice Diagnostic Instrumen *Jurnal Inovasi Pendidikan Kimia* 4 (1) pp 512-520

[6] Iriyanti, N.P, Sri M, dan Sri R D A 2012 Identifikasi miskonsepsi pada materi pokok wujud zat siswa kelas VII SMP Negeri 1 Bawang Tahun Ajaran 2009/2010 *Jurnal Pendidikan Kimia* 1 (1) pp 8-13

[7] Kurniadi, E 2008 Mengatasi Miskonsepsi Dinamika Dengan Konflik Melalui Metode Demostrasi. *Jurnal Pendidikan*, 14 pp 1-13

[8] Dahar, R W 2011 *Teori-teori belajar dan penebelajaran* (Jakarta: Erlangga)

[9] Dindar, A C dan Geban, O 2011 Development of a Three-Tier Test to Asses High School Students Understanding Of Acids abd Bases *Procedia Social and Behavioral Science*, 15 pp 600-604

[10] Tresnasih N, Ida F, dan Ratih, P 2013 Analisis Konsepsi Mahasiswa Terhadap Materi Elektrolisis Menggunakan Instrumen Tes Three Tier Multiple Choice *Prosiding Simposium Nasional Inovasi dan Pembelajaran Sainsi* 4 (1) pp 168-171

[11] Suhendi, H Y, Ida K, dan Johar, M 2014 Peningkatan Pemahaman Konsep dan Profil Miskonsepsi Siswa Berdasarkan Hasil Diagnosis Menggunakan Pembelajaran ECIIR Berbantuan Simulasi Virtual dengan Instrumen Three Tier Test *Prosiding Mathematics and Sciences Forum* 4 (1) pp 205-213

[12] Ekawati, I H 2015 Identifikasi Pemahaman Konsep Siswa Terhadap Materi Kestimbangan Kimia Menggunakan Instrumen Tes Three-Tier Multiple Choice Diagnostic *Skripsi* Jurusan Pendidikan Kimia Fakultas Matematika dan IPA Universitas Negeri Gorontalo

[13] Auliyani Aida 2016 Analisis Kesulitan Pemahaman Siswa Pada Materi Sifat Koligatif Larutan Dengan Menggunakan Three-TierMultiple Choice Diagnostic Test (Studi Kasus Pada Siswa Kelas XII IPA 2 SMA Negeri 5 Banda Aceh) *JIMPK* 2 (1) pp 55-64

[14] Mentari L, Nyoman S, dan Wayan S 2014 Analisis Miskonsepsi Siswa SMA pada Pembelajaran Kimia untuk Materi Larutan Penyangga *E-Journal Kimia Visvitalis Universitas Pendidikan Ganesha Jurusan Pendidikan Kimia* 2 (1) pp 76-87

[15] Abbas Muhammad 2016 Pengembangan Instrumen Three Tier Diagnostic Test Miskonsepsi Suhu dan Kalor *Ed-Humanistic* 1 (2) pp 83-92

[16] Jeein J and Douglas F 2020 Self-regulated learning: Is understanding learning a first step? Early Childhood Research Quarterly Vol. 50 Part 2 1st Quarter 2020 pp 17-27 https://doi.org/10.1016/j.ecresq.2018.12.007

[17] Jung S 2019 Semantic vector learning for natural language understanding *Computer Speech & Language* Vol. 56, 2019 pp 130-145 https://doi.org/10.1016/j.csl.2018.12.008
[18] Parkinson M M and Dinsmore D L 2019 Understanding the developmental trajectory of second language acquisition and foreign language teaching and learning using the Model of Domain Learning System Vol. 86 November 2019 102125 https://doi.org/10.1016/j.system.2019.102125

[19] Ming Ng Y and Yip W C 2019 A 3-step teaching approach for a blended learning of ‘understanding and avoiding unintentional plagiarism’. Nurse Education in Practice Vol. 41 November 2019 102643 https://doi.org/10.1016/j.nepr.2019.102643

[20] Sen S and Yılmaz A 2012 The Effect of Learning Styles on Student's Misconceptions and Selfefficacy for Learning and Performance Procedia - Social and Behavioral Sciences Vol. 46 2012 pp 1482-1486 https://doi.org/10.1016/j.sbspro.2012.05.325

[21] Kazemi F and Ghoraishi M 2012 Comparison of Problem-Based Learning Approach and Traditional Teaching on Attitude, Misconceptions and Mathematics Performance of University Students Procedia - Social and Behavioral Sciences. Vol. 46 2012 pp 3852-3856 https://doi.org/10.1016/j.sbspro.2012.06.159

[22] Weingartner M K and Masnick M A 2019 Refutation texts: Implying the refutation of a scientific misconception can facilitate knowledge revision Contemporary Educational Psychology Vol. 58 2019 pp 138-148. https://doi.org/10.1016/j.cedpsych.2019.03.004

[23] Lucariello J, Tine T M and Ganley M C 2014 A formative assessment of students’ algebraic variable misconceptions The Journal of Mathematical Behavior Vol. 33 2014 pp 30-41 https://doi.org/10.1016/j.jmathb.2013.09.001

[24] Kordaki M and Psomos P 2015 Diagnosis and Treatment of Students’ Misconceptions with an Intelligent Concept Mapping Tool Procedia - Social and Behavioral Sciences Vol. 191 2015 pp 838-842. https://doi.org/10.1016/j.sbspro.2015.04.478

[25] Durkin K and Johnson R B 2015 Diagnosing misconceptions: Revealing changing decimal fraction knowledge Learning and Instruction Vol. 37 2015 pp 21-29 https://doi.org/10.1016/j.learninstruc.2014.08.003

[26] Mutlu A and Sesen A B 2015 Development of a Two-tier Diagnostic Test to Assess Undergraduates’ Understanding of Some Chemistry Concepts Procedia - Social and Behavioral Sciences Vol. 174 2015 pp 629-635 https://doi.org/10.1016/j.sbspro.2015.01.593