An overview of conceptual understanding in science education curriculum in Indonesia

A Widiyatmoko¹,* and K Shimizu²

¹ Graduate student of Graduate School for International Development and Cooperation, Hiroshima University, Japan
¹ Lecturer of Integrated Science Department, Universitas Negeri Semarang, Indonesia
² Professor of Graduate School for International Development and Cooperation, Hiroshima University, Japan

*Corresponding author: arif.widiyatmoko@mail.unnes.ac.id

Abstract. The purpose of this article is to discuss the term of “conceptual understanding” in science education curriculum in Indonesia. The implementation of 2013 Curriculum focuses on the acquisition of contextual knowledge in respective areas and environments. The curriculum seeks to develop students’ evaluation skills in three areas: attitude, technical skills, and scientific knowledge. The core competencies in the curriculum 2013 represent the ability level to achieve the graduate competency standards of a student at each grade level. There are four mandatory core competencies for all educational levels and all subjects, including science, which are spiritual, social, knowledge, and skills competencies. In terms of knowledge competencies, conceptual understanding is an inseparable part of science concept since conceptual understanding is one of the basic competencies in science learning. This competency is a part of science graduation standard indicated in MoEC article number 20 in 2016. Therefore, conceptual understanding is needed by students for learning science successfully.

1. Introduction
The Indonesian government makes a series of alterations to the national curriculum. The transformation of Indonesian curriculum can be seen as follows: curriculum 1947, curriculum 1964 (the study plans for elementary schools), curriculum 1968, curriculum 1973, curriculum 1975, curriculum 1984, curriculum 1994, curriculum 2004 (competency based curriculum), curriculum 2006 (education unit level curriculum), and the latest is the curriculum 2013 [1]. The emphasis of curriculum 2013 is moving the focus of education away from the memorization of facts and theoretical knowledge towards students being able to achieve competencies. Conceptual understanding is one of the basic competencies in science learning. This competency is a part of graduation standard that indicated in MoEC article number 20 in 2016.

One of the reasons of the curriculum transformation is because of the low international research result that measures the quality of students, namely TIMSS and PISA [1]. Scientific literacy is used in PISA and characterized as consisting of four related aspects: context, knowledge, competencies, and attitudes [2]. From PISA result, Indonesian students show less understanding of knowledge of the natural world (content knowledge), knowledge of how such concepts are produced (procedural
knowledge) and an understanding of the underlying rationale for these procedures and the justification (epistemic knowledge). The students also do not have well performance in scientific inquiry as a part of the attitudes dimension [3]. Whereas scientific inquiry refers to activities through which students develop knowledge and understanding of scientific concepts [4]. Therefore, students’ conceptual understanding always has been regarded as one of the most important research issues, in terms of evaluating in science learning [5].

The implementation of curriculum 2013 is characterized by a very fundamental change in the learning process which focuses on active learning. Based on Ministry of Education and Culture regulation number 65 in 2013 about standard processes, curriculum 2013 uses a scientific approach as the main approach. The learning process consists of five main learning experiences as observing, questioning, experimenting, associating, and communicating. These essential features would help students to develop a clearer and deeper knowledge of science concepts and processes [6]. Some studies have suggested that scientific method is critical for developing conceptual understanding of science [7].

The development of conceptual understanding in science education is important for students in today’s world if they are to become citizens who can make informed decisions about themselves and the world in which they live [8]. To have a good conceptual understanding of the way of information is processed, students would be able to learn much more efficiently and systematically. The purpose of this research is to describe conceptual understanding in science education of curriculum 2013 in Indonesia.

2. Methods
This paper is an integrative review of the literature. This review includes published research addressing conceptual understanding in curriculum 2013 and also curriculum documents from Ministry of Education and Culture of the Republic of Indonesia. To investigate this review, we carried out a database search articles that related to conceptual understanding in science education curriculum in Indonesia.

The approach used in this study was a qualitative approach. The method of content analysis as a method of qualitative research was used in this study, and there are four steps that should be implemented, namely (1) identifying a research question, (2) choosing and identifying the data sources, (3) analyzing conceptual understanding from the curriculum documents, and (4) presenting the conclusion of this study. The data used in this study were documents of curriculum 2013 that related to a conceptual understanding that mentioned in the competencies and science textbooks for junior high school that published by the MoEC of the Republic of Indonesia.

3. Result and Discussion
Curriculum 2013 highlights two types of competencies: core competencies and basic competencies. Based on PP no. 32 the year 2013, core competencies is the level of ability to achieve the graduates standard competency which a learner should have on each level. The core competencies consist of four interrelated groups relating to religious attitudes (core competency 1), social attitudes (core competency 2), knowledge (core competency 3), and application of knowledge (core competency 4) become a reference of basic competencies and should be developed in each learning [1]. The teacher, before making the instructional process in the classroom, is seeing on the core competencies, basic competencies, instructional objective science subjects, studying the subject matter of science, and instructional approaches and measures of science instructional activities, which are in teacher book. Table 1 shows the core competencies in science learning in curriculum 2013.
Table 1. Core competencies in science subject in curriculum 2013

| Core Competency          | Description                                                                                           |
|--------------------------|--------------------------------------------------------------------------------------------------------|
| 1. Spiritual competency | Respect and appreciate the religion they believe                                                    |
| 2. Social competency     | Respect and appreciate the honest behavior, discipline, responsibility, caring (tolerance, mutual assistance), mannered, confident, in interacting effectively with the social and natural environment within reach of the association and its existence |
| 3. Knowledge competency  | Understanding and applying the knowledge (factual, conceptual and procedural) based on curiosity about science, technology, art, culture-related phenomena and events that can be seen with our eyes |
| 4. Skill competency      | Processing, presenting, and reasoning in the realm of the concrete (using, analyzing, composing, modifying, and making) and the realm of the abstract (writing, reading, counting, drawing, and writing) in accordance with the learned in school and other sources in the same viewpoint /theory |

Table 2. Example of Basic competencies in science subject in curriculum 2013

| Grade VII                                                                 | Grade VIII                                                                                     | Grade IX                                                                 |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 1. Understanding the concept of measurement of various magnitudes that exist in themselves, living beings, and the physical environment around as part of the observation, as well as the importance of the formulation of a standardized unit (basic) in the measurement | 1. Understanding linear motion, and the influence of the force of the motion based on Newton's laws, as well as its application to the motion of living beings and the motion of objects in everyday life | 1. Understanding the concept of atoms and their composition, ions and molecules, and its relationship with the characteristics of the materials used in everyday life |
| 2. Understanding the classification procedure of living and nonliving organisms as part of scientific work, and classify a variety of living and nonliving organism based on observation patterns | 2. Understanding and applying fluids characteristic to explain blood circulation and liquid transportation in plant, osmotic pressure, diffusion in the respiration process in daily life | 2. Understanding the importance of soil and the organisms that live in the soil for the sustainability of life through observation |
| 3. Understanding the characteristics of the substance, as well as physical and chemical changes in substances that can be used for everyday life | 3. Understanding of vibration, wave, sound and hearing, and its application in animal sonar system in daily life. | 4. Understanding reproduction in plants, animals, and humans, the nature of heredity, as well as the survival of living things |
|                                                                         | 4. Understanding reproduction in plants, animals, and humans, the nature of heredity, as well as the survival of living things | 5. Understanding the structure of the earth to explain the phenomenon of earthquakes and volcanoes, and its relation to the diversity of rocks and minerals in some areas |

Basic competencies is a set of competencies that describe the minimum attitudes, skills, and knowledge that students need to achieve for each subject at the end of each semester of each grade. Basic competencies are the competencies of each subject for each class derived from core
competencies. Table 2 shows the example of basic competencies in science subject in grade VII, VIII, and IX.

The teachers’ and students’ textbook of science are the tools for implementing curriculum 2013 in the learning process. The teachers’ and the students’ textbook have been prepared by the government based on Permendikbud No. 71 the year 2013. The students’ textbook is the learning source that contains: the title of the topic, information about core competencies that are appropriate to the topic in each chapter. Each chapter is equipped with a conceptual map, the students’ activities such as experimental, non-experimental, discussion, exercise, summary, evaluation, and assignment for the students. In particular, the evaluation part in the students’ textbook contains questions for measure conceptual understanding in a chapter that has been studied by students (Figure 1).

![Evaluation for measure conceptual understanding in science textbook](image_url)

Figure 1. Evaluation for measure conceptual understanding in science textbook

The finding of this paper focuses on the overview of conceptual understanding in science education curriculum in Indonesia. Conceptual understanding has been one of the primary goals for science studies in all levels of formal education. Based on constructivist theories of learning, it is believed that understanding is built as learners construct their meanings for the knowledge that they acquire [9]. Conceptual understanding is used in different and sometimes incompatible ways, guided or determined by theoretical beliefs about knowledge and learning. These ways are mainly because ‘understanding’ is closely linked to ‘learning,’ and that any account of learning considers the nature of the knowledge to be taught [10]. Therefore, learning science should involve students in the construction of knowledge and the creation of new ideas from what they already know.

Based on the national education system, the learning materials for science integrate physics, biology, chemistry, and earth science [11,12], which is intended to develop students’ knowledge, understanding, and analytical thinking towards natural surroundings and environment. Through the process of integrative science learning, students can get direct experience to enhance the strength for receiving, saving, and applying the science concept that has been learned.

The aim of curriculum 2013 is promoting students’ ability in applying knowledge in real life situations. This aim is similar with [13,14], stated that conceptual understanding of science concept is described as students' ability to apply the learned scientific concepts to scientific phenomena in an everyday life situation. This ability includes the capacity to recognize new information, construct explanation and make connections among scientific phenomena.

The characteristic of Junior High School students begins at the age of 12. At this age, the students develop their cognitive ability to think symbolically and understand something meaningfully without
the availability of concrete thing or even visual object. Meaningful science learning requires conceptual understanding rather than memorization [15]. Meaningful learning requires knowledge to be constructed by students, not transmitted from the teacher to the students [16,17]. Curriculum 2013 using a scientific approach as the main approach to change the learning process, from traditional learning into meaningful learning.

Conceptual understanding becomes meaningful only when it can be used to explain or explore new situations [18]. Similarly, core competencies and basic competencies in curriculum 2013 also mentioned the same thing about this meaningful conceptual understanding. For instance, one of the core competence in science learning is “understanding and applying the knowledge (factual, conceptual and procedural) based on curiosity about science, technology, art, culture-related phenomena and concrete events.” This core competency is drawn into basic competence. For instance, in grade VIII mentioned that one of the basic competency is “understanding the concept of temperature, thermal expansion, heat, heat transfer, and their application in the mechanism of the stability of body temperature in humans and animals in everyday life.” Meaningful learning activities helped students to cultivate deep learning and enhance conceptual understanding. The conditions that influence the achievement of conceptual understanding apply to the process of learning science as well. Meaningful learning strategies allow students to apply and make sense of what they are learning. As students engage in meaningful learning activities, they are also able to dispel misconceptions.

To completely understand and apply the knowledge, the students need to be encouraged to solve the problems, find everything for themselves, and engage with their ideas. The students of Junior High School are generally in the transformation phase from concrete operational into formal operational. It means that the students of Junior High School have been able to think abstractly, for example analysing, inferring, concluding, and using deductive and inductive logic. However, they should start from the real situation. Therefore, observing and experimenting play important role in the learning process of science using a scientific approach, so the learning process of science is not just memorizing activity.

In measuring students learning outcome for conceptual understanding, MoEC published science textbook contains general guidance, process skills, and assessment in science learning. In particular of evaluation part, the textbook using authentic assessment to measure learning outcome. Based on the implementation guidelines of the curriculum 2013, it is stated that assessment is directed to measure students’ competence stated in the curriculum, to measure conceptual understanding. Assessment can be performed by oral, tasks, daily test, mid-term test, final test, and national examination. Science test that measures conceptual understanding focus on application, such as using the information to solve a problem or to make inferences about cause and effect relationships. The common methods to investigate conceptual understanding are asking students to recall information, labelling a diagram, explaining a scientific phenomenon, explaining why a particular instance is an example of the concepts, or to distinguish between two similar concepts. Furthermore, the best way for students to improve their understanding of scientific concepts is to test them against their own experience [18].

4. Conclusion

Based on the result and discussion, it can be concluded that an overview of conceptual understanding in science education curriculum in Indonesia can be seen from graduate competency standards, core competencies, basic competencies and science textbook. To achieve conceptual understanding, the learning activities use a scientific approach and integrative learning which emphasize on meaningful learning condition.

References
[1] MoEC 2013 Development of curriculum 2013. Jakarta: Kementerian Pendidikan dan Kebudayaan.
[2] OECD 2013 PISA 2015: Draft science framework Paris: OECD Publishing.
[3] OECD 2014 PISA 2012 results: What students know and can do – student performance in
mathematics, reading and science (Volume I, Revised edition, February 2014) Paris: OECD Publishing.

[4] Bodzin A M and Cates W M 2003 *Journal of Science Teacher Education* **14** 237
[5] Eylon B S and Linn M C 1988 *Review of Educational Research* **58** 251
[6] National Research Council 2000. *Inquiry and the national science education standards: A guide for teaching and learning* Washington, DC: National Academies Press.
[7] Muukkonen H, Lakkala M and Hakkarainen K 2005 *Journal of the Learning Sciences* **14** 527
[8] Martin M O, Mulli I V S, Foy P and Stanco G M 2015 TIMSS 2015 International Results in Science. International Association for the Evaluation of Educational Achievement.
[9] White R and Gunstone R 1992 *Probing Understanding*. London; New York; Philadelphia: The Falmer Press.
[10] Driver R, Asoko H, Leach J, Scott P and Mortimer E 1994 *Educational Researcher* **23** 5
[11] Widiyatmoko A and Nurmasitah S 2014 *International Journal of Humanities and Management Sciences* **2** 53
[12] Wiyanto and Widiyatmoko A 2016 **5** 169
[13] Nieswandt M 2007 *Journal of Research in Science Teaching* **44** 908
[14] Ellis J T 2013 *Journal of Chemical Education* **90** 554
[15] Adadan E, Trundle K C and Irfing, K E 2010 Journal of Research in Science Teaching **47** 1004
[16] Jonassen D H, Peck K L and Wilson B G 1999 Learning with Technology: A Constructivist Perspective. Upper Saddle River, NJ: Merrill Publishing.
[17] Novak J D 2002 *Science Education* **86** 548
[18] Roth K J 1990 *Developing meaningful conceptual understanding in science. Dimensions of thinking and cognitive instruction* in Dimensions of Thinking and Cognitive Instruction (New Jersey: Lawrence Erlbaum Associates, Inc.
[19] Lewis E L and Linn M C 1994 *Journal of Research in Science Teaching* **31** 657