Analysis of senior high school student understanding on gas kinetic theory material

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Abstract. The purpose of this research conducted to find out student understanding profile about gas kinetic theory. Particularly, on ideal gas law material, ideal gas equations and kinetic energy of ideal gas. This research was conducted on student of class XII in one of the schools in Bandung. This research is a descriptive research. The data of this research collected by using test instrument which was the essay that has been developed by the researcher based on Bloom's Taxonomy revised. Based on the analysis result to student answer, this research discovered that whole student has low understanding in the material of gas kinetic theory. This low understanding caused of the misconception of the student, student attitude on physic subjects, and teacher teaching method who are less helpful in obtaining clear pictures in material being taught.

1. Introduction
One of the big challenges in education world recently was how to prepare students to become superior and competence generation, particularly, in faced some competitions in working world and faced the reality of being part of a global society that is connected to each other. In United Stated, Partnership for 21st Century Learning (P21) noted at least four qualities which is needed from students while entering job world such as critical thinking, creative thinking, solve the problem, communication skill, and collaboration skill. Those skills is known as 4C which is at least needed to be built within the students through any given learning, and also science is no exception, or in this case physic subject.

This ability complements core subject in the school such as art, history, science, sport and language. This ability also complements the core competencies that have been taught to students at every level of education such as reading skills, writing skills, and arithmetic skills. In this case, many countries in the United States feel need to be involved in developing this new paradigm. One of the countries that participated in developing this same paradigm is Indonesia.

The shift in education paradigm also occurs in Indonesia. The Education Unit Level Curriculum (KTSP) used does not equip students with the required skills. Exposure to the Ministry of Education and Culture in 2012 shows some of the problems that arise in KTSP, such as: The curriculum is not fully competency-based in accordance with the demands of national education functions and objectives. Thus, some of the competencies required according to the development needs (character education, active learning methodology, the balancing of soft skills and hard skills, entrepreneurship) have not been accommodated in the curriculum. Furthermore, the curriculum is not sensitive and responsive yet to social changes that occur at the local, national, and global levels.
The three of those components connected with learning competency which turned out to be irrelevant to the demands of the times. Therefore, the government is trying to shift this paradigm by developing the 2013 Curriculum to fill the gap between the qualities of graduates produced with real-world competencies that are expected. The 2013 Curriculum document states that one of the competencies expected to arise from students is the ability of students to understand, apply, analyze and evaluate factual, conceptual, procedural knowledge in science, technology, arts, culture and humanities with humanitarian, national, and civilization-related phenomena and events, and apply procedural knowledge to a specific field of study according to their talents and interests to solve problems. The above description explains the alignment between what is globally agreed upon, and what is regionally agreed (Indonesia) implies that all learning activities need to be directed to enable students to have the necessary competencies when faced with competition in the globalized world.

In Indonesia, one of the important learnings to be taught in senior high school level is physics. Physic subject focused on symptoms on natural objects, and how they interact. The physic subject becoming important because it was as field of science, not necessarily just stop as concepts alone. Richard Feynman states science is a way of teaching about how things can be known, what is still unknown, and to what extent we know something. Feynman also states that science is a way of dealing with doubts and uncertainties, how to set up proofs, ways of thinking to determine conclusions, and also how to separate fact from false news. Feynman's statement above states that science, including physics, is not just a process of coming and then listen when in school, but rather broader than that. Physics should train the way of thinking, with the result that in the future they are ready to face the development of the outside world because it has been equipped with skills of thought and competence adequate.

The explanation above shows that the understanding of physics becomes very important in the face of the development of the global world. However, in fact, the quality of students with understanding is still very low. The PISA (Program for International Student Assessment) publication in 2012 ranked Indonesia in 63 out of 64 countries involved in the science skills of 15-year-old students. When sorting by skill level, more than 80% of Indonesian students are below level 2. PISA itself calls level 2 as the level where students are expected to have adequate science knowledge to provide a reasonable explanation in a particular context, or try to draw conclusions from information given [1]. Looking at the information, it can be concluded that most Indonesian students do not have the ability to write the conclusions or the ability to present the reasons for not having sufficient knowledge and understanding of science.

The research on students understanding of the physics concept has been conducted for a long time. One of them is research conducted by Kautz, et al. [2]. In their research, they found that many students found it difficult to understand the physical content associated with the ideal gas, with the focus being on the concept of pressure, volume and temperature of the ideal gas. Based on the description above, the authors are interested to reveal what is the student's understanding profile for the kinetic gas theory material.

2. Methods
This research is a descriptive research. According to McMillan and Schumacher [3], descriptive research is a study that focuses on the current state of an event, with no precedence of treatment. This research was conducted on 31 students at one of the high schools in Bandung selected using purposive sampling method, with consideration of the 31 students selected have studied this material before. The data were collected using a test essay consisting of nine questions. The developed test is an understanding test consisting of two indicators based on Bloom's taxonomy revised, which is to explain and predict [4].

3. Results and Discussion
After thirty-one students were given an understanding test of the kinetic gas theory material, the results are shown in the figure below.
Based on the table above, it is seen that none student can answer all questions correctly. The highest score obtained by a student (48.14) is even lower than the teaching completion criteria established by the school. On the other hand, the distribution of student answers when viewed from the constituent indicators is shown in the figure below.

Figure 2. Comparison of student understanding indicators
Based on the results above, it is seen that the student's score in terms of explaining is higher than the student's score in terms of predicting. Nevertheless, on average, both values are located far below the teaching completion criteria defined by the school. In other words, no single comprehension indicator is comprehensively understood by the students.

Based on the description above, it can be said that all students still have inadequate understanding of the gas kinetic theory. This result is not much different from what has been found by previous researchers. From the results of the analysis of student answers, the results of researcher observations during the test took place and the results of interviews with teachers, it obtained some explanation: 1). Misconceptions. Suparno [5] refers to misconceptions as concepts that are inconsistent with the scientific notion or understanding received by experts in the field. The results of the analysis of student answers, found so many misconceptions that deliver students to the wrong or mistake answers. For example, one student answered that a presto pan was capable of producing higher temperatures than an ordinary saucepan because the presto pan maker was capable of delivering heat better than ordinary pots. The misconceptions above are born because students do not understand the working principle of a presto pot that utilizes Gay-Lussac law. Misconceptions can be a barrier for students to properly understand the concepts of physics, and ultimately deter students from achieving higher learning goals [6]: 2). Student learning interest. Based on the observations of the researchers when the tests took place, students did not show much enthusiasm about the physical content presented. The lack of enthusiasm is visible from the behavior of some students who are not too serious about the problem and prefer to remain silent until the test time is completed. This is also expressed by teachers who said that the students are less motivated when learning physics, in this case, it takes a larger stimulus to be able to motivate students.

Student learning method. Gas kinetic theory is one of the abstract physics materials, so that students need to be given many simulations as a tool to build concepts about gas kinetic theory. This statement is supported by the findings of Smetana, et al. [7]. In his study of 61 studies, Smetana stated that most computer simulations have a good effect on the development students' knowledge of science process skills, and also to support the change of the concept in the students. Unfortunately, this was not conducted by teachers who teach. From the results of interviews with classroom teachers, it is known that gas kinetic theory learning is only done by using lecture method that is assisted by the use of presentation slides as auxiliary media. That method makes the students lack of clear description of the gas kinetic theory because the teacher does not provide adequate stimulus about the material concerned.

4. Conclusion
Based on the data analysis and discussion results, it can be concluded that student understanding about gas kinetic theory is still very low. In the explanation indicator, the average score of the student is 15.40 and on the prediction indicator, the student's average score is 9.00. These findings could later become the basis for subsequent research, such as finding a suitable teaching method for the gas kinetic theory material.

5. References
[1] OECD 2014 PISA 2012 Results: What Students Know and Can Do - Student Performance in Mathematics, Reading and Science
[2] Kautz C H, Heron P R L, Loverude M E and McDermott L C 2005 Student understanding of the ideal gas law, Part I: A macroscopic perspective Am. J. Phys. 73 11 1055–63
[3] McMillan J H and Schumacher S 1984 Research in education: A conceptual introduction (Brown: Little)
[4] Anderson L W, Krathwohl D R, Airasian P, Cruikshank K, Mayer R, Pintrich P, Rath J and Wittrock M 2001 A taxonomy for learning, teaching and assessing: A revision of Bloom’s taxonomy, New York, Longman Publishing, Artz, AF, & Armour-Thomas, E.(1992). Development of a cognitive-metacognitive framework for protocol analysis of mathematical
problem solving in small groups. Cognition and Instruction 9 2 137-175

[5] Suparno P 2013 Miskonsepsi dan Perubahan Konsep dalam Pendidikan Fisika (Jakarta: PT. Grasindo)

[6] Council N R 1997 Science Teaching Reconsidered: A Handbook (Washington, DC: The National Academies Press)

[7] Smetana L K and Bell R L 2012 Computer Simulations to Support Science Instruction and Learning: A critical review of the literature Int. J. Sci. Educ. 34 9 1337–70