CONCEPTUAL PROFILE IN CHEMISTRY: THE MATTER OF ATOMIC THEORIES

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Abstract. *The aim of the study was to analyze the conceptual profile in chemistry matter of atomic theories. An instrument of three-tier diagnostic test was given to 35 students from X Science 4 class in SMAN 1 Driyorejo and regarding to this worksheet treatment session was given to enhancing students' achievement. This study shown the conceptual profile in chemistry varies in the reduction proportion value, but the lowest was Rutherford atomic theories with 0.48 in middle-category. The need of complementary views for the atomic structure especially in atomic theories bring important issues for understanding and teaching chemistry, which will be discussed further in the article.*

Keywords: *conceptual profile, teaching of chemistry, atomic theories*

INTRODUCTION

Chemistry is a part of natural science that is always related to how to find out about nature systematically. Thus, chemistry is not only the mastery of a collection of knowledge in the form of facts, concepts, or principles, but also a process of discovery. Therefore, the delivery of chemical materials must begin with the correct concept so that misconceptions do not occur. Misconception or wrong concept refers to one concept that is not in accordance with the accepted scientific understanding. The cause of misconceptions that occur in students is usually the initial knowledge possessed by the students themselves. According to several studies misconceptions are stable and difficult to change [1][2].

One of the subjects studied in the discipline of chemistry is the atomic structure. Atomic structure is an important concept in science, especially in chemistry education. Learning of student of scientific concepts has brought to light that student use several ideas to explain scientific and everyday phenomena which are different from they learned in formal school. The basic of chemistry learning is to make students understand and be able to apply the concepts of atoms and molecules [3]. Also, some researchers agree that to understand important concepts in chemistry requires a basic knowledge of the concept of atomic structure [4].

Many students who have difficulty in understanding the concept of the atomic structure. Around 30% students have moderate academic achievement, but more than 50% of students have a lack knowledge in the concept of atomic structure [5]. Other studies found some students have different understandings with the scientific concept settled by scientists about the concept of atoms called misconceptions [6]. In addition, another research shown that there were several student's misunderstandings about quantum mechanics atomic model.

The 2013 revised curriculum was developed to complement the strengthening of learning patterns in students such as strengthening learning patterns results in the understanding of subject matter. The most important thing in the teaching and learning process is the orientation of the learning objectives so that students are able to understand something based on their learning experience. The ability to understand the material is the basic thing that is expected to be able to build conceptual knowledge.

An understanding of concepts is very important for everyone. Mastery of concepts well, broadly, and deeply as those possessed by experts in certain fields of science, enables a person or expert concerned to apply his mastery in various purposes. The progress of Science, Technology, and Art as is happening today is very dependent on the understanding and mastery of the concepts possessed by everyone, especially experts in the relevant field of science [6]. However, mastery of concepts is often lacking or even incomprehensible. This will affect the understanding of other concepts. As a result, there is no ability to apply the concept correctly or even with the wrong application.

The theory of conceptual profile states that people expressing something they see in various ways and also used in broad conditions. The theory concedes that it has polysemy meaning, both in science and sociocultural context [7]. A conceptual profile of chemistry acquired from various sources, such as published research about history and wisdom on chemistry, studies about students' misconceptions, and fact in actual learning process in school [8].

METHOD

The key question driving this study was to explore the conceptual profile in chemistry especially the matter of the atomic theories. The subject of the research were students of a senior high school in Gresik. There were 35 students involved belonging to X Science 4 class. In this school using K-13 revised curriculum. The topic of atomic theories is first taught to grade 10 students.

This study belongs to pre-experimental which using one-group pretest-posttest design. The result will be recorded before and after worksheet treatment session that has been valid for conducting this research. The design shown in the table 1 below:

Table 1 One-Group Pretest-Posttest Research Design

Pretest	Treatment	Posttest
$\boldsymbol{O_1}$	X	O_2

Research data were obtained from students' conception about atomic theories with three-tier diagnostic test instrument. The identification instrument for student was a paper with twenty multiple choice questions. Each multiple choice question consisted of five possible answer, the reason of the answer, and the level of confident. All of the possibilities responses regarding to the three-tier diagnostic instrument test shown the table 2 below:

Table 2 All Possibilities Responses

First tier	Second tier	Third tier	Categories
Correct	Correct	Certain	Scientific knowledge
Correct	Incorrect	Certain	Misconception (false positive)
Incorrect	Correct	Certain	Misconception (false negative)
Incorrect	Incorrect	Uncertain	Misconception
Correct	Correct	Uncertain	Lucky guess, lack of confidence
Correct	Incorrect	Uncertain	Lack of knowledge
Incorrect	Correct	Uncertain	Lack of knowledge
Incorrect	Incorrect	Uncertain	Lack of knowledge

The conception profile for each concept can be viewed from the level of reduction in misconception by calculating the proportion price according to the following formula:

$$P = x/n$$

Description:

P = the proportion of reduction in misconception per concept

x = the difference between the percentage of the number of students who experience misconceptions during the pretest and posttest

n = percentage of the number of students who experienced misconceptions during the pretest

Criteria for the reduction of students' misconceptions based on the Hattie barometer (2009) are presented in Table 3 below [9]:

Table 3 Criterion for reduction students' misconception

No	P	Criterion
1	>0.71	High
2	0.41 – 0.70	Middle
3	0.01 – 0.40	Low
4	<0.00	Negative

RESULT AND DISCUSSION

Grouping students' understanding of concepts which includes scientific knowledge (know the concept), lack of knowledge, and misconceptions are identified using the three-tier method. The pretest was given before using the worksheet of the author that has been developed. 35 students were asked to follow the stages of PDEODE learning strategy and finish the question arranged in the worksheet with matter of atomic theories. The worksheet itself splitted into two parts, part one is about Dalton atomic theory, Thomson atomic theory, and Rutherford atomic theory, while for the part two consist of Bohr and Quantum mechanics theory. The following stages correspond to the PDEODE learning strategy are (1) Predict, (2) Discuss, (3) Explain, (4) Observe, (5) Discuss, (6) Explain. In the end of the worksheet treatment, students were asked to do the posttest session.

The results of students' conception shifts can be known from the results of the posttest given after the worksheet treatment session. Based on the posttest results it can be seen the percentage of the number of students who know the concept, misconceptions, and do not know the concept. The results of understanding students' concepts can be seen in Table 4 below:

Table 4 The Percentage Conception of Students

No	Concept	Conception (%)		
		Scientific Knowledge	Misconception	Lack of Knowledge
1	Dalton atomic model	94.29	5.00	0.71
2	Thomson atomic model	95.00	3.57	1.43
3	Rutherford atomic model	87.86	9.29	3.57
4	Bohr atomic model	94.29	2.86	2.86
5	Quantum mechanics atomic model	95.00	5.00	0.00

Based on the results of the pretest and posttest data obtained in the form of a combination of answers from each student. The combination of answers consists of 3 components: (1) answers, (2) reasons for choosing answers, (3) level of confidence. Then each combination of answers is grouped into misconceptions which include: (1) scientific knowledge, (2) misconception, and (3) lack of knowledge.

The results of the analysis of student's conception are shown in Table 5 below

Table 5 Conceptual Profile in Each Concept

No	Concept	Sub Concept	Misconception (%) Pretest	Misconception (%) Posttest	Proportion of reduction	Category
1	Dalton atomic theory	Postulates of Dalton	53	4.3	0.92	High
		The strength and weakness	48.5	5.7	0.88	High
2	Thomson atomic theory	Thomson atomic model	58.5	7.15	0.87	High
		Cathode ray experiment	47	0	1	High
3	Rutherford atomic theory	Rutherford atomic model	71	37.2	0.48	Middle
		Gold foil experiment	51.5	0	1	High
4	Bohr atomic theory	Bohr atomic model	37	0	1	High
		Hydrogen atom spectrum	61	5.7	0.91	High
5	Quantum mechanics theory	Quantum mechanics model	54	0	1	High
		Atomic orbital	47.5	20	0.58	Middle

Based on Table 5 it can be seen that the conception profiles of each concept are quite diverse. Overall, there was a changing in the students' conception with a high category. This showed that before worksheet treatment was given many students experienced misconceptions or did not know the concepts in the material development of atomic theory. The causes of misconceptions are not only caused by the type of questions given, but internal factor from student are possible to occur [4]. Specific causes originating from the main causes of the students themselves can be preconceptions, associative thinking, humanistic thinking, incomplete or wrong reasoning, stages of cognitive development, abilities, and students' interest in learning.

The lowest proportion of reduction of misconception lies in the concept of the Rutherford atomic model of 0.48 with the medium category. The proportion of reduction with this low criterion can occur because students have carried out an improper concept reconstruction. Based on the theory of Piaget and Vygotsky which emphasizes that cognitive change only occurs if the conception previously understood is processed through an imbalance process in an effort to understand new information [10]. This shows that the information obtained by students was in accordance with scientific conceptions. The proportion of reduction in misconceptions with this low criterion can occur because of a new phenomenon that is connected with the knowledge structure of the students well.

This can also be caused by the understanding of concepts or information received on each student is still limited, incomplete and different from scientific conceptions. Inaccuracy of students in observing activity can also lead to making wrong conclusions that result in misconceptions [4].

In question item number 9 there were shown several atomic models by earlier scientist, students asked to choose which one is the Rutherford atomic model. Then, they should choose the reason, and also choose the level of confident. Many students still experiencing misconceptions. One student experiences misconception known as false positive category and seven students experience misconception known as false negative category. This is why most students choose the Rutherford atomic model that should be modeled like a planet in the solar system with electrons surrounding the nucleus of the atom in the skin. Atomic mass is mostly centered on

the nucleus, so the location of the electron shell is relatively far from the nucleus.

In the same concept, the Rutherford atomic model, also found the highest percentage of misconceptions in item number 12. In this item number, students asked to choose which one of the statements that shown the weakeness of Rutherford atomic model. Then, they should choose the reason, and also choose the level of confident. Based on the answers in question item number 12, there were 5 students who experienced misconceptions with the category false positive as many as 1 student and false negative as many as 4 students. Students assume that the weakness of the Rutherford atomic model is that it doesn't know the type of electrons in the nucleus and empty space is unknown. What should be the weakness of the Rutherford atomic model is not the type of electron, but Rutherford cannot explain why electrons do not fall into the nucleus and are stable. This is because it is contrary to Maxwell's law because if the electrons move around the nucleus, there will be an emission of energy in the form of electromagnetic waves that cause the electron paths to become smaller and cause the electrons to eventually fall into the nucleus.

CONCLUSION AND SUGGESTION

Generally, misconceptions found throughout the sample in accordance with the result of this study regarding to the conceptual profile of atomic theories in term of reduction proportion value in the lowest is the concept of the Rutherford atomic model with a reduction proportion of 0.48 is belongs to middle category.

This might be the main focus for futher researcher to undertake the students' misconception especially in Rutherford atomic model. Further research study is called for in this regard into the future.

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