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Graphic representation ability in learning chemistry through multipresentation-based chemistry modules

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Abstract. Knowledge of appropriate science learning techniques can be found through analysis of multi representation abilities which include verbal, image, mathematical and graphic representation. Chemistry as part of science contains concept that can be presented through various representations (multi representation), one of them is a graphical representation. The ability of students to read and interpret graphics will provide additional knowledge for students in learning chemistry. This study aimed to explain students' ability to read and interpret graphs in chemistry learning on the reaction rate subject. The method used in this research was descriptive qualitative. The data used in this study came from various sources such as journals, books, proceedings, internet and observations. The result showed that using chemistry module based multi representation in learning chemistry could improve the understanding of chemical concepts and students' ability to read and interpret graphs.

1. Introduction

Chemistry is a part of science which studies matter including the structure, properties, energy and changes that accompany matter through phenomena in daily life [13]. Generally, concepts in chemistry are abstract and students had difficulty in understanding the concept [19]. In addition, the concept of chemistry includes mathematical calculations that requires mathematical skills to solve chemical problems [10]. Such discussion requires mastery of chemistry in a multi representation. This statement is strengthened by several experts who state that in studying scientific concept and methods, an understanding of the form of representation is needed [1] [22].

Reaction rate is a structured chemistry topic and it is a central part of the chemistry curriculum [4]. That is why the concept of reaction rate becomes an important prerequisite concept for studying the next chemical concept, such as equilibrium and thermodynamics [17]. The subject matter of reaction rate includes the concept of understanding reaction rate, order reaction, activation energy, factors that affect reaction rate, collision theory, catalysts, enthalpy and reaction mechanism [13].

In chemistry learning, the subject of reaction rate, students are required to make a descriptive concepts, particulates and mathematical modeling of the concept of reaction rate and their relationship in order to improve their understanding [5]. This concept cannot be explained by the lecture method herself. However, it is necessary to have a visual media that can assist students understanding in constructing these concepts such as using graphics.

Graphics are visual media used to summarize data and represent relationships between variables effectively [12]. The same data will be easier to read and understand when they are presented in graphical form than presented in a prose. The ability to read and interpret graphs requires mathematical thinking, so graphs are often considered as a mathematical tool. In fact, graphs are not only used in mathematics but also used in various fields of science such as statistics, social sciences



(psychology and sociology) and natural science (chemistry, physics and biology).

In science education, the function of graphics is to enhance students' comprehension about scientific concepts, build conceptual frameworks, and summarize subject matter. Graphics also play a role in improving students' science process skills such as explaining the relationship between various information or data and making conclusions from those data [11]. The inability of students to read and interpret graphs will increase students anxiety about using graphics and it will affect the quality of students' learning [18]. Teachers who effectively use graphic representations in learning will provide opportunity for students to work with various types of graphs and it will be able to improve students' understanding of graphs [12]. In addition, learning that supported by graphical representation will help students build meaning for the basic concepts of subject they are learning.

The concept of reaction rate presented through a graphical representation includes expressions of reaction rate, order reaction, factors that influence reaction rate and the distribution of molecular kinetic energy. Therefore, students must be able to read and interpret graphs in order to know and comprehend the concept of reaction rate correctly. If students are wrong or unable to read and interpret graphs correctly, then students will have a misconceptions in studying chemistry. Such a learning process will be easily understood if it is supported by the presence of appropriate teaching materials, such as module.

Module is one of teaching materials which is quite effective because it is independent and it focuses on mastering learning competency based on the potential and conditions of students in a certain time. Good modules use language that is easy for students to understand (simple and communicative), and it is appropriate with the advance of science and technology. It also developed by analyzing, designing, developing the evaluation, and revising process [14]. A developed module based on multirepresentation could help the students in improving their ability to read and interpret the graphs on the concept of reaction rate.

Multi representation is an activity of restating the same concept in various forms of representation which includes picture, verbal, graphic and mathematical representations [21]. Hence, the aim of this paper was to describe the students' ability to read and interpret graphs on the subject of reaction rate using chemistry module based on multi representation method.

2. Method

The type of this research was a survey research, and it emphasized on: 1) the material textbook used in the classroom; 2) previous source such as textbook and module used in teaching and learning process; 3) and the result of study from previous research related to learning science based on multi representation and students ability to read and interpret graphics. Based on the learning process resulted in the study, this research tend to be descriptive qualitative data. The data was collected by observing techniques, sharing the questionnaires, collecting the related documents, and finding the literature studies on various sources, such as: books, article from scientific journals, research reports to support the data needed. To collected data were analyzed by descriptive analysis. The subject in this research was students of class XI SMA/MA that used a chemistry module based on multi representation which could enhance students' comprehension and knowledge of concept in chemistry and students' ability in making, reading, and interpreting graphics. The participant in this research were senior high school students in Jember city.

3. Result and Discussion

3.1. Result of a Theoretical Review

3.1.1. The result of the research are related to multi representation in science learning.

The previous research about multirepresentation in the study of science was obtained by scientific journals, articles, and research reports. The result showed that multirepresentation in science learning could improve students' understanding of concept. See table 1.

Table 1. The result of previous study about multirepresentation science learning

Year	Result	Author
1991	Using multi representation in learning will lighten the cognitive structure of students in learning complex concept	Sweller & Chandler
2003	The learning process with multimedia is more effective than just words	Mayer
2005	Learning with multi representations is not only able to improve students' understanding of concept, but also it is able to expand students' understanding in utilizing and interpreting various representations to understand existing phenomena	Ardac & Akaygun
2007	By learning process based on multirepresentation, students were able to describe and explain changes in chemical reactions at the particulate level (atom, ions, molecules) by using symbols, formulas, and chemical equations properly.	Chandrasegaran, David F. Treagust & Mauro Mocerino
2009	Basically, learning the concept of chemistry must involve a combination of more than one representation	Maurice Cheng & John K. Gilbert
2010	Science learning with the use of program from computer could increase students' spatial abilities	Belma Yolcu & Aytac Kurtulus
2013	The use of multi representation can develop the scientific knowledge of pre service chemistry teachers about structure of matter	Buket Yakmaci-Guzzel, Emine Adadan

3.1.2. The results of study related to analysis graphics ability in learning of chemistry

The previous studies below were related to analysis graphic ability of students in learning chemistry which resulted minimum score. See table 2.

Table 2. The result of previous study related to students' graphic ability in learning of chemistry

Year	Result	Author
2006	Students are able to provide scientific explanantions correctly about the relationship of reaction rate to time orally and verbally. However, these students were not able to graph the relationship between reaction rate and time	Gultekin Cakmakci, John Leach & James Donnelly
2007	Most students found difficulties in the ability to read and interpret the graphics compared to their ability in conceptual and algorithmic understanding	Bayram Costu
2011	Teachers which using graphics in learning process could improve students' literation scientifically.	Fatma Alkan & Emine Erdem
2011	<ul style="list-style-type: none"> • Most teachers cannot graph the reaction rate of reactants or products against time correctly • Teachers have difficulty in explaining the relationship between enthalpy and activation energy on the energy graph 	Ali Kolomuc & Seher Tekin
2015	The average value of the test for understanding the non graphical reaction rate is higher than the average of the reaction rate test using graphical representation	Nilgun Secken & Hatice Gungor Seyhan

3.1.3. The result of survey, documentation, and field observation

The survey was done by distributing the questionnaires to 72 students of class XI science program

in Jember regency. The results of the questionnaire showed that students who had difficulty in understanding the concept of chemistry with image representation were 28,1%; verbal representation 35,9%; graphical representation 46,9% and mathematical representation 45,3%. Although students are often trained by answering the questions in class that need the ability to read graphical and mathematical representation, students still feel difficult when they have to study independently outside of the classroom. One of the chemistry modules that can improve students' graphic representation skills is a multirepresentation based chemistry module which include image, verbal, mathematical and graphical representation

4. Conclusion

Graphics are very important and critical concept for chemistry and other diciplines. The ability to read and interpret graphic are important in raising students' literation scientifically. Reaction rate is one of chemistry learning that is related to daily life and contains concepts that can be presented through graphical representation. It is considered that solving graphic problems and lacks in understanding graphics that are not developed well can create serious problems in students professional and daily life [16] [9]. Learning reaction rate will be more effective if the learning process is supported by teaching materials that student can use independently in a certain time according to their conditions and potential, such as well as module. Effective module is a module that leads students to develop their ability more than one representation. Module based on multi representation is needed to complete reaction rate learning process and to improve students' understanding of concept chemistry and students' ability in making, reading, and interpreting graphics.

Based on the problem happened, I recommend the students to have a balance ability among conceptual, algorithmic, and especially for the graphical understanding in learning chemistry. All this time, they have a fear in answering the question in the form of graphics. This is why graphical understanding is needed to learn due to the fact that it can increase students' comprehension and it is very useful in their life.

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