

Description Mental Model Students of Thermochemistry Basic Concept

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Abstract - Thermochemistry is one of the material studied in chemistry which consists of abstract concept concepts because it discusses the energy that accompanies changes in physics or chemical reactions. The purpose of this study is to describe the mental models of students on the basic concepts of thermochemistry by using essay tests supplemented by interviews. A mental model is a concept in the minds of students that is used to describe and explain a phenomenon. The mental model of students in this study was classified based on five indicators of mental model assessment, which were complete mental models, incomplete mental models, misconceptions, no mental models, and no response. This type of research is descriptive research. Informants in this study were students of Education Class 23 people and 16 Non-Education class students one semester level two majoring in chemistry at the State University of Padang academic year 2015-2016. The instruments used in this study were essay tests and interviews. Data analysis technique used is percentage. The results of the study show that most students tend to only memorize chemical concepts related to symbolic levels and do not understand the meaning of the symbols used. Furthermore, most students have not been able to associate the observations at the macroscopic level with the symbolic level. Students tend to be on the indicator of mental model assessment "there is no mental model", with the highest percentage of 87.5% means that students still do not understand most of the basic concepts of thermochemistry.

Keywords - mental models, concepts, thermochemistry.

I. INTRODUCTION

Chemistry is one of the fields of science that focuses on matter and energy in terms of the properties, reactions, structures, compositions and changes in energy that accompany reactions [1]. The existence of a review of these materials and energy makes abstract chemicals. Its properties that abstract chemicals tend to be difficult learning material for students [2]. In addition, the abstract nature is also difficult to use. Daily life, also differences in levels of representation used by chemists in explaining chemical phenomena [3].

Chemical learning in certain contexts, namely macroscopic, submicroscopic, and symbolic [4]. Chemists determine the phenomena and chemicals at three levels of representation; namely macroscopic, microscopic, and symbolic, which are mutually related to each other [5]. To build understanding in good and correct chemistry requires the ability to explain, understand

and regulate strategies and problems with chemical problems in the form of macroscopic, microscopic, and symbolic representations simultaneously. This is quite basic and important in chemistry learning, because students have relative ability and visualization of different levels of understanding. At present, scientists determine three levels of chemical representation, namely macroscopic, microscopic and symbolic levels. This is because of the three levels of chemical representation associated with understanding that reflect the development of mental models [6].

Mental models can be described as conceptual models, mental representations, and mental images, internal

representations, mental processes, a construction that cannot be seen, and personal cognitive representation [7]. Furthermore, it states that mental models are concepts in students' minds (conception) which are used to describe and explain phenomena [8]. The individual mental model is a construct of complex knowledge that represents a person's experience regarding a particular phenomenon and the mental development model is not limited to visible objects; this phenomenon may be as abstract as the terms "right" and "wrong" [9]. Thus, the mental construction model is the core of learning, where in discussion and reasoning how a system works; an individual needs to make a mental model in his brain towards the system he is facing. In this case, these individuals will develop related concepts and understand the relationships of different aspects and levels of the system [10].

Thermochemistry is one of the materials discussed in chemistry which consists of abstract concepts because it discusses the energy that accompanies changes in physics or chemical reactions. The concept of energy is at the heart of science [11]. Therefore it is very important to study the mental models of students / students regarding the concept of thermochemistry. In the study of special chemistry at universities for chemistry majors, thermochemistry is one of the most basic materials. Therefore, conceptual knowledge of thermochemistry is very important as a relation to solve and solve other chemical problems.

Conceptual knowledge is an essential part that must be possessed by students / students who solve chemical problems that must be stored in a long and easily accessible memory to solve chemical problems [12]. In order for knowledge to be gained by students / students into long-term memory, students / students must be supported to use their mental models in connecting three levels of chemical phenomena (macro, submicro, and symbolic). This third-level phenomenon is interrelated and all three contribute greatly to the model of students' mental development in building conceptual meaning and understanding [13].

A person's mental model is not as easy as expected. The mental model of students / students is not fixed / consistent [14]. While during this test it has not been able to reveal mental models that require students. Therefore a special test tool is needed that can reveal mental models. Free in reviewing the mental models used by the instruments issued: MCQs, open minded questions (with images, graphics, symbols, which need to be explained), interviews that are often equipped with concrete images, graphics, models, or

symbols, or can be used consists of interviews with presentation questions, or classroom observations, etc. [15].

Based on studies from various literature that have been carried out in the field of chemistry carried out by mental models of students / or students. Among the research mental models of first-year students in recognizing the concept of stoichiometry with essay test instruments with sub-micro images and supplemented with interviews and the results of the study stated that the macroscopic or verbal mental model is still a mental mental model of first year students and students who have an increase in B and Subjects Basic Chemistry I) so as to be able to interpret submicro images better than students graduating C and D [6]. Furthermore, research related to mental models of high school students, S1 education and postings on chemical bonding material using interview techniques and results is a mental model of students / students explaining chemical and physical properties according to composition, so that the mental model he refers to is wrong [17].

Based on the background and research on mental models and knowledge of students' mental models on the basic concept of thermochemistry, this study discussion "Student Mental Drawing Model Basic Thermochemical Concepts".

II. METHODS

Operating Research What is done is descriptive research. Descriptive research is included in one type of qualitative research that aims to reveal or describe information by taking existing data without providing preparation for designing and analyzing what is needed. This research was carried out at the Padang State University campus for students in the Chemistry Department, Faculty of Mathematics and Natural Sciences, Padang State University. The research informants were two-semester level students of two chemistry majors at the State University of Padang in the academic year 2015-2016.

Whereas the research informants for the analysis of thermochemical mental concept models were taken randomly by one class of chemistry education study programs for 23 people and one non-chemistry education class to capture 21 people.

The data collection technique used in this study is a test technique that is an essay test. The essay test used in this study consisted of 5 questions with a total number of 12 items, while the essay test consisted of cognitive processes collected, analyzed, and created. The non-test technique is interview. Interviews were conducted to confirm students' answers to essay tests on mental models of the basic concepts

of thermochemistry and to find out their direction in answering this.

Data from the essay test results are processed in the following way. Grouping Student Answers. Student answers are corrected using the rubric. Student answers temporarily grouped into indicators Assessing mental models, then interviewed their reasons for answers to essay questions. Grouping student answers is based on five models Saying mental models are complete mental models, incomplete mental models, misconceptions, no mental models, and no response [18].

Open questions are used to explain and differentiate between complete mental models, incomplete mental models, mental models of misconceptions, mental models without mental models and mental models with no response. Ask students for opinions about mental models between the first and second parts. The response needs to be completed both parts: the first and second levels, and analysis according to the consistency between students. Student acceptance is a model of students' mental acceptance. Students as alternative mental models with compilation have an additional 10% of student samples. In this study, alternative mental models have 7% of student samples [19].

A student's answer considers a "complete mental model" if the student has chosen the content choice and the reason for the first part correctly. If students only choose the first part correctly but without giving reasons to answer, it is considered a "mental incomplete model". If the answer in the first part is wrong and without answering the second part, it is determined as "no mental model". In addition, if the student gives the wrong answer for the first part, and the reason for the second part is not reasonable, it is also considered "no mental model". If students have chosen correctly at the first level and provide reasons that indicate an alternative mental model, this response is considered a "misconception". In short, the complete mental model of the meaning of the student gives the correct answer for the second part. An incomplete mental model for giving the correct answer is only one part but there is no answer for the other. Mental models of misconceptions mean the response of students holding conception both in the first or second part or all. Without a mental model means student responses There are no mental models including students who write "I don't know" or "I'm not sure" or "I don't know". Finally, there were no responses including students who were not approved or received blank questions.

III. RESULTS AND DISCUSSION

A. Research Results

Students' mental data models were obtained through essay questions given to 23 students of the Education Class and 16 Non-Education class students of the class of 2015/2016 chemistry department of Padang State University Education force 2015/2016 chemistry department at the State University of Padang. The test is conducted on Friday 30 September 2016 for educational students and Tuesday 27 September 2016 for non-educational students. The interview was held on 10-19 October 2016. Next will be explained the 2015/2016 student mental model of the chemistry department of Padang State University regarding the basic concept of thermochemistry.

1. Analysis of Concepts

Analysis of concepts about the basic concepts of thermochemical basic material to be discussed. The basic concepts of thermochemical basics are published with the concepts of exotherms and endotherms, the processes that occur in simple calorimeters between NaOH and HCl, reaction equations and thermochemical equations of carbon and oxygen reactions, the phenomenon of propane with oxygen and the concept of decomposition of Hydrogen Peroxide.

2. Description of the Student Mental Model of Exotherm and Endotherm

First Question Essay Questions about Exotherms and Endotherms

Based on the results of the analysis, it was obtained that the 2015 chemistry education class mental concept (conception) of the Department of Chemistry, Padang State University for the first question about exothermic and endothermic use based on on indicators, "misconception" mental models with a percentage of 69.6% as can be seen in Table 1 below.

Table 1. Educational Class Student Mental Models for the First Essay Problem about exotherms and endotherms

Jawaban	Alasan	Model Mental	Testee	Jumlah	Total	Persen (%)
Benar	Benar	Lengkap	Ja,Ar,Mw,Ms,Aps	5	5	21,7
Benar	Tidak ada alasan	Tidak lengkap				
Tidak menjawab	Benar					
Benar	Miskonsepsi	Miskonsepsi	Ki,Ir,Dyd,Ds,Yru,Sye,Az,As,Ngm,Th,Ee,Ra	12	16	69,6
Miskonsepsi	Benar					
Miskonsepsi	Miskonsepsi					
Miskonsepsi	Salah					
Salah	Miskonsepsi		Fm,Agr,Sd,Nyh	4		
Salah	Salah	Tidak ada model mental	Wj,Cn		2	8,7
Salah	Tidak menjawab					
Salah	Saya tidak tau, tidak ingat, tidak yakin					
Tidak menjawab	Tidak menjawab					
Total					23	100

Based on Table 1, it looks like the percentage of non-educational students according to the "complete" mental indicator that is equal to 25% of students who are in charge of the exothermic and endothermic essay questions completely and provide reason correctly in accordance with scientific concepts. Furthermore, 75% of students consider the indicator assessing the mental model of "misconception", this shows the reason given by students in explaining the concept of exothermic and endothermic processes. What is interesting is that there are no students in the mental model indicator "incomplete, no mental model and" no response "which is 0%.

Percentage diagram of distribution of mental models of education and non-education class students for the first essay questions on exothermic and endothermic processes Figure 1.

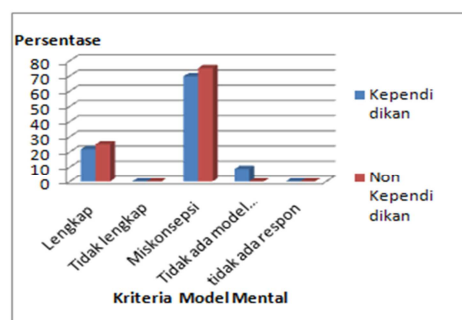


Figure 1. Digested Percentage of Distribution of Student Mental Models Essay Problem 1a

Based on Figure 1 can be seen by classes that can be used by misconceptions, try Students there is a lot of misconception because it refers to a concept that is not in accordance with the scientific understanding of exothermic reactions and endotherms.

This interview was conducted on students who used mental model indicators of misconception and mental models did not exist. Examples of interview results about the 1a education class problem as shown in Table 2.

Table 2 Results of Student Education Class Interview Essay Questions 1a

No Soal	Responden	Kriteria Model Mental	Pertanyaan wawancara	Tanggapan Responden
1a	FM	Miskonsepsi	Air mendidih adalah eksoterm, apakah anda yakin?	Eksoterm karena suhu akan naik jika sistem menyerap kalor dari lingkungan

B. Discussion

Mental models can be explained as conceptual models, mental, mental representations, internal representations, mental processes, construction cannot be seen and personal cognitive representation [19]. Mental models are concepts in students' minds that are used to describe and explain phenomena. So mental models are students' conceptions of concepts that explain phenomena that are not always valid and reliable [20].

Analysis of students' mental models for classes namely education classes and non-education classes. Indicators Assessment of mental models that have been grouped and the percentage obtained so that for each question in the education class can be seen in Table 3. and Figure 2 below.

Table 3. Percentage of mental models of the education class students in the essay questions on thermochemical mental models

No	Nomor Soal	Persentase Model Mental				
		Lengkap	Tidak Lengkap	Miskonsepsi	Tidak Ada Model Mental	Tidak Ada Respon
1	1a	21,07	0	69,6	8,7	0
2	1b	13,04	8,69	4,35	73,91	0
3	1c	34,78	30,43	0	30,43	4,35
4	2a	39,13	17,39	8,70	34,78	0
5	2b	30,43	8,70	13,04	43,68	4,35
6	3a	52,17	26,09	0	2,74	0
7	3b	8,70	8,70	30,43	52,17	0
8	4a	26,09	8,70	60,87	4,38	0
9	4b	13,04	17,39	69,57	0	0
10	5a	34,78	4,38	60,87	0	60,87
11	5b	52,17	4,38	0	43,48	0
12	5c	30,43	8,70	0	56,52	3,48

Based on Table 3 it can be seen that the highest percentage of education in each question is greater than the percentage of students in the mental assessment model "there is no mental model". While the criterion of the mental model, each of which has a "complete" mental model criterion, there are 5 questions, "misconception" as many as 4 questions and 1 question each for criteria incomplete and no response. The percentage distribution diagram of the educational student mental model in Figure 4.16 below is

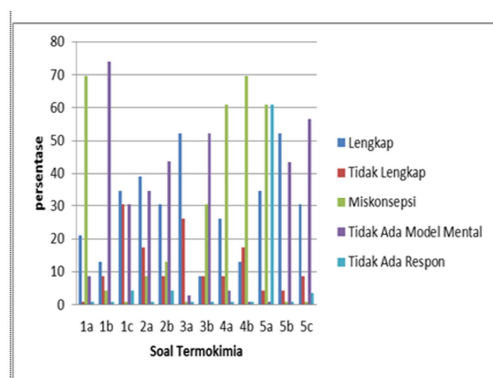


Figure 2. Percentage diagram of the distribution of educational students mental models on the thermochemical basic concept.

In the picture above it can be concluded that mental models of educational students in the basic concepts of thermochemistry are appropriate mental misconceptions and no models mentally. Key indicators Assessing mental models

for each question in the non-education class can be seen in Table 4 below.

Table 4. Percentage of non-educational class mental models in essay questions of the mental models of the majority who asked questions

No	Nomor Soal	Persentase Model Mental				
		Lengkap	Tidak Lengkap	Miskonsepsi	Tidak Ada Model Mental	Tidak Ada Respon
1	1a	25	0	75	0	0
2	1b	12,5	50	0	37,5	0
3	1c	8,75	6,25	0	62,5	12,5
4	2a	12,5	0	0	87,5	0
5	2b	0	0	25	50	25
6	3a	12,5	0	0	81,25	6,26
7	3b	31,25	0	0	62,5	6,25
8	4a	6,25	6,25	6,25	75	6,25
9	4b	0	18,75	0	76	6,25
10	5a	18,75	0	0	75	6,25
11	5b	0	8,75	12,5	56,25	12,5
12	5c	0	0	0	31,25	68,75

Based on Table 4, can we see the same as the education class students that they have a greater number of mental models "no mental models". Incomplete mental model criteria are 2 questions. The large number of criteria for the mental model is "no mental model", so it can be concluded that non-educational class students also depend on the mental model of "no mental model". Percentage diagram of mental model distribution (conception) number of students This 3dibawah

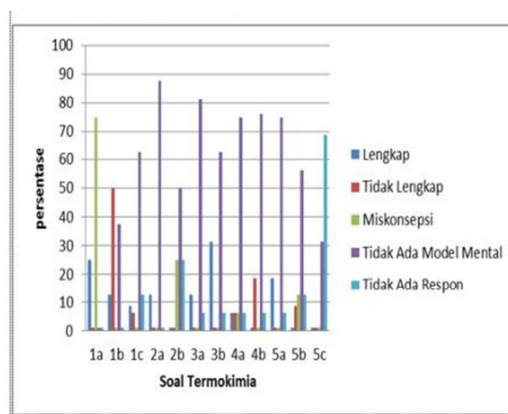


Figure 3. Percentage Diagram of No Education Student Mental Distribution Model on Basic Concepts of Thermokimia

Based on Figures 3 and 4 can be used in students with basic concepts of thermochemistry with exothermic and endothermic concepts as question 1 .a in the education class is on the indicator of "misconception" mental model Assessment. There are still many education students who improve misconceptions; they are still unable to distinguish between the concepts of exotherms and endotherms. While in

the non-education class according to the indicator the assessment of mental models is "incomplete". Non-educational students answer the questions correctly, but the reasons given by students do not yet exist. The concept of equations for exothermic and endothermic processes is saol 1, b educational students based on indicators of mental model assessment "there is no mental model" where students are mostly unable to make reaction equations for exothermic and endothermic processes. While the non-education class lies in "incomplete". Non-educational students answer the questions correctly, but the reasons given by students do not yet exist. The enthalpy diagram for the process is a matter of 1.c educational students in accordance with "complete" assessment indicators where students are able to make enthalpy diagrams correctly and with the right reasons. While the non-education class is in accordance with the assessment indicator "there is no mental model", while the students answer the wrong essay questions and the reasons given are not in accordance with the concept.

The basic concept of the ionization reaction of NaOH and HCl is the question 2.a in the education class according to the indicator of the "complete" mental model. Education students are more able to answer questions 2.a correctly and provide the right reasons. While in the non-education class according to the indicators, the mental model "there is no complete model". Non-educational students answered the questions correctly, but the reasons given by students did not exist, there were also those who answered that they did not know the answers. The concept of calculating heat released in the reaction process of ionization of NaOH and HCl is saol 1, b students of education and non-education classes in accordance with indicators The value of the mental model "no mental model" when larger students cannot calculate the heat required in the NaOH ionization reaction process and HCl correctly and give wrong reasons or do not know.

The basic concept of the ionization reaction of NaOH and HCl is the question 2.a in the education class according to the indicator of the "complete" mental model. Education students are more able to answer questions 2.a correctly and provide the right reasons. While in the non-vocational class on the Exit indicator the mental model is "no complete model". Non-educational students answered the questions correctly, but the reasons given by students did not exist, there were also those who answered that they did not know the answers. The concept of calculating heat released in the reaction process of ionization of NaOH and HCl is saol 2, b students of education and non-education classes in accordance with indicators Assessment of mental models "no mental model" when larger students cannot calculate the heat

needed in the NaOH ionization reaction process and HCl correctly and give wrong reasons or do not know.

The basic concept of thermochemistry about questions 3.a in the education class in accordance with the indicator of assessment of the "complete" mental model. Education students are more able to answer question 3.a correctly and provide appropriate reasons for thermochemistry. While in the non-vocational class on the Exit indicator the mental model is "no complete model". Students answered that they did not answer thermochemical questions but the reasons given by the students did not yet exist, some also answered that they did not know the answers. Explaining the concepts of thermochemical equations, namely question 3, b students of education and non-education classes according to indicators of the mental model "there is no mental model" where most students are unable to explain the concept of thermochemical equations correctly and give false reasons or do not know.

The basic concept of thermochemistry regarding the reaction heat for burning 1 mole of propane is question 4.a in the education class on the indicator of the assessment of the mental model "misconception" where students answer the questions correctly, but the questions raised are not in accordance with the answers given, while non-educational classes try on the indicator Rating mental models "there is no complete model". Educational and non-educational students answered the question of heat for 1 mole of propane with one of the reasons given by students not yet available, there were also those who answered that they did not know the answer. Explaining the concept of the thermochemical equation is the question 46a in the education class about the indicator of the mental misconception model where students answer the questions correctly, but the reasons presented are not in accordance with the answers given and some answer incorrectly for reasons that are misconceptions. mental class model "there is no complete model". Students answer questions Make a thermochemical equation for burning 1 mole of propane with one of the reasons given by the student does not exist, there are also those who do not know the answer.

The "thermochemical" concept of the hydrogen peroxide reaction is the question 5.a in the education class on the indicator of the "misconception" mental model in which students answer the questions correctly, but the questions raised do not match the answers given and the answers are wrong with misconceptions. While the non-education class is according to the mental model indicator "there is no complete model". Non-educational students answered the hydrogen

peroxide reaction with one of the reasons given by the students did not exist, some answered that they did not know the answer. Explain the reaction to hydrogen peroxide formation, which is a question 5.b in the education class on the indicator The assessment of the "complete" mental model in which educational students answer more correctly about the hydrogen peroxide formation reaction gives the right reasons. Non-education classes according to indicators of mental model indicators "there is no complete model". Non-educational students answered the hydrogen peroxide reaction with one of the reasons given by the students did not yet exist, some answered that they did not know the answer. Making a diagram of two hydrogen peroxide reactions, namely question 5.c in the education class on the mental model assessment indicator "there is no complete model", where the educational student answers incorrectly the wrong diagram of one of the two processes of making hydrogen peroxide and some do not know. Non-educational students on indicators Evaluation of the "no response" mental model, where non-educational students are unable to answer the enthalpy diagram questions of the two reactions to hydrogen peroxide production and give no reason.

Based on the discussion above, it can be explained that the students' conception is still low on the concept of thermochemistry; we can see that this is still related to students based on indicators of mental model assessment "no mental model». Students' mental models are constructed from their experience, interpret and explain what they see, reflecting their understanding of the level of submicroscopic material [21].

IV. CONCLUSION

Based on the research that has been done, it can be concluded that the mental model of students on the basic concept of thermochemistry that depends on the criteria of "no mental model" can be seen as the basic material of thermochemistry which is actually abstract.

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