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Conception Analysis of Student on Alcohol as a Study of Learning Needs

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ABSTRACT

This study aims to diagnose learning needs of students focusing to conception of students on Alcohol concepts. It used open ended questions as the instrument which was diagnose conceptions of 80 university students in the grade second, third and fourth. The data found shows that most of students do not understand about some concepts of Alcohol such as solubility of alcohol, reaction of alcohol with Na, identification of primary, secondary and tertiary alcohols. The result of this study gives the information about the concepts which are need emphasized in learning resources, media and lecture can choose appropriate method in learning Alcohols.

Keywords: Alcohol concepts, learning need, conception analysis.

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INTRODUCTION

Chemistryis the study of the composition and properties of matter, which includes all of the chemicals that make up tangible things [1]. Chemistry consist of some abstract concepts that can explain using models, media and so on. One of branch of chemistry is organic chemistry that discuss about carbon compound [4]. One of carbon compound is alcohol which is a hidrocaron with functional group –OH. Based on the position of –OH, alcohol devided into primary, secondary dan tertiary alcoho. Three type of alcohol can identify using Chromic acid, Lucas, Iodoform, and Lucas test. This reaction are oxidation reaction that can prove in laboratory so that students can compare the rory and laboratory identification [2].

There are some other reactions of alcohol such as esterificationand reaction with Na metal. Esterification reaction is the reaction of alcohol and carboxilic acid to produce esther. The production of esther known if there is specific smell. In addition, reaction of Na with alcohol will produce sodium alcoxide and hidrogen gas [3].

Multiple Representation

Chemistry has many abstract concepts which can represent using three representation level of chemistry that is suggested by Johnstone. He recommended to represent abstract concept as macroscopic, submicroscopic and symbolic [7][8]. The three representation is shown as triangl shape as **figure 1**.

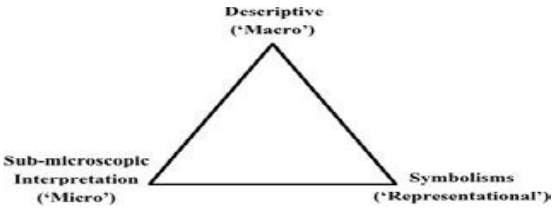


Figure 1. Chemistry triangle [8]

One of the application of this representation is shown as figure 2 which repesents multiple representation of water and ice. The water and ice in the beaker glass called as macroscopic level and the H_2O molecule in the phase solid (ice) and liquid phase. The symbolic level shown by chemical formula H_2O.

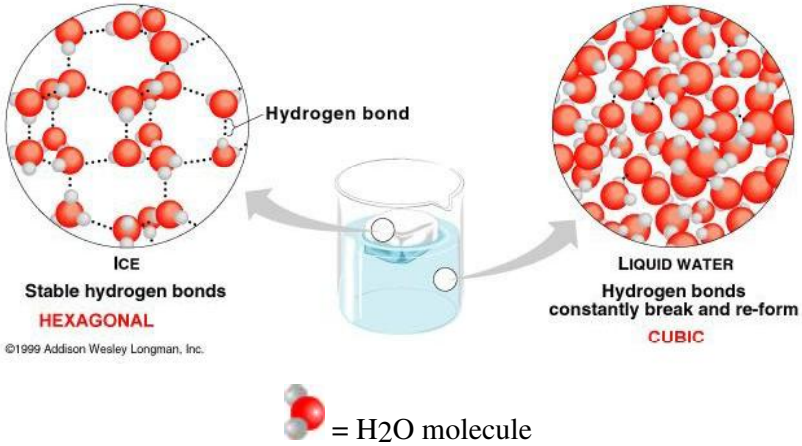


Figure 2. Multiple representation of ice and water

1. Macroscopic level
   In this level, people can directly observe the object under study. It can be observe through experiments and daily experiences such as the change of colour, pH, temperature, the formation of gas and sediment [5][7]
2. Microscopic level
   Chittleborough[5] said that particle in the level sub-microscopic can not see directly such as electron, molecule and atom. Representation of sum-microscopic explain structure and process of chemistry in the particle level about macroscopic phenomenon. Jansoon[7] stated that sub- microscopic level is an abstract level, but related to the observed phenomenon in the macroscopic level.
3. Symbolic level
   This level is used to explain chemistry and macroscopic phenomenon and sub-macroscopic. This level represent as chemical equation, mathematics equation, graphic, mechanism reaction and model [7].

Conception

Rosser in Sagala [9] stated that the concept is an abstraction which has a class of objects, phenomenons, activities or the relations whih have sama atributes. The concepts founs from fact, phenomenons, experiences through generalisation and abstract thinking. Concepts can be use to explain and predict. The concepts show a relationship of simple concepts as the basic of prediction or human answer of the questions about the symptoms.

Siegler [10] explained that the concepts make people can arrange the coherent paternt and make the conclusion in the situation with less experience. Concepts also develop the people mentally to apply their prior concepts in the new situation. Based on Siegler [10], the human shows their concepts in three ways:

a. *Defining-feature representation*

Defining-feature representation is acquisition of meaning such as defenition in dictionary. It means, a person presents their concepts in a simple way, just as available defenition.

b. *Probability representation*

Probability representation is like article in ensiclopedia. It means, the person does n't only the definition but explain the properties or characteristics of defenition and relate it to the concepts but not perfect yet.

c. *Theory based-representation*

Theory based representation is analog as the chapters in a text book. It emphesized the relation of elements in a syste,. Some of concepts have teoritical aspects since childhood, but the depth and scope of representations based on theory increase with increasing of age and experience.

MATERIAL AND METHODS

Analysis of students' conception on alcohol was done to 80 chemistry students who come from second, third and fourth level because they learnt organic chemistry in the topic alcohol but the first level students are not learn organic chemistry yet. The instrument use was eight open ended questions which classify into some different level answers. The questions are shown as below,

Question 1 write the name of the structure below!

a. CH3CH2CH2CH2CH3

b. CH3CHCHCH2CH3
   | |
   OH OH

c. CH3CHCHCH2CH3
   | |
   H3C OH

Answer:
Level 1 :students understand nomenclatur of alkane
Level 2 : students understand the nomenclature of alcohol atom with two hydroxyl groups
Level 3 : students understand the nomenclature of alcohol compound which has one alkyl group

Questionl 2 write the structure of the compounds below

a. 3-metil-1 pentanol
b. 2,3-dimetil -1-pentanol
c. 2-metil-1,2-pentanadiol

Level 1 : students understand how to make the structure of alcohol compound with one alkyl group
Level 2 : students understand how to make the structure of alcohol compound with two similar alkyl group.
Level 3 : students understand how to make the structure of alcohol compound with one alkyl group and two hydroxil group.

Soal 3. Explain the solubility of ethanol in water (H2O) and the solubility of ethanol in hexane. Complate it with submicroscopic representation (molecule level)
Level1 : students understand the solubility of ethanol in water Level 1 : students understand the solubility of ethanol in n-hexane
Level 3 : students understand submicroscopic of solubility of ethanol in water and n- hexane
Level 4 : students understand submicroscopic of solubility of ethanol in n- hexane

Question 4. 3 ml of methanol is reacted to little piece of sodium metal which is free from water. What phenomenon will happened?
Level 1 : students understand macroscopic of the reaction
Level 2 : students understand symbolic of the reaction (chemical equation)

Question 5. A student wants to identify primary, secondaru and tertiary alcohol in the laboratory. The alcohols in test tubes labeled as A, B, C after reacted with acidic Pottasium dichromate, the colour
green-blue produced in A and B test tubes and nothing change in the test tubes C.

a. Identify the primary, secondary and tertiary alcohol!.
b. Explain with reactions

Level 1 : students understand macroscopic reaction
Level 2: students understand symbolic of the reaction (chemical equation)

Question 6. 2 ml of Lucas reagent (ZnCl2, H^+) into three test tubes and add with 4 drops of etanol, sec-butanol and tert-butylalcohol. The symptoms observed was tert butyl alcohol produced the cloud directly in the
test tube, sec-butanol produced cloud after 25 minutes and there was no change of ethanol. What is your conclusion of this reaction? Explain with reaction!
Level 1 : students understand macroscopic reaction
Level 2 : students understand symbolic of the reaction (chemical equation)

Question 7. 100 ml of ethanol pour into 100 boiling flask and added to 100 ml of gacial acetic acid and 2 ml of concentrated H2SO4 drop by drop. Put boiling chips to the mixture till specific smell produce. Explain what happened and complate it with reaction!
Level 1 : students understand macroscopic reaction
Level 2 : students understand symbolic of the reaction (chemical equation)
Question 8. The reaction below is given CH3CHCHCH2CH3 + H2SO4 □
H3C OH

a. Predict the possible product of the reaction!
b. Predict the excess product!
c. Write mechanism of reaction for excess product

Level 1: students can predict the possible product of reaction Level 2 : students can predict the excess product !
Level 3 : students can write the mechanism of reaction for excess product

RESULTS AND DISCUSSION

The students answers are classify and the result is shown in the figure 4.

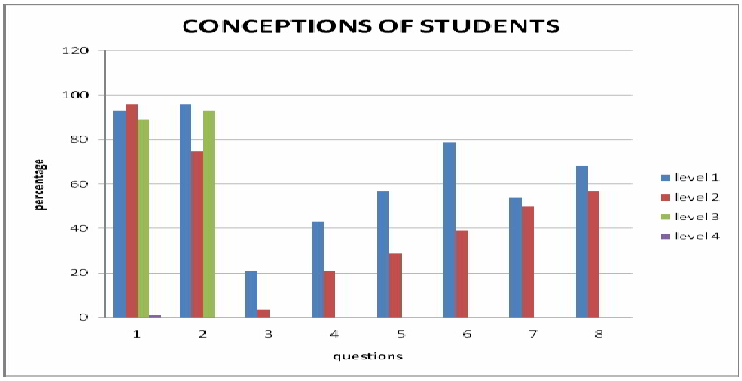
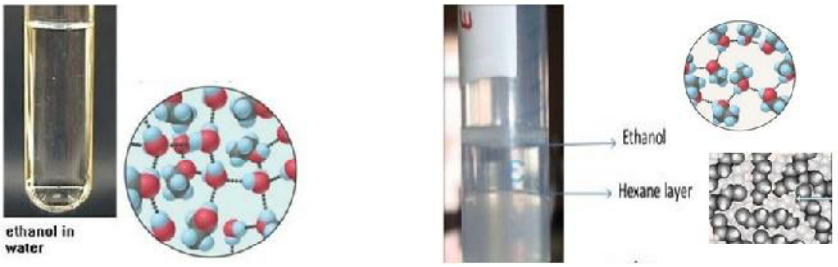


Figure 3. Graphic of Student's Conception on Alcohol

Based on the grapic above, 89 % of student understand the nomenclature of alcohol and more than 75% of students can write the structure of alcohol compound based on IUPAC. Alcohol are named using IUPAC rules designating the hydroxyl group as a functional group, meaning that it has a higher priority than ordinary substituents. For simple chain alcohols, the standard IUPAC prefix is followed by a location and suffix "-ol". For example, attachment of a methyl group to a hydroxyl produces the structure methanol. Just like with alkyl halides, once we reach propanol, multiple distinct locations are available to support the attached hydroxyl, requiring that we number the location of this functional group. Placing the hydroxyl at the end of the chain gives us propan-1-ol (also called as 1-propanol), while placin it at the middle gives us propan-2-ol (also called as 2-propanol). Addition of one more carbon to the mix gives us four potential isomers with the IUPAC names butan- 1ol, butan- 2-ol, 2-methylpropan-1-ol and 2- methylpropan-2-ol. But these IUPAC names are a bit unwiedldy, so chemist have applied common names of n- butanol, sec-butanol, isobutanol and t-butanol to these four, repectively [6]

The second question asks the students to explain the solubility of ethanol in water and solubility of ethanol in n-hexane. The solubility of ethanol in water was answered by 21% of students that ethanol is soluble in the water because short chain of alcohol such as methanol, ethanol and propanol are soluble in water but than longer chain of alcohols are partially soluble or insoluble in water altough alchol is polar compound like water. Based on Bruice, (2004) an alcohol has both a nonpolar alkyl group and a polar OH group. The solubility of alcohol depend on the size of the alkyl group. As the alkyl group increases in size, it becomes a more significant fraction of the alcohol molecule and the compound becomes less and less soluble in water. In other words, the molecule becomes more and more like an alkane. Four carbons tend to be the dividing line at room temperature. Alcohols with fewer than four carbons are soluble in water, but alcohols with more than four carbons are insoluble in water. In other words, an OH group can drag about three or four carbons into solution in water. The four-carbon dividing line is only an approximate guide because the solubility of an alcohol also depends on the structure of the alkyl group. Alcohols with branched alkyl groups are more soluble in water than alcohols with nonbranched alkyl groups with the same number of carbons, because branching minimizes the contact surface of the nonpolar portion of the molecule. So tert-butyl alcohol is more soluble than n-butyl alcohol in water.



(a) Solubility of ethanol in water [11] (b) Solubility of ethanol in n-hexane [11]

Figure 4. Solubility Ethanol in Water and n-hexane

Identification of primary, secondary and tertiary alcohol in macroscopic level is understand by less than 60 % and only 30% of students explained the reaction correctly. There some tests that can be used to identify primary, secondary and tertiary alcohol. Two of them are using acidic pottasium dichromate and using Lucas Reagen acidic $ZnCl^2$.

Identification of the alcohol using acidic pottasium dichromate observed by the change the colour of acidic pottasium cromate which has orange colur to blue-green colour. It happened because pottasium chromate has Cr(VI) with brown-red colour. It reduce to be Cr(III) in the colour blue-green when react with primary and secondary alcohol. In however, there was no change of the colour of pottasium dichromates when added to tertiary alcohol. Using acidified dichreomete solution,primary alcohols are oxidized to carboxylic acids, secondary alcohols are oxidized to ketones, tertiary alcohols are not oxidized. The macroscopic symptom observe of this identification is shown in the Figure 6.

A B C

Figure 6. Macroscopic oxidation test using Lucas Reagent (A = primary alcohol, B = secondary alcohol, C = tertiary alcohol[12]

The reaction of primary, secondary and tertiary alcohols with Lucas reagent as follow

$$CH_3CH_2\text{-}OH + HCl + ZnCl_2 \rightarrow$$

no reaction Primary alcohol

$$(CH_3)_2CH\text{-}OH + HCl + ZnCl_2 \rightarrow (CH_3)_2CH\text{-}Cl + H_2O \text{ (10 minute heat)}$$

Secondary alcohol insoluble

$$(CH_3)_3C\text{-}OH + H_2CrO_4 + H_2SO_4 \rightarrow CH_3)_3C\text{-}Cl + H_2O$$

Tertiary alcohol insoluble [2]

The reaction of alcohol with sodium metal can only explain by 21% students. This reaction will produce sodium alcoxide and hidrogen gas which written as follow.

$$R\text{-}OH_{(l)} + Na_{(s)} \rightarrow Na\text{-}OR_{(aq)} + H2_{(g)}$$

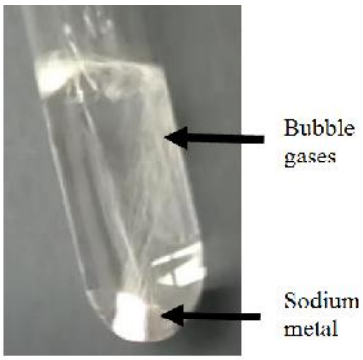


Figure 7. Macroscopic Reaction of Ethanol and Sodium Metal

Different with those reaction above, the students understand the esterification reaction which is the reaction of alcohol and corboxylic acid to form esther that known because of the specific smell of esther. So does with elemination reaction, the students can predict the product of the reaction and the mechanism of the reaction.

CONCLUSIONS

Most of students do not understand about some concepts of Alcohol such as solubility of alcohol, reaction of alcohol with Na, identification of primary, secondary and tertiary alcohols but almost all of them undestand naming and write the structure of alcohol.

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REFERENCES

[1] Brady, James E.. *Chemistry Mattes and Its Change5th Editon* (New York, John Wiley And Sons , 2009)
[2] Bettelheim, A Frederic, et all., *Laboratory Experiments for Introduction to Genereal, Organic, and Biochemistry. 7th Edition* (USA, Brooks/Cole, Cengage Learning, 2010)
[3] Bruice Y Paula, *Organic Chemistry 4th Edition* (Pearson Education, 2004)

[4] Carey, A Franchis, *Organic Chemistry 4th edition*. (USA, The McGraw-Hill Companies Inc, 2000)
[5] Chittleborough, Gail Diane, Contrains to the Development of First Year University Chemistry Student's Mental Models of Chemical Phenomena. *Teaching and Learning Forum. Focusing on the Student* (2002)
[6] Davis B Ron Jr, *Foundation of Organic Chemistry Course Guidbook*. (The Great Courses, Virginia, 2014)
[7] Jansoon.. Understanding Mental Models of Dilution in Thai Students. *International Journal of Inveromental & Sains Education*. Vol 4, No. 2, 147-168 (2009)
[8] Reid N., Working Memory and Science Education : Concusions and Implication, *Research in Science & Technological Education* Vol. 27 (2) : 245–250(2009)
[9] Sagala, Syaiful, *Konsep dan Makna Pembelajaran*. (Alfabeta, Bandung, 2011)
[10] Siegler, Robert S and Martha Wagner Alibali. *Childrens's Thinking*. Practice Hall Inc, New Jersey, 2005)
[11] (https://www.slideshare.net/caneman1/new-chm-152-unit-6-power-points-sp13) (https://www.slideshare.net/justine06/pl-alcohols-and-phenols)