# THE INFLUENCE OF MULTIPLE REPRESENTATION STRATEGIES TO IMPROVE THE MENTAL MODEL OF 10TH GRADE STUDENTS ON THE CONCEPT OF CHEMICAL BONDING

Sunyono Sunyono[1], Tasviri Efkar[2], Feni Munifatullah[3]
[1]Chemistry Education Study Program, Faculty of Teacher Training and Education, University of Lampung, Indonesia, e-mail: sunyono.1965@fkip.unila.ac.id.
[2]Chemistry Education Study Program, Faculty of Teacher Training and Education, University of Lampung, Indonesia, e-mail: tasviriefkar@yahoo.com.
[3]English Education Study Program, Faculty of Teacher Training and Education, University of Lampung, Indonesia, e-mail: fenimunifa@gmail.com.

## ABSTRACT

Student's mental models in this study was built through model-based learning with multiple representations. The samples in this study was conducted through random cluster sampling with the study subjects were taken from a high school student in Lampung Province. The selected number of samples as many as two classes of students grade 10 and students involved in this study as 76 peoples. Mental models of the students was measured through tests in the form of an essay. This test is a test of creative problem solving to look at the ability of the student's imagination. The results showed that (1) After learning by using multiple representations strategy, mental models abilities of students becomes higher, which is located at the level of intermediate-3; (2) Multiple representation strategies give a high influence to the improvement of the students' mental models to the concept of atomic structure. These findings indicate that learning by multiple representations strategy could been alternative strategy in the teaching of chemistry to solve problems creatively, particularly concepts related to the phenomenon of sub-microscopic, macroscopic and symbolic.

**Keywords:** Influence, Chemical Bonding, Mental Models, Multiple Representation

## INTRODUCTION

Some researchs (such as Coll, 2008; Strickland, et al., 2010; Davidowitz, et al., 2010) provide information that students have always had difficulty in giving explanations about the representation of sub-microscopic based on macroscopic and symbolic representations. Related to this, students tend to use symbolic transformation to the macroscopic level, but are not able to transform from a symbolic level to the macroscopic and sub-microscopic level. This is due to the knowledge gained and difficulty to access memory back or knowledge that is difficult to enter long-term memory (Woolfolk, 2008). The results of these studies have shown that many students have a very simple mental model of chemical phenomena, for example, models of atomic and molecular models are depicted as discrete and concrete structure, but does not have the skills to build mental models. Some studies have also suggested that both high school students, undergraduate, and graduate prefer the simple and realistic mental models (Coll, 2008; Strickland et al., 2010; Sunyono et al., 2015a).

Hsu (2014) revealed that to assist students in developing reasoning abilities required visual image, because it can evoke sensory involvement of students, and further enrich the experience by drawing, then the sensory participation in the body can provide a better learning experience. The pictures are examples of creative imagination that can help students in understanding the phenomenon of sub-micro. Sunyono et al (2015a) through sub-microscopic image visualization, students will be easier to build up their mental models. Mental model is a representation of the intrinsic (internal representation) of an object, idea, or processes produced by a person during the ongoing cognitive processes (Harrison and Treagust, 2000). According to Mumford et al. (2012) found students' mental models can be generated through mapping tasks conceptual map or model which is expressed through pictures structural model that describes the relationship between the concepts chosen by students in problems solving creatively.

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

Students' mental models reported in the literature is not consistent with the scientific models or learning should be, and not only considered defects, but also found to contain several misunderstandings (Vosniadou & Brewer, 1992). Therefore, the research reported in this paper seeks to provide a description to provide a profound insight into students' understanding of the chemical bond is expressed through their mental models. One step in addressing the problem, Sunyono (2015a) has conducted research by utilizing various representation based learning to foster the mental model of students with the concept of stoichiometry. The results of this study indicate that multiple representation strategies can improve students' imagination and stoichiometric mental models of students can be developed. Through multiple representation strategies, the imagination potential of the students can be optimized, thus spurring the increase in reasoning skills in interpreting chemical phenomena (Sunyono et al, 2015b). Learning that emphasizes imagination can help students in mental models and mental models can be improved from the unclear direction of "moderate" and "high (medium-3)" mental models (Sunyono et al., 2015a).

In this study, students' mental models categorized by level of understanding of the concept of chemical bonding. Wang (2007) categorize mental models into 3 (three), the ability of mental model "low," "moderate," and "high." Sunyono et al (2015a; 2015b) combine categorization of Wang (2007) and Park et al. ( 2009) by making the following classifications: (a) the initial mental models that are not shaped or unclear; (b) mental models of intermediate-1; (c) the mental model of intermediate-2; (d) the mental model of intermediate-3; and (e) mental model target is a mental model that is characterized by the concept / description and image structure created precisely learners in science.

This study was conducted to answer the question: (a) "whether the learning with multiple representations strategy is effective in improving students 'mental models?" (B) "how the characteristics of students' mental models in understanding the concept of the chemical bond?

## RESEARCH METHODS

### *Research Procedure*

The method used refers to the research conducted by Sunyono et al. (2015a). The subject of research involved is grade X high schools in the Province of Lampung on odd semester. Students involved as samples came from two high schools in Bandar Lampung Indonesia with the overall number of students as many as 76 people. All students are spread into two classes derived from State high school (SMAN) and private high school (SMAS). In both classes conducted learning with multiple representations strategy with learning syntax consists of four (4) phases, namely: orientation, exploration - imagination, internalization, and evaluation (Sunyono et al., 2015a).

### *Instruments and Data Analysis*

Measurement of mental model of student in this research is done through material test about essay matter as much as 5 item test. . Mental model which analyzed the mental model that emerged in response to the questions in the matter of the mental model tests for chemical bonds (Wang, 2007; Coll, 2008). Data obtained from tests of mental models were then analyzed by means transcribed and categorized, so that it can be identified students' mental models and the difficulties that are common when dealing with external representation of submicroscopic level. To categorize the emergence of mental models through the responses of the students do with the scoring system. Mechanical scoring is done by using a rubric, to determine the achievement of problems solving (Sunyono et al., 2015a). The level of achievement of resolving the issue further in categorized as a mental model "very bad" (score = 1), the "bad" (score = 2), "moderate" (score = 3), the "good" (score = 4 ), and "excellent" (score = 5). Based on the results of the scoring, then the mental models of students who appear characterized into five characters mental models (Sunyono et al., 2015a; Park et al., 2009), includes model is not clear, intermediate-1, intermediate-2, intermediet- 3, and the target. Analyses were also conducted to measure the effect (effect size) of learning with multiple representations strategy strategies to increase mental models (N-gain) through t-test and test of effect size. The confidence level used $\alpha$ = 0.05. Effect size is calculated by the formula proposed by AbuJahjouh (2014) and Dincer (2015).

## RESULTS OF THE RESEARCH

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

Results of the scoring of the answer (response) of test students on mental models were analyzed descriptively by comparing the mental models of students before and after learning. In this analysis, students are grouped based on the total score obtained, as Figure 1 and 2 below

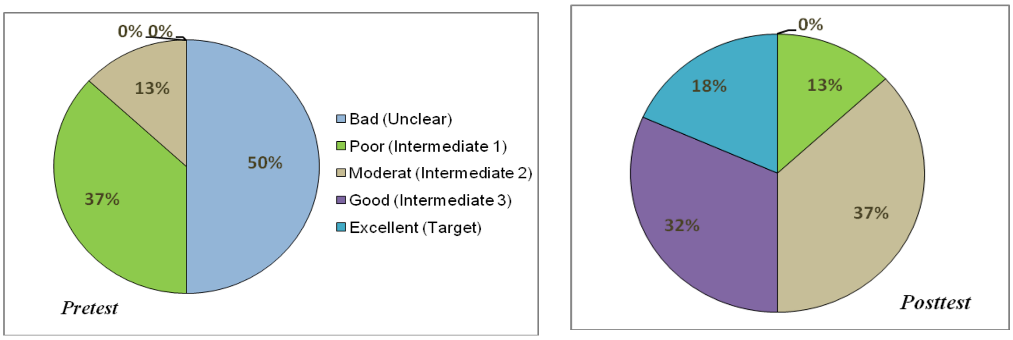



**Figure 1.** Percentage of categories with Mental Models Association of Chemistry Students Before and After learning (SMAN 7 Bandar Lampung).

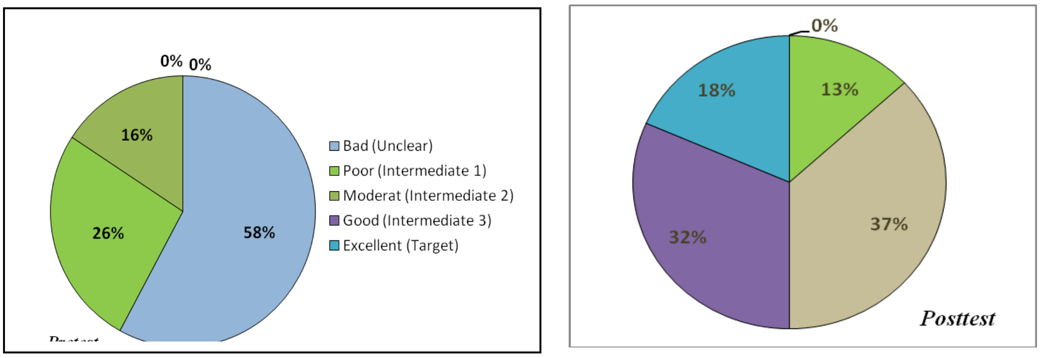



**Figure 2**. Percentage of Categories with Mental Models Association of Chemistry Students Before and After learning (SMA Gajah Mada).

Figures 1 and 2 show that the mental models of the students to the concept of chemical bonds after learning with multiple representations strategy experienced a significant improvement compared to prior learning. It appears that prior to learning by using multiple representations strategy , mental models students mostly in the category of "bad (not clear)" and "bad (intermediate-1)", but after the implementation of learning with multiple representations strategies, mental models students are mostly located in category of "good" or "intermediate-3" and partly in the category "excellent" or "target," although there is still categorized as "bad" or "intermediate-1" and the category "medium" or "intermediate-2".

This indicates a change in the mental models of students on the concept of chemical bonds of "bad" or mental models "unclear" and "bad" or "intermediate-1" improved to "good" or “intermediate-3" and "excellent"or "target". The results of this study indicate that learning by using multiple representations strategy is effective in improving students' mental models, so multiple representations strategy that has been developed can be used in further research.

The percentage of n-Gain students' mental models are shown in Figure 3, which shows that the average percentage of n-Gain mental models majority of students are in the categories of "moderate" (> 60.00%, and for the high category in the range of 15.00% - 40.00 %%. This means increased mental models of the students after the application of learning with multiple representations strategy is high enough. In addition, students with the knowledge capital chemistry taught in class X is still not

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

capable of performing the transformation of a macroscopic (the phenomenon of water and gas $NH_3$) to submicroscopic and symbolic phenomenon (the process of bond formation). The phenomenon of transformation is done through the imagination of the position of the electrons in the atoms of a molecule and then compose the image sub-micro about the formation of covalent bonds, explained the occurrence of bonding, explain differences in the molecular properties due to differences in bonding, and so forth.

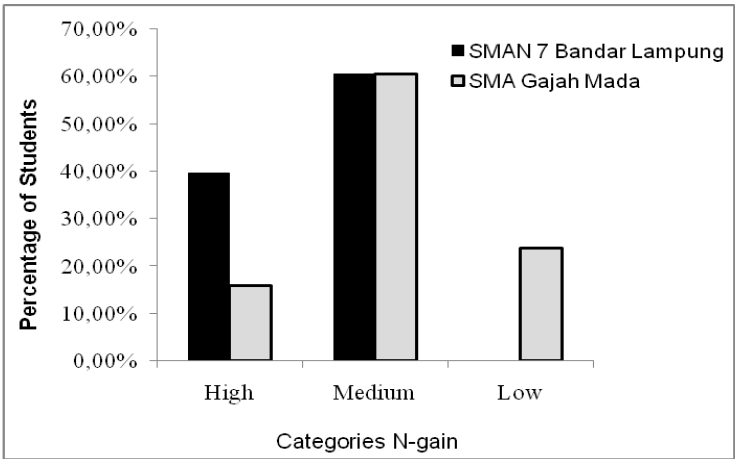



**Figure 3.** Percentage of Students vs N-Gain Mental Model Institute of Chemistry in Second Class X of Two Different High School.

Analysis of the effect size of the learning with multiple representations strategy against mental models are presented in Table 1 below.

**Table 1**. Effect Size Analysis

| School Name | Value t | df (n-1) | Effect Size (μ) | Criteria |
|---|---|---|---|---|
| Grade X SMAN 7 | 10,89 | 37 | 0,87 | Big |
| Grade X SMA Gajah Mada | 21.60 | 37 | 0.96 | Big |

The test results of effect size (Table 1) shows that learning with multiple representations strategy has the “big” effect to increase students' mental models, both in grade 10 SMAN 7 Bandar Lampung and in grade 10 SMA Gajah Mada Bandar Lampung. These results provide information that multiple representations strategy can be applied in the chemistry classroom teaching to cultivate students' mental models towards mental model of intermediate-3 (consensus) and the mental model of the target.

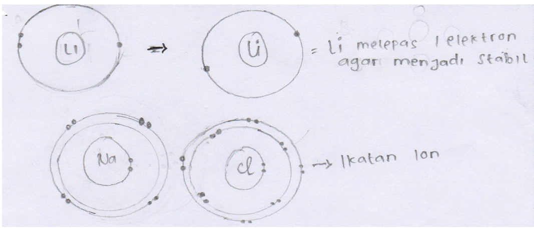
## DISCUSSION AND CONCLUSIONS

Based on the students' answers, it appears that the visual images that the students are still very simple and most (30% - 45%) seem unable to distinguish between the formation of ionic bonds, covalent and coordination bonds (example below). Difficulties students may be because students have not been involved with sub-microscopic phenomena in learning. This result seems to be consistent with the statement by some researchers that the understanding of chemical concepts does not involve rote verbal only, but also requires an understanding of the phenomenon of representation submicroscopic structure of molecules or atoms (Ben-Zvi, et al., 1987; Devetak & Glažar 2010 ; Guzel & Adadan, 2013).

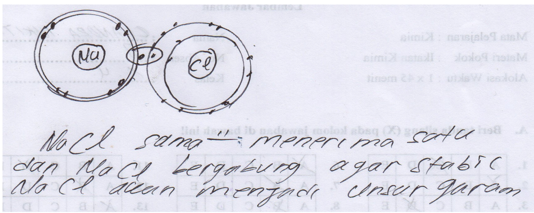
### *Mental Models on Ionic Bonding Concepts*

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

*Students A1*: Describes the process of forming ionic bonds of LiCl and NaCl, but it is unclear how the two atoms were able to bind the ionic form LiCl and NaCl. A1 According to the students that Li release one electron to be stable. Furthermore, students describe the use of the pair together at NaCl as an ionic bond. The students' answers is confusing, because it gives no explanation of where the electrons released by Li. Similarly, why Na and Cl can be joined to form an ionic bond.

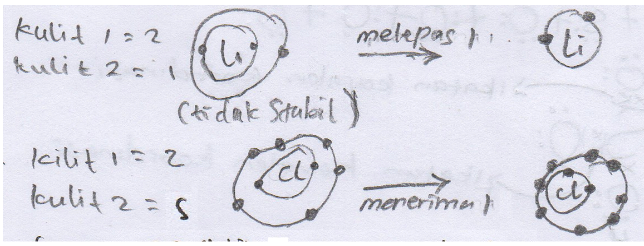



*Student B1*: Unable to distinguish between the process of the formation of ionic and covalent bonds, which mentions that the Na and Cl binds to equally accept electrons to form NaCl. Answer students and bring up the misconceptions about the formation of NaCl ionic bond.



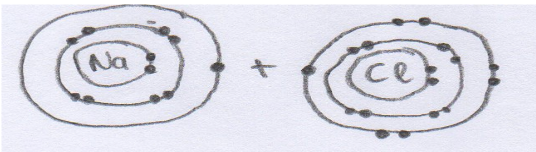

Seen that student A1 and B1 (for example) are students who have difficulty when dealing with the transformation from verbal to visual in describing the phenomenon of sub-microscopic. These findings are consistent with the findings of Wang (2007) that students with a score of medium and low mental models have difficulties in terms of visualization of electrons in an atom, so the difficulty in explaining the formation of bonds on the compound NaCl. Nevertheless, the majority (>75.00%) students had been able to properly perform the transformation from verbal to visual or otherwise in describing the phenomenon of sub-microscopic. The students' answers illustrate that the ability of the creative imagination can be improved in the reasoning of the macro phenomenon, sub-micro, and symbolic. With the ability of creative imagination the mental models that can be built student at the level of "medium (intermediate-2)" and "good (intermediate-3)" can even achieve mental model "of consensus" (Treagust, et al., 2003; Park , et al., 2009). Here are examples of student answers that illustrate the ability of mental models at intermediate level-3.

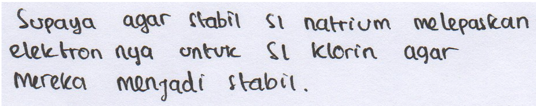
*Students A2*: Able to explain the stability of Li and Cl atoms is either through visual images. According to the students of A2 that Li release one electron and Cl accept one electron, so that it can form ionic bonds LiCl. Only students still use the term skin instead of the energy level, these errors can be corrected in the next lesson.

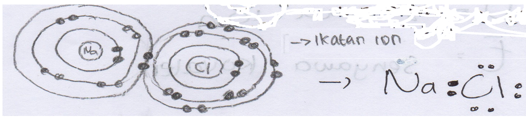



*Students B2*: Providing an explanation about the formation of the compound NaCl ionic bond. According to the students of B2, that sodium (Na) will release electrons that will be accepted by chlorine (Cl) so that they become stable in form ionic bonds NaCl.

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137




After learning, mental models like the students to the concept of ionic bonding electrostatic model is simple, some students describe as a model mixture and uses concepts from other models (such as students A1 and B1), giving rise to misconceptions. The results showed that the students see the chemical bonding occurs due to the attraction between atoms charged in achieving octet rule (stability). Students of A2 and B2, for example, says that the ionic bond is formed of a "tug of war between positive and negative charges" and it happens because the atoms that donate electrons and there is an atom that accepts electrons ". The results of the students' answers show that the students have been able to understand that bond chemistry occurs because it is driven by the octet rule. as students B2 say "chlorine needed one more electron to fulfill stability alone" another student said that the ionic bonds of NaCl occurs because "sodium prefer to have a positive charge and chlorine prefer to have one negative charge", it is a result of encouragement octet rule to achieve" the electron configuration of a noble gas”. However, they put more emphasis on the lattice structure by saying that “sodium chloride is a classic cubic structure in which each sodium ion is surrounded by six chlorine, as well as any chlorine ion surrounded by six sodium ions ".

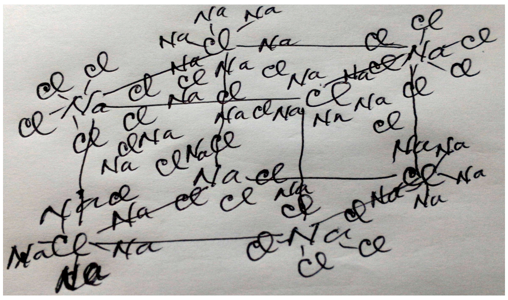


**Figure 4.** Structure of NaCl Created by Students.

These findings are consistent with the findings Coll (2008) that high school students prefer an actualization which looks simple from an ionic bond NaCl compared with an overview of the practitioners chemicals such as teachers depiction is more focused on the shape of balls to describe atomic Na and Cl).

***Mental Model in Covalent Bonds Concept***

Mental models like the students to the concept of a covalent bond is a model fulfillment octet rule, it is because the students have learned and practiced visualizing the atoms towards stability noble gas electron configuration. Relating this, the students have understood that covalent bonds occur as a result of the sharing of electrons between atoms, driven by the strength of the formation of a stable octet. For example bonding in the molecule of ammonia ($NH_3$) and water molecules ($H_2O$).

In the case of $NH_3$ molecules, students have the right to write the electron configuration of atoms N ($1s^2 2s^2 2p^3$) and H ($1s^1$). Through the configuration of the students have been able to transform the sub-microscopic to the symbolic by hybridization to form compounds $NH_3$, where N as the central atom by

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

atom binding 3 H form $sp^3$ hybrid orbitals, which is a merger between the orabital 2s by three 2p orbitals. Figure 5 is an example of the form of $NH_3$ molecules made by students.

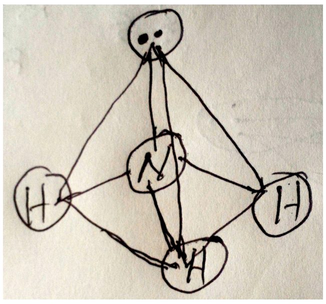



**Figure 5.** The molecular structure of $NH_3$ (example of the structure is made of students

These students' answer approach the scientific concept by the expert, in which case the molecule $NH_3$, hybridization of the nitrogen atom center in ammonia ($NH_3$) is $sp^3$, because it happened the proper mixing of the 2s orbital with the three 2p orbitals and provide a set of four orbital ($sp^3$) , hereinafter referred to as the new $sp^3$ hybrid orbitals (Ozmen, et al., 2009). The findings are also consistent with the findings of Coll (2008) that high school students prefer portrayals in more detail for the covalent bond (two hydrogen atoms bonded to the O atoms to form molecules of $H_2O$, and three H atoms bonded to one atom N to form $NH_3$).

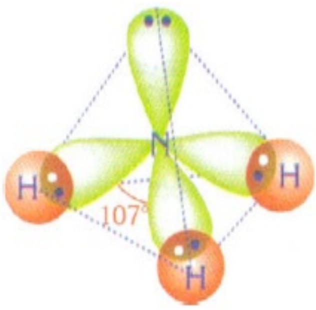



**Figure 6**. Shape $NH_3$ molecules with $sp^3$ hybridization (Ozmen, et al., 2009).

According to some literature sources (Silberberg, 2007; Ozmen, et al., 2009; Chang & Jason, 2011), under normal conditions, is expected to ammonia is a tetrahedral molecule; four pairs of electrons around the atom N in a tetrahedral geometry. Thus, H-N bond angles in ammonia should be close to the standard, i.e. 109,5$^o$ (ideal tetrahedral angle). However, the results of the experiment turns a corner bond H-N ammonia is slightly smaller than the ideal tetrahedral angle because of the repulsion between the lone pairs and pair bonding. This shows that there is repulsion between the lone pair of electrons and a pair of bond that is greater than the repulsion between the two couples bond. Therefore, one of the bonding electron pair on the nitrogen in ammonia encourage couples together more closely together and the bond angles H-N becomes 107,3$^o$ due to this repulsion.

Though some students are still confused with the bonding of molecular iodine, which appear simple view that a covalent bond at the molecular iodine ($I_2$) occurs involving the sharing of electrons, but the electrons are distributed is not clear articulated. On the other hand, they are easily able to discuss ties in chloroform and draw diagrams (visual image) showing the structure of the Lewis based octet rule. Coll (2008) in his study also found similar things.

The results showed that students from both schools (SMA) raises more simple or realistic mental models of the target system and the chemical bonds at the level of the intermediate-3. This indicates that the student has been able to demonstrate a number of mental models and illustrate the ability of the creative imagination more developed to model the target (ionic and covalent). In addition, students are also better able to be critical of a mental model, especially the model described and presented in Student worksheet . These findings indicate that the learning with multiple representations strategy able to raise the creative imagination of students by bringing up the mental model of a simple and

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

realistic with intermediate category-3. This was confirmed by the results of the analysis of the effect size that provides information that influence learning with multiple representations strategy to improving the mental models is quite high with a large effect size (AbuJahjouh, 2014; Dincer, 2015).

The findings in this study are consistent with other studies involving chemistry concepts that are abstract, such as the atomic structure, stoichiometry, and reaction mechanism. For example, a previous study found that learners prefer a realistic model of the atomic orbitals models in electron configuration (Harrison & Treagust, 2000; Sunyono et al., 2015b). Additional depth explanation of the mental models provided by the students, it seems no different from the findings Kleinman et al. (1987) that shows that students who are trained and learn through visualization sub-micro phenomenon will be able to increase the ability of abstraction and have more mental images as a result of the creative imagination.

Based on the research results and by reviewing other studies it can be concluded that (1) strategy based learning multiple representations effective in improving students' mental models problems solving of chemical bonding; (2) After learning to use with multiple representations strategy , mental models abilities of students in problems solving of chemical bonding becomes higher, and at the level of the intermediate-three, mental models are simple and realistic.

## RECOMMENDATION

Based on the findings of the study, the chemistry learning in school should be carried out taking into account the multiple representations. Such learning will be more able to improve thinking skills through the formation of students' mental models are high, because learning emphasis on exploration and imagination that is characterized by a collaborative, cooperative, and imaginative. Students 'mental models is one measure of students' abilities to solve chemical problems, so that the findings in this study can be used as a basis for considering the appropriate learning strategies to help students in solving chemistry issue.

The results of this study are limited to the formation of mental models on the concept of chemical bonds, and therefore still needs further research based instructional strategies associated with multiple representations of the concepts other chemicals, and for the parameters of high-level thinking skills to another.

## KNOWLEDGEMENT

Researchers would like to thank the Directorate of Research and Community Service, which has provided funding this research through Competitive Research Grant scheme Year 2015. Thanks also goes to the head writer and high school chemistry teachers in Lampung Indonesia that has helped smooth the study.

## REFERENCES

AbuJahjouh, Y.M., 2014. The Effectiveness of Blended E- Learning Forum in Planning for Science Instruction. *Journal of Turkish Science Education.* 11. No. 4, p. 3-16.

Ben-Zvi, R., Eylon B. and Silberstein, J., 1987, "Students' visualisation of a chemical reaction." *Educ. Chem.*, 24, p. 117-120.

Chang, R. & Jason O., 2011. *General Chemistry*. McGraw-Hill Companies, Inc. New York.

Coll, R.K., 2008. Chemistry Learners' Preferred Mental Models for Chemical Bonding. *Journal of Turkish Science Education*, 5, (1), p. 22 – 47.

Davidowitz, B., Chittleborough, G., and Murray, E., 2010. Student-generated submicro diagrams: a useful tool for teaching and learning chemical equations and stoichiometry. *Chem. Educ. Res. Pract.*, 11, p. 154–164.

Devetak, I. and Glažar, S.A. 2010. "The Influence of 16-year-old Students' Gender, Mental Abilities, and Motivation on their Reading and Drawing Submicrorepresentations Achievements." *International Journal of Science Education.* 32, No. 12. p. 1561–1593.

Dincer, S., 2015. Effects of Computer-Assisted Learning on Students' Achievements in Turkey: A Meta-Analysis. *Journal of Turkish Science Education.* 12. No. 1, p. 99-118

Franco, C., de Barros, H. L., Colinvaux, D., Krapas, S., Queiroz, G., & Alves, F. (1999). From Scientists' and Inventors' Minds to Some Scientific and Technological Products: Relationships

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137

between Theories, Models, Mental Models and Conceptions. *International Journal of Science Education*, 21(3), p. 277-291.

Guzel, B.Y. & Adadan, E., 2013. "Use of Multiple Representations in Developing Preservice Chemistry Teachers' Understanding of The Structure of Matter." *International Journal of Environmental & Science Education*. 8, No. 1. p. 109-130.

Harrison, A.G., and Treagust, D.F. (2000). Learning about atoms, Molecules, and Chemical Bonds: a Case Study of Multiple – Model Use in Grade 11 Chemistry. *Science Education.* 84, p. 352 – 381.

Hsu, L. (2014). Modelling Determinants for the Integration of Web 2.0 Technologies into Hospitality Education: A Taiwanese Case. *The Asia-Pacific Education Researcher*, 1-9.

Kleinman, R.W., Griffin, H.C., & Kerner, NK. (1987). Images in chemistry. *Journal of Chemical Education*, 64 (9), p. 766-770.

Mumford, M.D., Hester, K.S., Robledo, I.C., Peterson, D.R., Day, E.A., Hougen, D.F., & Barrett, J.D. (2012). Mental Models and Creative Problem-Solving: The Relationship of Objective and Subjective Model Attributes. *Creativity Research Journal*. 24 (4), p. 311-330.

Özmen, H., Hülya D., Gökhan D., 2009. The Effects of Conceptual Change Texts Accompanied with Animations on Overcoming 11th Grade Students' Alternative Conceptions of Chemical Bonding. *Computers & Education*. 52. p. 681–695.

Park, E.J., Light, G., Swarat, S., & Denise, D., 2009. "Understanding Learning Progression in Student Conceptualization of Atomic Structure by Variation Theory for Learing." Paper presented at the Learning Progressions in Science (LeaPS) Conference. June 2009. Iowa City, IA.

Silberberg, M., 2007. *Principles of General Chemistry*, 1st Ed. The McGraw-Hill Companies, Inc. New York.

Strickland, A.M., Kraftb, A., & Bhattacharyyac, G., 2010. What happens when representations fail to represent? Graduate students' mental models of organic chemistry diagrams. *Chem. Educ. Res. Pract.*, 11, p. 293–301.

Sunyono Sunyono, Yuanita, L., & Ibrahim, M. (2015a). Supporting Students in Learning with Multiple Representation to Improve Student Mental Models on Atomic Structure Concepts. *Science Education International.* 26 (2), p. 104-125.

Sunyono Sunyono, Yuanita, L., & Ibahim, M. (2015b). Mental Models of Students on Stoichiometry Concept in Learning by Method Based on Multiple Representation. *The Online Journal of New Horizons in Education,* 5 (2), p. 30 – 45.

Treagust, D. F., Chittleborough, G. D., & Mamiala, T., 2003. "The role of submicroscopic and symbolic representations in chemical explanations." *International Journal of Science Education.* 25, No. 11, p. 1353–1368.

Vosniadou, S., & Brewer, W. F. (1992). Mental Models of The Earth: A Study of Conceptual Change in Childhood. *Cognitive Psychology*, *24* (4), p. 535-585.

Wang, C.Y., 2007. The Role of Mental-Modeling Ability, Content Knowlwdge, and Mental Models in General Chemistry Students' Understanding about Molecular Polari. *Dissertation for the Doctor Degree of Philosophy in the Graduate School of the University of Missouri*. Columbia.

Submit Date: 01.09.2017, Acceptance Date: 15.11.2017, DOI NO: 10.7456/1070DSE/137