Conjecturing via Analogical Reasoning in Developing Scientific Approach in Junior High School Students

Supratman¹, S Ryane² and R Rustina³
Mathematics Education, Faculty of Education, State University Siliwangi Tasikmalaya, West Java, Indonesia
E-mail: ¹) supratman_id@yahoo.com, ²) siskayane@yahoo.co.id, ³) ratna.rustina@yahoo.com

Abstract. This study aims to explore the extent to which the use of analogy reasoning when students conduct conjecture in developing the scientific approach, so that the knowledge of the students can be used to build new knowledge. Analysis was conducted on student learning outcomes in Ciamis district. Based on these results, it was found the teacher not give an opportunity to the students to make conjecture on the students in problem solving as well as the construction of new knowledge. Moreover, teachers do not take advantage of analogical reasoning and scientific approach in constructing new knowledge.

1. Introduction
Math ability was based on the ability to make conjectures and convincing in solving the problem. As stated [1] that the mathematical competence of students can basically be divided into two types: conjecturing and convincing. Furthermore [2] said in expressing mathematical problem solving, there are three possibilities, namely through hunches, guesses, and conjectures. Importance conjecturing, also contained in the content standards is "to improve the ability to solve problems, develop the skills necessary to understand the problem, create mathematical models, settle of problem, and interpret the solution" [3]. In addition it is conjecture is essential to a learning community of students, as stated in [4], conjecturing as: "(1) empowers students by promoting a sense of ownership and investigation, (2) provide a means for students to construct knowledge of mathematical , (3) encourage opportunities for students to make connections".

According to [5] learning perspective today combines three important assumptions: (1) learning is the process of knowledge construction, not recording or absorption of knowledge, (2) learning is to build new knowledge based on the use of knowledge at this time, (3) learners aware of the processes of cognition, and learners can control and regulate cognition. In the process of learning in secondary schools oriented towards active student learning. One of the learning processes that involve students actively, those students are given the opportunity to make conjectures. That is, students in solving problems or construction of new knowledge based on knowledge that has been mastered. In the standards of evaluation [4] "conjecturing and demonstrating the logical validity of conjectures are the essence of the creative act of doing mathematics.

In approach learning of curriculum republic of Indonesia in 2013 includes the scientific approach. The scientific approach is one approach to learning that emphasizes the inductive reasoning of learners. As revealed by [6] analogy that is often used in problem solving and inductive reasoning, because analogies can capture a significant parallel in different situations. Outside of regular use, the analogy is a key mechanism in creativity and scientific discovery. Students conduct conjecture can be done through analogical reasoning.
Offender of conjecture solved problem via analogical reasoning, according [7] and [8] beginning with observing the cases on the basis of analogy and cases that exist on the target of analogy (new knowledge to be achieved) is expected. Searching for similarities between the cases on the basis of analogy and targets of analogy. Formulating a conjecture as problem solving based on the similarity of the cases on the basis of analogy and targets of analogy. Validating the conjecture, like “testing,” involves both making a prediction and verifying the correctness of that prediction by some independent method. This establishes the truth of the conjecture for a new specific case but not in general. Generalizing the conjecture involves a change in what [9] calls its “epistemic value”, from a possible conjecture to an accepted general rule. This is a change in what is believed about the statement. If one believes (as the child in the example did) that the Goldbach conjecture is true in general, then one has generalized it. If not, it remains a conjecture. Justifying the generalized conjecture involves giving reasons that explain the conjecture, perhaps with the intention of convincing another person that the generalization is justified. If it is necessary, one might create a mathematical proof as the justification that guarantees the truth of the conjecture. So far, no one has managed to justify the Goldbach conjecture.

This is one of the measures of student learning is active in mathematics, as stated in the basic competence SD/MI Curriculum 2013 [10] and [11]. Students must learn mathematics with understanding. Actively building new knowledge from experience and prior knowledge. There are some researchers who uncover the theory of active student learning in mathematics such as: [12], [13], and [14]. Countries that embrace the learning process of students actively in the learning of mathematics are: United States [4] and 11, Italy [15], Ukraine [16], Europe [17] and [18], in Indonesia contained in Regulation Minister of National Education No. 22 of 2006 Chapter II, article 3, paragraph b, and Curriculum 2013 [10].

Teachers sometimes forget that learners already have the basic knowledge that can be developed to build a new knowledge in the learner, by using a similar problem, the solution almost as though in terms that is not always exactly the same. Thus in learning, learners are given the widest opportunity to make conjecture on solving the problem to construct new knowledge of mathematics for himself. While [19] found the reasoning ability analogy classical elementary school teachers are not encouraging, this raises concerns authors: Elementary School Teacher does not lead learners to master the basic knowledge to the maximum to be developed further [3] and [10].

[20] found in solving the problem on the target analogy, there are four (4) conjecturing possibilities generated by the students. First conjecturing produced students true and the result saw the similarity between the problem and solving the problem on the basis of an analogy with the problem and solving the problem on the target analogy, followed by the use of the same concepts to solve problems on the base and the target analogy, that means really conjecturing through reasoning analogy. Both conjecturing generated false and the result saw the similarity between the problem and solving the problem on the basis of an analogy with the problem and solving the problem on the target analogy, followed by the use of the same concepts to solve problems on the base and the target analogy, but there are errors / mistakes when calculation, this is also the result conjecturing through analogical reasoning. The third result conjecturing correct but not based on seeing similarities between the cases on the basis of analogy and the target analogy, this means that the results of conjecturing not through a process of reasoning analogy, but it is possible the results of conjecturing through 4 (four) conjecturing others through: (a) empirical induction of a finite number of discrete cases, (b) conjecturing based on empirical induction from dynamic case, (c) conjecturing through abduction and (d) conjecturing on the basis of perception. Fourth conjecturing wrong result and not the result of comparing the two cases among the problems that exist on the basis of analogy and the problems that exist on the target analogy, this means that the results of conjecturing not through analogical reasoning. In addition [21] found conjecturing via analogy reasoning can develop higher-level thinking.

Particularly worrying in the case of learning reasoning apparent (pseudo) on the students, so there is no learning is expected but only a transfer of knowledge without any meaning at all, as found
by [22] the occurrence of errors in constructing new knowledge due to imperfections and mismatches using students' cognitive structure with structural problems in the assimilation and accommodation.

2. Literature Review

2.1 Conjecturing

Understanding conduct conjecture by some experts [2], [23], [24], [25]; [26]. [2] explains that conjecturing is sensible reasoning. [23] argues that in mathematics, conjecturing is a proposition which appear yet to be proven correct. [24] argues, "conjecture" is: an expression of mental activity to solve the problem based on the knowledge that has been previously owned while the truth needs to be proven. [25] argues, conjecturing is tested according to the statement of reasons is acceptable. [26] argues, conjecturing is a statement which appears reasonable, but the truth that has not been set. Based on some of these opinions can be concluded, that the conjecturing as an expression of mental activity make conjecture in solving problems believed to be true by the students based on concepts that have been owned.

Examples conjecturing in mathematics was done by experts include Euler [2] do conjecturing about: $1 + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \ldots + \frac{1}{n^2} + \ldots$, conjecturingnya result is equal to $\frac{\pi^2}{6}$ and turns conjecturing of Euler true. Unlike the case with conjecturing Fermat [2] to search for prime numbers: 5, 17, 257, 65537, ... and conjecturingnya form of formula primes $2^{2^n} + 1$, with values $n \geq 1$. However, conjecturing of Fermat is not generally accepted as found by Euler for $n = 5$ is not applicable because the results can be shared $641^2$. Unlike the Goldback performing tests conjecturing of Fermat and it turns out that $2^{2^n} + 1$ holds for $n = 30$ and $2n = 60$. Euler and Fermat had done conjecturing, although conjecturing of Fermat is not generally accepted, but only valid for $n = 1,2,3$, and 4 and n only. Euler has convinced conjecturingnya so that others can use the results of generalizations. Thus, Euler has fulfilled expression of [1] basically mathematical competence includes two (2) things that do conjecturing and convincing.

Truth conjecturing result, need to be proven [2] and [27]. [2] explains, the truth conjecturing seen after proving although initially people were not sure with the conjecturing. [27] argues, conjecturing done to solve a problem, then to conjecturing results corroborate the truth needs to be done further verification. Thus, after the students do conjecturing, then the student conjecturing results should be verified.

There is a fundamental difference in the understanding conjecturing in pure mathematics and in mathematics. Conjecturing on pure mathematics is intended to construct a way / statement / new principle, which has not found someone else / not at all. While the study of mathematics, conjecturing intended to construct new knowledge for students, as stated by [28]. Examples conjecturing on learning mathematics: students conduct conjecture by analogy reasoning in constructing the interior angles amount hexagons. Presented a problem such as a triangle: $180^\circ$: tetrahedron: $\cdots$, A:B relationship is a relationship geometry with a number of angles in the interior surface of the first surface $180^\circ$, while the tetrahedron there are four triangular surfaces. Thus students are able to construct knowledge in the form of a triangle has 3 angles, 3 sides, and one face while the tetrahedron has four vertices, four sides, and four surface, so that the students know that the sum of the interior angles requested was $720^\circ$. Location of conjecturing through analogy reasoning on one face is $180^\circ$ then 4 face are: $4 \times 180^\circ$. Students did conjecturing corners and sides, but determining the surface conjecturing as a triangle on the field, while the tetrahedron in space. The new knowledge obtained is the sum of the interior angles of a tetrahedron surfaces is: $720^\circ$.

According [29], there are 5 types of conjecturing based on how conjecturing was obtained, namely (1) conjecturing based empirical induction from a finite number of discrete cases, (2) conjecturing based empirical induction from dynamic cases, (3) conjecturing by analogy, (4) conjecturing based abduction, and (5) conjecturing on the basis of perception. Subsequently explained about the types of conjecturing as follows:
Type 1: Empirical Induction from a Finite Number of Discrete Cases. A conjecture can be made based on the observation of a finite number of discrete cases, in which a consistent pattern is observed. This type of conjecture is frequently found in problems involving numbers. In some situations, but not all, the conjecture can be proved by mathematical induction once the general rule has been found.

Type 2: Empirical Induction from Dynamic Cases. A conjecture can be made of a general rule that describes the nature of a set of dynamically related events. The basis for the conjecture is an apparently infinite number of continuous events, which are, however, only a subset of the infinite number of possible events accounted for by the conjectured general rule.

Type 3: Analogy. A conjecture can be made by analogy to something already known fact. A general rule can be conjectured on the basis of another known general rule, or a specific fact conjectured on the basis of another known fact.

Type 4: Abduction. A conjecture can be made of a general rule that would explain an otherwise inexplicable event. This is one of Peirce’s meanings of abduction (see Reid, 2003). In this type a general rule is conjectured on the basis of a single case, example or event.

Type 5: Perceptually Based Conjecturing. A conjecture can be made from a visual representation of a problem or a perceptual translation of its statement. The basis of this type of conjecturing is a careful representation of the content of the problem either concretely or as a mental image. There is not an immediate attention to the relationships existing between the problem’s elements because instead the initial focus is on creating a new representation of the problem.

2.2 Analogical Reasoning

The thought process is ongoing and according to the hierarchy of thought. According to [30] thinks is divided into four categories, which are (1) recall (recall), (2) basic thinking, (3) critical thinking, and (4) creative thinking and reasoning are part of the process think. The thinking that is included in the reasoning is: basic thinking, critical thinking, and creative thinking.

[2] explains, the analogy is a kind of similarity. It is, to say the similarities at a deeper level and definitely more conceptual, but can be expressed a little more accurate. According [31], a general sense the analogy is a basic human ability to reason with relational patterns. Humans are able to detect a pattern to identify recurring patterns in the face of the various elements, to the abstract of the pattern, and to communicate abstractions. Literally the definition of analogy as similarity [31]; [33]; [34]; and [35]. Further [31] explains the similarities involving overall compatibility at all levels. According to this view, which fits within the structure of a relational rather than match the attributes of an object, even in the assessment of the similarity in their entirety.

Analogy occurs when there are two interrelated events in the formation, which is used as the basis for the first occurrence of subsequent events on the basis of the similarity in the use of propositions (proposition / formulas), predicate, and object [36]. Furthermore, [36] said mapping analogy can be seen as the process of finding the correspondence between the elements of the existing structure on the basis of analogy and the target analogy. In proportional representation, the elements will include a proposition, predicate, and object. [37] and [38] "analogies can help students learn new information by Relating it to concepts they already know", while according to Reed [39], the analogy requires that solves problems using a solution from the same problem to solve current problems. [40] states that the analogy is to use a solution before the problem to solve new problems. [24] explains, the analogy is a very rich source models. Two bodies, two said the system analogies if, on the basis of certain partial similarity. One feels entitled to assume that each entity is the same in other respects as well. [40] explains, the analogy is central in the study of learning and discovery, as well as analogies allow the transfer of the whole concept, situation or a different domain, and is used to describe a new topic.

[42] suggested the analogy reasoning is the kind of reasoning that applies between specific cases, one case is known about used to infer new information about other new cases. [43] argues, reasoning analogy is a reasoning in which decisions about one thing or event that concluded based on the similarity of objects, including things or events other events are known. [36] argues, the core of the
reasoning analogy lies in the mapping process: establishing a regular correspondence between the elements of the source (basic) analogy and elements of the target analogy. [44] states, analogous reasoning presupposes knowledge transfer from known situation (source analogy / basic analogy) to the new situation on the target analogy with the aim of increasing understanding of the latter. Based on the above, it can be concluded that the analogy reasoning is a cognitive process associated with the development of representational ability, understand, and operate on the basis of similarity in the structure of the corresponding object, the surface features are not always the same.

Furthermore, [45] said, reasoning analogy consists of classical analogy, analogy problem, and the analogy pedagogy. The explanation classical analogy, analogy problems, and pedagogy analogy is as follows: (1) classical analogies or conventional is the analogy takes the form A:B∷C:D (e.g. 3:9∷2:⋯, becomes: 3:9∷2:6), with the proviso C and D it is to be connected in the same way as relationship A and B. In this case 3 to 9 were multiplied by 3 then to fill in the blanks (⋯), 2 multiplied by 3 to 6. that's one example of a simple analogy. The ability to connect the pair to pair C:D, A:B involve higher relationship. (2) Analogy problem to overcome the ability of reason by analogy in problem solving. In this study, the student must recognize the similarities in the relational structure between the known problems (called base/source/ basic analogy) and new problems (target of analogy). That is a "structural alignment" or "mapping" between the two issues must be found. In this case, the students in solving new problems should be based on solving problems that have been solved before. (3) The analogy pedagogical "is the instructional analogies have long been used in mathematics and science education. Analogies pedagogy is designed to give a concrete representation of an abstract idea. That is, the analogy is a real source students can build a mental representation of an abstract idea or process that delivered.

2.3 Scientific Approach

[10] learning process using a scientific approach is the combination of the learning process which originally focused on the exploration, elaboration and confirmation comes by observing, to question, to reason, to try and communicate. Scientific method was first introduced to American science education in the late 19th century [46] and [47] as a formalistic emphasis on laboratory methods that lead to scientific facts. In addition, [48] expresses this method allows teachers or curriculum developers to improve the learning process, namely by breaking the process into steps or stages in detail which contains instructions to the students carry out learning activities. It is the basis of curriculum development in 2013 in Indonesia.

Scientific or more general approach is said to be a scientific approach is an approach in the curriculum of 2013. In accordance with Standard Competency, learning objectives include developing realm of attitudes, knowledge, and skills elaborated for each educational unit. The third domain of these competencies have a trajectory acquisition (the psychology) are different. Attitude obtained through the activity of "receiving, running, cherish, appreciate and practice". [10] The knowledge gained through the activity "remembers, understand, apply, analyze, evaluate, and create". The skills acquired through the activity of "observe, ask, try, reasoning, serving, and creating ". Characteristics competence acquisition along the path difference participated affect the characteristics of standard processes. Scientific approach to learning referred covering observe, to question, to reason, to try, to form a network for all subjects.

To strengthen the scientific approach is necessary for the reasoning and critical thinking of students in the context of the search (discovery). In order to be called scientific, the search method (method of inquiry) should be based on evidence of the object observable, empirical and measurable principles specific reasoning. Because of the scientific method is generally includes a series of data collection activities or facts through observation and experimentation, and then formulate and test hypotheses. [10] Exactly what is discussed with reference to the scientific method: (1) the fact, (2) the nature of prejudice-free, (3) the nature of the objective, and (4) for analysis. With the scientific method as it is expected we will have the nature of love in the truth that is objective, not easy to believe in things that are not rational, curious, is not easy to create prejudice, always optimistic.
Furthermore, in a simple scientific approach is a means or mechanism to gain knowledge of the procedure based on a scientific method. [10], the learning process should be spared from the properties or non-scientific values. Shall include non-scientific approach based solely on intuition, common sense, prejudices, discovery through trial and error, and critical thinking. Furthermore, [10] changes the learning process (of the students were told a student to find out) and the assessment process (of output-based to one based on process and output). Assessment of learning process using authentic assessment approach (authentic assessment) that assesses student readiness, processes, and learning outcomes as a whole.

2.4 Research Methods
This research is a quantitative-qualitative, because the data will be collected and used is the data of the numbers of observations and experiments and verbal data. Research conducted in junior in Ciamis district. The reason is taken Junior High School in Ciamis District are expected to know the extent to which the implementation of government programs in the execution of the curriculum in 2013, and achievement of students. Instruments in this study were researchers as an instrument, which is guided by the assignment sheet instruments and perfected with the interview. As revealed [49] the reason researchers as an instrument, because the researcher as manager of research as well as one of the instruments in the collection of data that cannot be replaced by other instruments. The following are the instruments used in this study.

- Are the teachers had received training related to the use of reasoning student learning?
- Have teachers utilize reasoning in the learning process?
- Is there school textbook supports scientific approach?
- Is the teacher giving students the chance to do a prediction?
- Are teachers to motivate students to do conjecturing in problem solving and in constructing new knowledge?
- Are students already take advantage of prior knowledge to develop new knowledge?
- Does the teacher have to motivate students to construct knowledge independently?

3. Results
From the observations, censuses, interviews as well as the reality has obtained several findings blessings with questions to the teacher researchers including the following. The results of surveys and observations and look directly in the field:

- The teachers have not received training related to the use of reasoning student learning.
- Teachers do not use the reasoning of students in the learning process.
- Existing school textbooks still use the curriculum in 2006.
- There are several teachers provide an opportunity for students to perform estimation, but the allotted time is very limited.
- Teachers do not motivate students to do conjecturing in problem solving and in constructing new knowledge.
- Students already take advantage of prior knowledge to develop new knowledge, but teachers can not wait to deliver the material.
- Teachers do not motivate students to construct knowledge independently, but teachers impart knowledge to the students directly

It was shown in the interesting findings, including the following.
Student 1: is this circle (he pointed to a circle whose diameter) has an area of pie and segments of circles?
Teacher 1: this circle does not have pie and segments of circles, so it does not have extensive pie and earthenware.

Student 2: in finding the line for an obtuse angle (which meant students were: outside $\angle$ RPQ), Are the same way by looking for the line to the acute angle ($\angle$ RPQ the arc MN? 

Teacher 2: The confusion arises from the teachers, although in the end the teacher said the same, by making a bowstring from outside $\angle$ RPQ

Teacher 3: solve the following arithmetic operations $\left(3 \frac{2}{3} \times 1 \frac{1}{2}\right) \times \left(2 \frac{1}{2} \times 1 \frac{1}{3}\right)!

Student 3: not able to finish

4. Discussion
Teachers are not ready with the curriculum in 2013, is shown by the learning that is still dominated by the teacher. so that:
- Students only receive knowledge owned and controlled by the teacher.
- Students are not given the opportunity to develop cognitive already owned to construct new knowledge.
- Students do not realize cognitive development, because it does not use reasoning.
- Students are not motivated to develop the knowledge already possessed as a basis, to solve a problem or to construct new knowledge.
- students only learn problem-solving procedures, not directed to find solutions masala with procedures based on the knowledge already possessed.

References
[1] Stacey, K, Mason, J and Burton. L. 2010, Thinking Mathematically Pearson Education Limited 2010, Second edition published.
[2] Polya, G. 1954. Mathematics and plausible reasoning; volume 1. Princeton: Princeton University Press.
[3] BSNP (National Education Standards Agency). 2006. Content Standard for Primary and Secondary Education. Regulation of the Minister of National Education of the Republic of Indonesia no. 22, 2006, Jakarta.
[4] NCTM (National Council of Teacher of Mathematics). 1989. Principle and standards for the school mathematics. RestonVA; NCTM
[5] Anthony, G. 1996. Active learning in a constructivist framework. Educational Studies in Mathematic, 31, p.349-369
[6] Wilson, R.A. and Keil, F.C.(Eds) 1999. The MIT Encyclopedia of The Cognitive Sciences. Cambridge, MA: MIT Press.
[7] Canadas, M. C. 2002. Razonamiento inductivo puesto de manifiesto por alumnos de secundaria. Granada: Universidad de Granada.
[8] Canadas, M. C. & Castro, E. (2005). A proposal of categorisation for analysing inductive reasoning. In M. Bosch (Ed.), Proceedings of the CERME 4 International Conference (pp. 401-408). Sant Feliu de Guixols, Spain. Published online at http://ermeweb.free.fr/CERME4/
[9] Duval, R. 1990. Pour une approche cognitive de l’argumentation. Annales de Didactique et de Sciences Cognitives, 3, 195-221
[10] Regulation of the Minister of Education and Culture of the Republic of Indonesia. 2013. Enclosure Regulation the Minister of National Education and Culture of the Republic of
Indonesia number 65 of 2013 About the standard process of Elementary and Secondary Education

[11] NCTM (National Council of Teacher of Mathematics). 2000. *Principle and standards for the school mathematics*, Reston VA; NCTM

[12] Hiebert, J. 1992. Reflection and communication: Cognitive considerations in school mathematics reform. *International Journal of Educational Research*, 17, 439-456.

[13] Wang, M.C., Haertel, G. D. and Walberg, H. J. 1993. Toward a knowledge base for school learning. *Review of Educational Research*, 63, 249-294.

[14] Yevdokimov, O. 2005. About A Constructivist Approach for Stimulating Stu-dents' Thinking to Produce Conjectures and Their Proving in Active Learning Of Geometry, Kharkov State Pedagogical University, Ukraine, *Proceedings of CERME 4*

[15] MIUR (Ministero dell'Istruzione, dell'Università e della Ricerca / Italian Ministry of Education, University and Research), 2004. *New mathematical standards for the school from 5 through 18 years*. MIUR.

[16] UMES (Ukrainian Ministry of Education and Science). 2003. *Programmes for Schools. Mathematics*. Kiev, UMES.

[17] CERME (Congress European society For Research In Mathematics Education). 2005. *Proceedings of CERME 4* Working Group 4. Argumentation and Proof.

[18] CERME (Congress European society For Research In Mathematics Education 6). 2009. *Proceedings of CERME 6* Working Group 5 Geometrical Thinking. Francis.

[19] Supratman. 2012. Analogy Reasoning Classical Elementary School Teachers of Mathematics, *Proceedings of the National Conference of Mathematics XVI*, Bandung, p.1081-1088.

[20] Supratman. 2013a. Conjecturing Via Analogical Reasoning to Explore Creative Thinking, *Proceeding The 14th International Conference on Education Research*, Seoul Korea, p. 271-292

[21] Supratman. 2013b. Piaget’s Theory in the Development of Creative Thinking, *Journal Korean Society Mathematical Education, Serie D, Res. Math. Educ. Vol. 17, No. 4*, December 2013, p.291-307.

[22] Subanji and Supratman. 2015. The Pseudo-Covariational Reasoning Thought Processes in Constructing Graph Function of Reversible Event Dynamics Based on Assimilation and Accommodation Frameworks. *J. Korean Soc. Math. Educ., Ser. D, Res. Math. Educ. Vol. 19*, No. 1, March 2015, 55–73

[23] Schwartz J.L. 1995. Shuttling Between the Particular and the General: Reflec-tions on the Role of Conjecture and Hypothesis in the Generation of Knowledge in Science and Mathematics, *Software Goes To School: Teaching For Understanding With New Technologies*. Oxford: Oxford University Press, Inc.

[24] Fischbein E. 2002. *Intuition in science and Mathematics*. New York: Kluwer Academic Publisher

[25] Popper, K. R. 1979 *Objective knowledge: an evolutionary approach*. Oxford: Oxford University Press.

[26] Mason, J., L. Burton dan K. Stacey, 2010. *Thinking Matematically*, Printed And Bound In Great Britain By Henny Ling Ltd Dorchester Dorset.

[27] Lakatos, I, 1976. *Proofs and refutations: The Logic of Mathematical discovery*, New York Cambridge University Press.

[28] Lee, K.H. & Sriraman, B. 2010. Conjecturing via reconceived classical analogy. *Educational Studies in Mathematics*, 76 . 123-144.

[29] Canadas, M. C., Deulofeu, J., Figueiras, L., Reid, D., & Yevdokimov, A. 2007. The conjecturing process: Perspectives in theory and implications in practice. *Journal of Teaching and Learning*, 5 (1), 55–72.

[30] Krulik, S., Rudnick, J. & Milou, E. 2003. *Teaching Mathematics in Middle School*. Boston, MA: Allin and Bacon.
[31] Gentner, D., Holyoak, K. J., & Kokinov, B. (Eds.). 2001. *The analogical mind: Perspectives from cognitive science*. Cambridge, MA: MIT Press.

[32] Gentner, D., & Markman, A. B. 1995. Similarity is like analogy: Structural alignment in comparison. In C. Cacciari (Ed.), *Similarity in language, thought and perception* (pp. 111-147). Brussels: BREPOLS.

[33] Goldstone, R. L. (1994) Similarity, interactive activation, and mapping. *Journal of Experimental Psychology: Learning Memory and Cognition*. 20. 3-28

[34] Markman, A. B., and Gentner, D. 2000. Structure-mapping in the comparison process. *American Journal of Psychology, 113*. 501-538.

[35] Medin, D. L., Goldstone, R. L., & Gentner, D. 1993. Respects for similarity. *Psychological Review, 100*(2), 254-278.

[36] Holyoak, K. J dan Thagard, P. 1989. Analogue Mapping by Constraint Satisfaction, *Cognitive Science* 13, 295-355

[37] Bulgren, J., Deshler, D., Schumaker, J., & Lenz, B. 2000. The use and effectiveness of analogical instruction in diverse secondary content classrooms. *Journal of Educational Psychology, 92*(3), 426-441.

[38] McDaniel, M. A., & Dannelly, C. M. 1996. Learning with analogy and elaborative interrogation. *Journal of Educational Psychology*, 88(3), 508-519.

[39] Tussyani, A. 2011. *Cognition Theory and Applications*, Salemba Humanika Jakarta.

[40] Matlin, M W. 1994 *Cognition*, Holt, Rinehart and Winsthon, Inc Florida. third edition.

[41] Gentner D. 1999. *Analogue Reasoning, Psychology of*, Intermediate article Northwestern University, Evanston, Illinois, USA.106-112.

[42] Gentner D., 1983. Structure-mapping : a theoretical framework for analogy. *Cognitive Science* 7(2) : 155-170.

[43] Matsumoto, D, Yoo, S.H., dan Fontaine, J., 2008. Mapping Expressive Differences Around the World: The Relationship Between Emotional Display Rules and Individualism Versus Collectivism. *Journal of Cross-Cultural Psychology* vol.39 no. 1. 55-74.

[44] Trench M, Oberholzer N, & Minervino R. 2002. Dissolving The Analogical Paradox: Retrieval Under A Production Paradigm Is Highly Constrained By Superficial Similarity, *Proceedings of the 2nd International Analogy*.

[45] English LD. 2004. *Mathematical and analogue Reasoning of Young Learners*. New Jersey London Lawrence Erlbaum Associates Publisher Mahwah.

[46] Hudson, D. 1996 Laboratory work scientific method: Three decades of confusion and distortion. *Journal of Curriculum Studies, 28* (2) 115-135

[47] Rudolp, J.L. 2005. Epistemology for the masses: The origins of the scientific method in American school. *History of Education Quarterly, 45*. 341-376.

[48] Varelas, M and Ford M. 2009. The Scientific Method Snf Scientific inquiry: Tension In Teaching And Learning. USA: Wiley Inter Science.

[49] Yin, R. K. 2014. *Case Study Research, Design and Methods*. Thousand Oaks, CA: Sage Publications.