# THE INFLUENCE OF PROBLEM BASED LEARNING TO STUDENTS' COGNITIVE STYLE DYNAMIC ON ACID-BASE SOLUTION CONCEPT IN SENIOR HIGH SCHOOL

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**Abstract**

The activitiy of students and teachers are specific individual behaviors, each of which is called learning styles and teaching styles, which describe the personality styles of the individual concerned. However, most of the learning process in class are still held by the assumption that each learner is identical. Almost ignoring the uniqueness of each students' learning style. Problem Based Learning is starting point of the process of learning based on real-life problems. These problems stimulated students to study the problem based on the knowledge and experience they have had previously (prior knowledge), so that prior knowledge of these will form the knowledge and new experience. This paper is a mixed method experiment, a pre-experimental design: the one group pre-test-post test experimental design with embedded design with 30 natural science students in Senior High School, SMA Negeri 3 Jambi. Cognitive Style's has been obtained such as Analytic-Imagery, Analytic-Bimodal, Wholist-Imagery, Analytic-Verbalizer, Intermediate-Imagery, and Intermediate-Bimodal showed difference the cognitive style's dynamic of students before and after intervention by using Cognitive Style Questionnaire for measure cognitive vulnerability and Problem Based Learning. Both has increased the chemistry learning's outcome from 55,33% to 78.76%. The various dynamic is due to the high school adolescent students began to show that things become the focus of the ability to think hypothetically, counterfactual, and imaginative of adolescents although it was not easy to predict exactly when cognitive style that could change in intervention.

Keywords: Problem Based Learning, Cognitive Style, Cognitive Style's Dynamic

## Introduction

One of the efforts to improve the quality of education quality is to improve the quality of learning for each learner. If students are more active learning, the quality of its human resources will also increase. However, one thing that should be noted, that we can not force others to learn by imitating our learning styles. Let others learn by his own style, as long as their learning style can be used to understand the material being studied. Furthermore, Uno (2008) described some students prefer their teachers who teach the way to write everything on the board. That way they can read and then try to understand it. However, most of the other students prefer their teachers to teach the way to do it verbally and they listen to can understand it. Meanwhile, there are students who prefer to form small groups to discuss questions related to the lesson. Such conditions as the cause of the lower quality and quantity of learning. During the learning process of students who are learning and teachers who teach. This learning process is no oriented students, some are centered on the teachers. Students' learning activities and teaching activities of the individual learner is a specific behavior, each called a learning style and teaching style, which describes the personality styles of the individual concerned. However, most of the learning process in the classroom is still held by the assumption that each learner was identical. That is, the learners in the learning process barely care about the uniqueness of each learner's learning style. There are still a lot of learning practices that lack of looking to the characteristics of the students.

Learning activities look as only complete the programs contained in the curriculum. Correct understanding of the concept is the foundation that allows the formation of a correct understanding of other concepts related or more complex concepts, facts, laws, principles and theories in science. Especially when one considers that one of the characteristics of the concept of science is the interdependence and evolve from a simple concept into a more complex concept (Middlecamp and Kean, 1989; Sastrawijaya, 1988). Understanding a concept that does not really allow the formation of other concepts related not true anyway. In science learning, factors affecting learning outcomes of cognitive science is the style (cognitive style) owned by each student. Raven (Yunos, 2007) explains that "learning should be designed so that it can accommodate differences in learning styles". Reflect the individual's cognitive style in the learning process (Lin and Chen, 2008).

According to the data collecting of students' learning outcomes in academic year 2010/2011, for an average value of cognition in a solution of acid-base concept in grade 11 natural science in Senior High School, SMA Negeri 3 Jambi, is about 75 (including remedial programs), whereas can be estimated more than 75 for subjects of chemistry. Students always have difficulty in understanding the concept of acid-base solution. Students are still less accurate in analyzing the pH of acid and base based on the color change of the indicator solution. Most students are interested in the discussion of the calculation of pH rather than theoretical concepts,

but still less accurate in the calculation of the pH of a solution of some kind.

The lower of student learning outcomes is influenced by various factors such as lack of motivation that have been given to the student, the student inaccuracy in answering any questions about the acid-base solution, both theoretically and pH calculations need skills in understanding the concepts of acid-base solution and determination of the measuring the pH of solution based on the color change of the indicator. PBL (Problem Based Learning) is the starting point of the learning process of learning based on real-life problems in the past on this issue stimulated students to study the problem is based on the knowledge and experience they have had before (prior knowledge) so that prior knowledge of this will form the knowledge and experience The new. Cognitive processes that occur in the processing of information of each individual is different so that differences in proficiency level of each individual show the characteristics in perceiving, thinking and remembering, and problem solving (cognitive style). Cognitive style in which individuals tend to organize and structure information is known as cognitive style type Wholist-Analytic, Cognitive Style of students while explaining the individual modes of representing information in memory is known as the Cognitive Style type Verbal -Imagery. In order to improve the quality of learning, the researchers in the field of learning and the learning designer needs to make students and cultural characteristics as a basis in developing the principles and programs of learning through the dynamics of cognitive style, how is the direction of change in cognitive styles of students from early learning to the changes that occur during the learning process and the learning.

## METHOD

### Research Design

This reseach used mixed method, embedded design, pre-experimental design: the one group pre-test-post-test. (Creswell, John,2007)
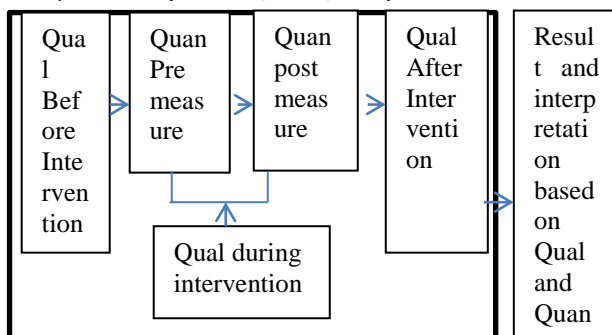


Figure 1. Embedded Design: Embedded Experimental Model

### Participants

30 natural science students grade 11 of Senior High School, SMA Negeri 3 Jambi has contributed in this project, only used one class, selected by the homogeneous characteristic of skill, both in terms of study habits, interaction with peers, and how the responses of others and between genders.

### Data Collection Instruments

In an effort to collect data, were used Cognitive Style Questionnaire as main instrument for observing the condition and dynamic of student's cognitive style, the scientific approach were represented by Problem Solving Skill Questionnaire and Scientific Attitude Questionnaire. For supporting analysis data, test and interview were used too.

### Procedure

Mix design procedure is different from the data collected at the design level with the type of data inserted in a methodology, framed by other data types. At the stage of **Qual Before Intervention**, conducted through a questionnaire measuring to gathering the beginning cognitive style to see the profile of students, then proceed to the stage of **Quan Pre-Measure** (Pre-test). During the implementation of intervention **(Qual during intervention)**, qualitative measurements through observation sheet of PBL on student activity and also analyzed students' understanding through practical work and after the study ended, the stage **Quan Post- Measure**, post-test performed the learning outcome and proceed in stages **Qual After Intervention** by measuring the cognitive styles of students again through the cognitive style questionnaire to see the dynamics that occur in cognitive styles of students and interviews with students according to cognitive styles respectively. Interpretation of the data by analyzing Quan (post-test data analysis) and Qual (using qualitative data interpretation techniques).

### Data analysis

Design inserts data, both quantitative and qualitative, but one type of data is used as an additional role in the overall design. CSQ consists of 24 items, each of which consists of 12 statements were significantly positive and 12 negative statements are meaningful. However, the adjustment in this study, taken only a few items matching statements, each consisting of 6 main indicator that refers to: (A) cause, (B) internality / externality, (C) globality, (D) stability, (e) Consequences, and (F) self-worth implications. This questionnaire was then classified into two types returned questionnaires for Wholist-analytic cognitive style and Verbal-Imagery after the end of the lesson. This questionnaire has been modified in such a way in the form of scale 1-7.

### Quantitative Data Analysis

*Analysis Cognitive Style Questionnaire*

Cognitive style questionnaire consists of 24 items which are a combination of two versions of

the questionnaire, Wholist-Analytic and Verbal Imagery with the following provisions:

Questionnaire number 1-12 type Wholist-Analytic

If the questionnaire is filled with a score of 1-3 scale was represented by code of W (Wholist), scale 4 was represented by code of B (Bimodal), and given the scale 5-7 tally was represented by code of A (Analytic)

Questionnaire number 13-24 type Verbal-Imagery

If the questionnaire is filled with a scale of 1-3 was represented by the code of V (Verbal), scale 4 was represented by the code of B (Bimodal), and given the scale 5-7 was represented by code of I (Imagery) of the score obtained, the highest score representing taken Wholist-Analytic and Verbal-Imagery that will determine the stage of cognitive styles of students

*Analysis Problem Solving Skill dan Scientific Attitude Questionnaire*

The second questionnaire was administered after the learning process to see how much the students' skills in problem solving and scientific attitude of the students in learning science. Each questionnaire consists of 20 items that refer to the Likert Scale

Qualitative Data Analysis

*Analysis Cognitive Style Questionnaire*

Cognitive Style Questionnaire given to students at the beginning of learning to know the type of beginning of each student Cognitive Styles and given back at the end of the lesson so that it can be analyzed map the dynamics of cognitive styles of students during the learning process that occurs in students during lab work, discussions, presentations, and question and answer . Cognitive style questionnaire consists of 24 items which are divided into two versions of the questionnaire-type questionnaire Wholist-Analytic and Verbal-Imagery. Researcher analyzed the answers of each student, then based on the 1-7 scale questionnaire that had been made, to determine the initial profile of cognitive styles of students before and after the implementation of PBL models, tend to be characterized whether wholist or analytic and verbal or imagery or even Bimodal / Intermediate. After that, proceed with analyzing the results of the questionnaire answers of each student with the provisions of a higher scale indicating the level of cognitive style tendencies towards, positive, for positive situation  and negative, for negative situations. After the obtained highest score representing taken Wholist-Analytic and Verbal-Imagery. From these scores, then we can determine the stage of cognitive styles dynamic of  students before and after intervention  by PBL.

*Analysis of  Issues and Students' Worksheet*

Usage students' worksheet in the experimental lab characterized as acid-base is needed for comparison in order to view and analyze the level of students' ability to argue, both in the presentation, the discussion information, and solve problems with a certain level of difficulty based on a cognitive style that is owned by each student.

*Analysis of Cognitive Psychology Interview Result*

This analysis to describe the characteristic of students by the cognitive style that they had. Dividing student in some group by the profile of cognitive style and analysis their characters.

**Result and Discussion**

Qual Before Intervention (Initial Analysis)

The analysis showed a difference between the cognitive style level of Students. The data of cognitive style of show tthat 10% of students type Wholist -Imagery, 3.33% Intermediate--Imagery, 3.33% Intermediate-Bimodal, 66.7% analytic-imagery, 13.33% Analytic-Bimodal type, and 3.33% Analytic-Verbalizer. The difference is due to differences in cognitive psychology students when students are exposed to different psychological condition at the time of filling the Cognitive Style Questionnaire.

Quan Pre-Measure (Initial test result)

Results of Pre-Test Acid-Base Solutions does not show a strong description of Cognitive Style for each student. The results of the Pre-Test numbered 25 items show that pre-learning, prior knowledge of students is still relatively less and have not reached the minimum limit of 75. Learning Outcomes with the highest score is 64 and the lowest score was 32.

Qual during Intervention (Qualitative Analysis During PBL)

At this stage, has entered the initial learning phase, in which high school students who enter adolescence began to recognize the Learning Model of Problem Based Learning, which will study the implementation of the system changes from the original lectures before teachers will be transformed into a model that can enable the participation of student learning.

Quan Post-Measure (Final Quantitative Analysis)

Learning outcome from the implementation of Problem Based Learning will cause an increase when compared to the pre-test. Students are able to understand the material, both in the learning process and then supported by the results of Problem Solving Style which includes the analysis of grain answer 25 questions in the Post-Test. The highest value obtained at the score of 100 and the lowest value at which 76 have reached the limit of mastery learning minium 75 Student Results in Acid-Base Solutions material increased with the percentage from 55.33% to 78.76%.

Qual After intervention (Qualitative Analysis After PBL)

At this stage, be re-charging the Cognitive Style Questionnaire by 30 students, to see the dynamic of the cognitive style of learning that occurs subsequent to the Problem Based Learning Model. It was observed during the 10 indicators of learning, namely the dynamics Cognitive Style of 3.33% students Wholist-Imagery-type, 10% of students of type Intermediate-Imagery, 13.33% Intermediate-Bimodal, 63.33% students of type Analytic-Imagery, 3.33% of students Analytic-Bimodal type, and 3.33% of type Analytic-Verbalizer students. These dynamics result from differences in cognitive psychology and thinking patterns observed each student in cognitive (problem solving ability in the learning process), psychomotor aspects (high scientific attitude), and affective aspects (communication and arguing). These three aspects are always associated with what should be measured as set out in the Cognitive Style Questionnaire. Area Distribution of Cognitive Style Stage still survive in Stage Anaytic-Imagery, although the change is accompanied by strong decrease in analysis when compared to pre-learning. Still other types such as Student that had type cognitive style M code that does not change as Intermediate-Bimodal (located at the center point 0.0) in a static position.
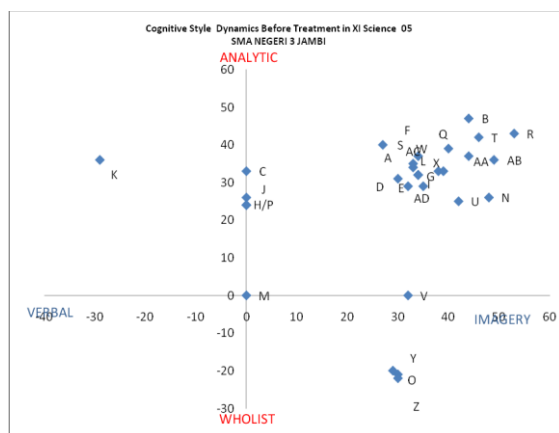


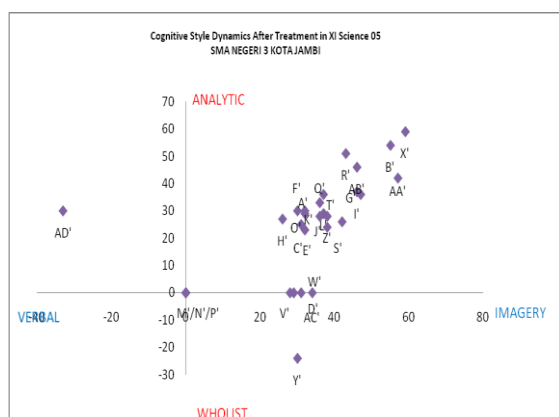Figure 2.   Cognitive Style's Dynamic Before Intervention



Figure 3.   Cognitive Style's Dynamic After Intervention

Cognitive Style Questionnaire was the main research instrument that can determine the type of student cognitive style in learning. Cognitive Style Questionnaire Results of the analysis showed a difference between the Cognitive Style Level Students. Cognitive Style Type Students generally dominate in quadrant II, Analytic-Imagery stage, where the level of sharpness for the analysis and translation of a stable symbol. The character of the student is subject to change as a result of an innovation in teaching. The main steps in PBL are study questions or problems, focusing on the relationship of science disciplines, authentic investigation, produce a product or work and show it off and collaboration in the group.(Trianto,2007)

Cognitive Styles type Wholist-Imagery

Wholist-Imagery Cognitive Style is located at the level of "extreme wholist",(Riding,1998). The character is described as a type of cognitive style who likes to solve problems, but the level of analysis is not too sharp. Type these students so spontaneous, caring with ambient conditions, flexible, and very open. Seen in the dynamics of the student code of Y, which changes the position of the stage but still in Wholist-type imagery, from the position of (29I, -20W) into (30I, -24W), in this case an increase in the level sensing images, but decreased levels of analysis, the need for aid to visualize all his images. Unlike the case with the student code of O and Z which have changed the cognitive style of Quadrant II (Wholist-Imagery) to Quadrant III (Analytic-Imagery) as indicated by the increased ability of analyze. Student Code of O seen protruding from the stage (30I, -21W) into (31I, 25W) and the student code of Z (30I, -22W) into (28I, 38W). PBL models have been able to change the way of thinking in students.

Cognitive Style type  Intermediate-Imagery

Characteristics of type Intermediate-Imagery students still highlight the picture translation/ special symbols as a learning development tool, even though the student is not too strong highlights the quality of analysis. Not rule out the few students there as opposed to the type of Cognitive Style-Intermediate Students like Bimodal (located in the center 0.0) that looks good from the behavioral and psychological analysis of the interview feel difficulty in learning Problem Based Learning, which do not reveal the analysis / translation that is so mean. As happened in the student code V with position changes (32I, 0B) into (28I, 0B), the pattern of thought is not experiencing rapid change, but the actual character of these students are still able to overcome the problem by asking / need for peer tutors in learning and Style this is more likely to be interested cognitive explain the symbols / special picture that became his trademark, although it is not accentuate sharp analytical results. Cognitive Style dynamics experienced by the student code of Analytic-Imagery of student D and student AC type Intermediate-Imagery can be influenced by the

difficulty in overcoming the problems that both students tend to solve problems with a visual aid.

## Cognitive Style type Intermediate-Bimodal

Students with this character are generally not too highlight the talent and ability to analyze problems that are too complex. There are some psychic students who sometimes feel burdened by learning they are not unusual and in accordance with their learning styles. For these students, sometimes can actually explore a problem with simple things such as visualization and some formulations are made simpler. As happened in the student code of M, which is static in the position of the center point (0,0), which is easily bored, unstable, and generally tend to alternate solutions in solving problems. These students also need the help of peer tutors in the learning process.

## Cognitive Style type Analytic-Imagery

This study shows that the majority of students dominate in Analytic-Imagery Cognitive Style with the strength that starts from weak to strong analyst. Character problem solving supported by prior knowledge into their main capital in problem analysis, problem solving skills supported skills and scientific attitude that can be said relatively moderate to high. Retrieved 14 students who still persist in quadrant II, although none of them had decreased levels of analysis such as student A, L, Q, T, and AB, there is also increasing and is quite good in its development such as students E, F, R, and S, and a very strong increase, both in the level of analysis and how to visualize as students B, G, I, X, and AA. For them, the things that is difficult is the challenge and they are always trying to find solutions and provide the best for the results of the analysis and translation of picture / special symbols. Along with the use of PBL in the class model, there are also changes in cognitive style, some students from another quadrant to the second quadrant, as the K student, students of O and Z, C and H. The ability of students to think of new and allows the individual to think abstractly and hypothesized.

## Cognitive Analytic type Analytic-Bimodal

Analytic-Bimodal character can indeed be said to be interested in the analysis of the problem, but sometimes this type of erratic student in the translation problem, either in the explanatory sentence also special symbols. The character of the student is classified as a conscientious student and good in business maslaah analysis. Analysis of the scientific attitude is maintained, although not yet know when the codes are suitable for use in the imaging analysis. This character also maintain cohesiveness in communication with peers. As happened in several student code of C, H, and J which was originally located at the position of the Analytic-Bimodal turned into Analytic-Imagery has been an increase in terms of visualization. However, there is also a drastic change in the students' P,

where a decline in terms of its analysis that changes the position of the Intermediate-Bimodal stage.

## Cognitive Style type Anaytic-Verbalizer

Analytic character-Verbalizer tend to analyze the use of explanatory sentences compared to images / special symbols. Cognitive style character like this is unique, although not too keen to highlight the strong analyst. As happened in the student code of the original character of students K Analytic-Verbalizer, analysis capabilities that can drive change throughout the verbal ability to the ability of imagery as a learning medium. In contrast to the student code of AD, which was originally to have a habit like to analyze the visual coded entirely changed the character into a verbal code in the analysis of the problem. In Sukmadinata (2010) explained that the dynamics of the individual's behavior is dependent on several factors such as:

## Student Motivation and Character

The strength of the driving motivations activity called individual motivation indicate a condition within the individual that push or move the individual activity goals to achieve something. The higher and mean a goal, the greater the motivation, and the motivation will grow stronger activity undertaken. The strength of the motives or need something subjective and situational, not always the same for every individual and situation. Motivation for Cognitive Style diverse students clearly differ, depending on the type of motive inidvidu, though individuals are in the same type of cognitive style, the motive is different. This teen age feels quite open and can begin to grow a variety of scientific attitudes, especially in science learning as problem-solving skills, each argues, opinions, and work together in groups as well as of different types. Rapid development as a result of changes in emotionality social influences also be complicated by the fact that the individual is experiencing cognitive changes.

## Quality of Social Interactivity and Gender

There are two tendencies of individual interaction with the environment that the individual receiving environment and the individual refuses environment. Adjustment is one form of interaction that is based on the existence or the acceptance of each other closer. To the things that endeared or perceived benefit, the individual will perform a variety of forms of self adjustment activities. In this adjustment, the change could be things that exist in the individual or things that exist in the environment modified according to individual needs. Problem solving is one form of adjustment is very complex. Through the process of solving this problem developed or developing real human. This is in accordance with the character of the Analytic-Imagery. In this study, the dynamics is possible comes from good communication between members of the group that contains several different cognitive

styles. It is estimated that students Analytic-Imagery character can spur the development of other students with cognitive styles through their interactions. In this study also found female students that hefty influence in each analysis because of problems of type Analytic-Imagery than male students.

Problem Solving Skill and Cognitive Style of Student

Problem Solving Skills, known as Problem Solving Style to each individual with different cognitive styles. The results of the analysis score Level Problem Solving Style 61 students score lowest on the Analytic-Imagery cognitive style (weak) and 88 points with the Analytic-Imagery cognitive style (strong). For students with Analytic-Imagery cognitive style on average have a good rating and very good at problem solving. This capability has been adapted to the PBL learning process experienced by students, in which students are required to communicate, argue in discussions and practical work and individual presentations to the class. This result is supported by another of student learning outcomes, such as for Analytic-Imagery Cognitive Style can improve their learning outcomes by optimizing the full PBL has been implemented so that the maximum post-test with the highest score of 100, although there are also some weak analytic-imagery that the score of 76, who have met the minimum limit for the completeness of the acid-base solution concept.

## Conclusion

Based on the above, it can be seen that the dynamics that have occurred in each Student Cognitive Style, Cognitive Style of characters ranging from students who are so unique and after treatment did PBL model also changed the thinking of students and improve student learning outcomes. This model is very suitable to be applied and can also be used as innovations in more active learning by students. Students are also required to have a suitable problem solving strategies and tailored to their cognitive style, although we can not be sure exactly when cognitive style that could change in the provision of intervention.

## Acknowledgements

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