

# Instructional Model and Thinking Skill in Chemistry Class

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**Abstract.** Chemistry course are considered a difficult lesson for students as evidenced by low learning outcomes on daily tests, mid-semester tests as well as final semester tests. This research intended to investigate the effect of instructional model, thinking skill and the interaction of these variables on students' achievement in chemistry. Experimental method was applying used 2 x 2 factorial design. The results showed that the use of instructional model with thinking skill influences student's learning outcomes, so that the chemistry teacher is recommended to pay attention to the learning model, and adjusted to the student's skill thinking on the chemistry material being taught. The conclusion of this research is that discovery model is suitable for students who have formal thinking skill and conventional model is fit for the students that have concrete thinking skill.

## 1. Introduction

The term Chemistry, lately often used in the entertainment world to declare the existence of a harmonious blend among others. The chemistry subject introduced to students in Indonesia during their upper secondary school, and it concerned with the properties and reactions of substances. Chemistry is the study of material and the changes that material undergo. One of the joys of learning chemistry is seeing how chemical principles operate in all aspects of our lives, from everyday activities like lighting a match to more far reaching matters like the development of drugs to cure cancer. Chemistry principles also operate in the far reaches of our galaxy [1]. However, many students say that chemistry is difficult. It has been observed that a lot of students nowadays are losing interest in the science subject such as chemistry [2]. These perceived difficulties are part of the context in which the students develop concepts and problem-solving skills [3].

Students live and operate in the macroscopic world of matter. Unfortunately, they do not perceive chemistry as related to their surroundings. Moreover, they do not easily follow shifts between the macroscopic and microscopic level [4]. Studies in chemistry involve three dimensions, they are dimensional of macroscopic reasoning (relating to what is observed), symbolic dimensions (symbol, formulas, equations), and sub-microscopic dimensions (atom, molecules, ions, molecular structure [5]. Think in three dimensions is a demand chemical disciplines that distinguishes chemistry from other disciplines. Related to this dimensions it is important to the teacher providing models or strategies in order the teaching and learning to be successfully in terms of student learning outcomes.

Here, the purpose of this study was to answer the question is there a difference in the learning outcomes of student that learned with discovery model and direct learning model in chemistry? Moreover, is there a difference in the learning outcomes of students with formal and concrete thinking skills that learned with discovery learning model and the students that learned with direct learning



model? This research also examines the interaction between teaching model with the ability to think toward the students learning outcomes.

## 2. Methods

This study is a quasi experiment with a 2 x 2 factorial design, to compare the effect of discovery learning model and direct learning model or conventional model, directly to the learning outcomes of 80 high school students taken randomly to be the sample based on their thinking ability. The research design is described in Table 1.

**Table 1.** Research design factorial 2x2.

Thinking Skill (B)	Instructional Model (A)	
	Discovery (A1)	Direct (A2)
Formal (B1)	$\mu A1B1$	$\mu A2B1$
Concrete (B2)	$\mu A1B1$	$\mu A2B2$

Data analysis used descriptive statistic and inferential statistic for hypothesis tested. Hypothesis testing is preceded by analysis requirements test, including normality test and homogeneity test.

## 3. Results and Discussion

Description of result of this study can be seen in the Table 2.

**Table 2.** Description of research data.

Thinking Ability	Learning Model		Total
	Discovery (A1)	Direct (A2)	
Formal (B <sub>1</sub> )	X 25,67	X 22,70	X 24,62
	s 2,80	s 1,93	s 3,07
	S <sup>2</sup> 7,97	S <sup>2</sup> 3,75	S <sup>2</sup> 9,36
	N 20	N 20	N 40
Concrete (B <sub>2</sub> )	X 19,83	X 20,90	X 20,71
	s 2,08	s 2,47	s 2,49
	S <sup>2</sup> 4,35	S <sup>2</sup> 6,08	S <sup>2</sup> 6,22
	N 20	N 20	N 40
Total	X 23,04	X 22,03	X 22,64
	s 3,86	s 2,29	s 3,29
	S <sup>2</sup> 14,87	S <sup>2</sup> 5,23	S <sup>2</sup> 10,87
	N 40	N 40	N 80

Result of hypothesis testing based on the Analysis of Variance (Anova) 2x2 factorial and the statistical of inferential showed that chemistry learning outcomes of students that learned with the discovery model is higher than that learned by direct learning model.

Teachers' teaching methods are factors that may influence the students' learning outcome. The discovery model applied in teaching colloidal system keeps students active, so the learning outcomes are high. The used of discovery model can encourage motivation, active involvement, and creativity of students, it also promotes autonomy and independence [5].

In this case, the using of student work sheet in teaching of colloidal system gave the student opportunity to expressed their thinking ability. Student with formal thinking ability showed high performance in doing laboratory practical. According to Piaget's theory, during the stage of formal operations probably less well understood than that which occurs during any other stage. At the age of 15-18 years, children become capable of solving problem even when the relationship between the two denominators is not a simple factorial one [6]. In the learning of colloidal system students were expected to find out examples of colloidal in their daily life, how to group colloidal system based on the characteristic of solvents, how to do practical work in the laboratory.

Discovery learning is also strongly tied to problem solving (or learning how to solve problems under a more meta-cognitive perspective): Learning theorists characterize learning to solve problems as discovery learning, in which participants learn to recognize a problem, characterize what a solution would look like, search for relevant information, develop a solution strategy, and execute the chosen strategy [7].

Thinking ability is a matter of attaining capabilities of reasoning including 16 logical operations which make up formal operations [8]. The concrete operational stage is the third in Piaget's theory of cognitive development. This stage lasts around seven to eleven years of age, and is characterised by the development of organized and rationale thinking. Piaget considered the concrete stage a major turning point in the child's cognitive development, because it marks the beginning of logical or operational thought. The child is now mature enough to use logical thought or operations (i.e. rules) but can only apply logic to physical objects (hence concrete operational). Children gain the abilities of conservation (number, area, volume, orientation) and reversibility. However, although children can solve problems in a logical fashion, they are typically not able to think abstractly or hypothetically [9]. Teaching with direct model only can facilitate the way student memorize examples of colloidal system. The students' achievement in chemistry related to their level of interest in the subject. It can be inferred that students who do not have the passion for chemistry may not be able to score high in chemistry exams [10].

#### 4. Conclusion

The results of the study found that instructional such as discovery contributed in chemistry especially in colloidal system teaching. Students' score is higher for them who learned with discovery model compare to direct model. Related to thinking ability, students with concrete thinking skill learned with discovery model get the low scores compare to students learned with direct model. There an interaction between instructional model and thinking skill ability, so teachers have to find out ways to implemented the models.

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