

# The Ability of Generic Science at Observation and Inference Logic Prospective Chemistry Teacher in Organic Chemistry Experiment

Prof. Dr. Sudarmin, M.Si<sup>1</sup>, Dr. Sri Haryani, M.Si<sup>2</sup>

<sup>1</sup>Professor, Chemistry Education Department, Science and Mathematics Faculty, State University of Semarang, Indonesia

<sup>2</sup>Chemistry Education Department, Science and Mathematics Faculty, State University of Semarang, Indonesia

**Abstract:** *The ability of generic science at observation and inference logic is very important in scientific work. This description of the research aims to describe the ability of generic science observation and inference logic chemistry education students in organic chemistry experiment activities. The subjects of study was conducted on 79 chemistry student teachers. Research activities include the analysis of the results of the pretest methodological and conceptual mastery of students expressed through Vee diagram, evaluation of students' ability, both individually and in groups for observation and inference logic every activity of organic chemistry experiment. Organic chemistry experiment as research objects include distillation experiment, solubility tests and recrystallization, the composition chain hydrocarbons, alcohol-phenols, aldehydes and ketones. At the end of each experiment done scoring results of scientific work for observation and inference logic, presentation of the results of the experiment, and report experimental posttest evaluation. All data pretest scores, postes, the report every trial of observation and inference logic is processed and interpreted. Research results found for the distillation experiment, solubility and recrystallization found chemistry student teachers have the ability generic science observations reach the N-gain average of 0,462 or moderate level of achievement. Experiment arrangement chain hydrocarbons, alcohols phenols, ketones and aldehydes obtained value of N-gain average of 0.468 or moderate level of achievement. The results show the ability of logical inference in the category based on the value of N-gain.*

**Keywords:** The ability of generic science, observation, inference logic, prospective chemistry teacher, organic chemistry experiment.

## 1. Introduction

In the 3rd millennium in this 21st century Indonesian nation must be prepared to face global challenges. Many global problems felt by the people of Indonesia today, including conflict between social groups, the gap between the rich and poor [1], as well as gaps in scientific literacy and scientific thinking skills [2]. Scientific thinking skills a number of different, and one of them is the ability of generic science that is thinking skills and scientific work through the activity of observation and inference logic (3, 4, 5). In the chemistry lesson, the students are required to study natural phenomena, especially related to the structure and composition of the constituent of a substance or object, chemical reactions, as well as the accompanying energy [6]. On learning that chemistry is a field study of science was developed through direct and indirect observation to look for causality of what is observed from a natural phenomenon or social issues and then performed activities conclusion makers or inferential logic [7]. Thus, if the observation of a natural phenomenon that careful, thorough, and correct the results the conclusion is correct, this implies reconstruction scientifically correct knowledge of chemistry

Chemistry learning in the context of the curriculum in Indonesia aims to make human Pancasila productive, innovative, creative and affective, so it requires the ability generic science as an effort for the preparation of the young generation in the future [8, 9]. One of the skills of thinking in the future is the ability to solve problems using scientific approaches. Problem-solving skills required capabilities generic science observation and inference logic thinking ability is good, in terms of empowering students to be able to

assume responsibility for defining and analyzing problems, as well as building the solution [10]. On the development of generic capabilities logical inference, then the student is required to connect between the methods with concepts, theories, principles and rules within the scientific or experimental work [11].

The observation in one of the School in Pati, Central Java found that the ability of students to observe and draw conclusions still. Causes of the problems arising in chemical experiments are mostly students just summarize the results of an experiment by taking the existing theories in books such as understanding the solution and the solution of differences [12]. This method such experiments led to learning outcomes and also lower the ability of generic science. Experimental method is less support students' thinking skills, so the impact on the quality of learning that are less meaningful and touching the root causes of learning in class and when doing experiments in the laboratory. Limitations of the human sensory organs in making observations in an experiment need to be assisted chemical sensing device, this is the emergence of the term indirect observations. In the experiment of organic chemistry, for example, to determine the acidity level of an amino acid necessary litmus indicator paper or pH meter, determine the temperature of a steam distillation of organic substances necessary tools Thermometer, and determining the purity of a substance used results recrystallization melting point data using the tool Thiele.

Chemistry as part of science is a science which is based on a chemical reaction experiment or investigation of natural phenomena [13]. Therefore, the ability of generic science

observations during the experiment is a scientific activity that is important in the study of organic chemistry. Basil observations of chemical reactions, symptoms or natural phenomena that can be observed directly with the senses, but others can not be observed directly so well known generic capabilities indirect observation [14]. In this study, the definition of generic science observation capabilities include the ability of generic science of direct observation or indirectly. The importance of this research, because if the ability of generic science observation well, it will have implications for the quality of scientific work and chemical education quality [15]. This study aimed to describe ability generic science observation and inference logic for chemistry teacher candidates [16].

## 2. Method

### 2.1 The Subject, Type, Location, and Research Instruments

The subjects were chemistry student teachers in the second half of Semarang State University, which conducted the research while being taking courses in Organic Chemistry Experiments. Subjects research numbered 79, and subjects are grouped into three groups based on grade point average the first semester that students with higher ability category (achievement index between 3:01 -3.80), medium (between 2,75-3.00 achievement index), and low (index of achievement between 2.18 to 2.74). The location study was conducted at the Department of Chemistry, Faculty of Mathematics and Science in State University of Semarang.

This research is a descriptive study; in the sense to give an explanation and description of or related to the ability of generic science portrait of observation and inference logic chemistry teacher candidates for organic chemistry experiment. In this study the generic capabilities of observation and inference logic diagram Vee revealed using the instrument, namely to determine the conceptual and methodological mastery of the research subject of each experiment. The ability of generic science observation and inference logic revealed by direct observation of each student and experimental group followed by scoring basil observation and inference logic contained in the observation sheets that have been distributed each group before the experiment. Observation sheet contains a table of observation and inference logic is still empty filled by students according to the results of the experiment, and then write the conclusion, and answered questions mastery of concepts, theory or principle underlying an organic chemistry experiment

The main instrument of research include conceptual and methodological mastery tests of experimental organic chemistry experiments revealed through a pretest using Vee diagram test format. Pretest using Vee diagram means students are required to complete the sections in question, related principles, theories, focus questions, or methodological side of the Vee diagram. While the ability of observation and inference logic of the study subjects were measured through direct observation when the students make observations, analysis of the data has been loaded on the observation sheet, the percentage of experimental results, as

well as scoring against the relevant report data analysis capabilities, as well as the conclusion of the experiments that have been made student. The results of pretest and posttest scores were analyzed using the formula N-gain with the formula:

$$\text{Value of N-gain (g)} = \frac{\text{posttest scores} - \text{pretest scores}}{\text{maximal scores} - \text{pretest scores}}$$

The rate of scores are categorized into three categories [17], namely:  $g < 0.30$   $g \leq 0.30$  = low,  $< 0.70$  = medium, and  $g \geq 0.70$  = high. In this research, scientific inference for generic skills test data taken from a matter completely wrong assessment followed by a description, while data on non tests were taken on the assessment of the observation sheet. Problem correct one is used to analyze the cognitive learning outcome, while the matter of the description is used to measure the ability generic science of inference logic that consists of asking about the prediction of chemical events, applying concepts and concluding observations.

### 2.2 Procedure Research Activities

This study aimed to describe the ability of a generic observation and inference logic in organic chemistry experiments. The customized research activities with a focus of this study, namely organic chemistry experiment learning activities that put more emphasis on equipping science process skills and observations on chemistry student teachers. Organic chemistry experiment activity patterns following the first meeting of a contract following activities lectures organic chemistry experiments, exposure of the introduction and use of tools or instruments contained in the organic chemistry laboratory, the division continued At the initial meeting of this group are presented exposure trial implementation distillation, the structure of the hydrocarbon chain, phenol alcohols, aldehydes and ketones are packaged in a media-based instructional videos prepared by researchers with the purpose of provision of the student experience to be able to conduct experiments with the correct observation.

The second meeting was held pretest for conceptual mastery of the material and methodology used instruments Vee diagram, where students are required to answer the element or elements related to the focus questions, the object of the experiment, events, concepts or principles stated in the Vee diagram. The second meeting of this group of students are conducting experiments that some groups are conducting experiments (groups 1-4) simple distillation and fractionation as well as most other groups (groups 5-8) conducted experiments solubility tests and recrystallization after the pretest. During obseleted student experiments conducted trial observations concerning the activities of students to express mastery of generic skills of observation and followed the guidance if there is a trial implementation problem. At the end of the implementation of distillation and recrystallization experiment that the second and third meetings, each group reported the results of observations during the trial by filling tables / sheets observation sheets that have been prepared and distributed before the experiment for each group. Observation sheets filled with collected and evaluated by researchers and handed back. Furthermore, to evaluate the ability of a generic observation, each student is required to

report the results of observation, analysis of experimental data/ observations, draw conclusions and answer all questions related to the mastery of concepts and methodological.

The fourth meeting of the pretest for the next three trials that arrangement hidrokrabon chain, phenol alcohols and aldehydes-ketones. Pretest to unveil the conceptual and methodological mastery of each student using Vee diagram. At the fourth meeting also included presentations observations distillation and recrystallization experiment by experimental groups, followed by a discussion to evaluate the activity during the experiments that have been carried out; as well as to strengthen the ability of generic observations and concepts supporters. Results presentation and discussion on the experimental distillation and recrystallization experiment, it was found problems regarding the lack of clarity or mastery of concepts related azeotropic mixture, the phase diagram, and implementation principle of "like dissolves like" in the process of dissolution. Therefore, at the end of the discussion doses team of researchers aided other organic chemical experiments explain concepts or principles that the student has not mastered. At the meeting fifth, sixth and seventh students conduct experiments arrangement chain hydrocarbons, alcohols phenols, aldehydes and ketones. By the time the students do any experiments, such as distillation and recrystallization experiment activities before the researchers observed the ability of observation and inference logic in each group to be able to conduct experiments or observations are correct. At each end of the experiment the students in groups and take turns presenting the results of observations of experimental organic chemistry, guidance and to report observations and makes logical inference (conclusion) of the experiment.

### 3. Result and Discussion

#### 3.1 Research subjects grouping.

In this research, the grouping of research on group achievement subject high, medium and low. Grouping the subject of this research into the achievement of high, medium and low based on the semester grade point of unity. Achievement index chosen as the basis for grouping the first half because of the cumulative achievement index more thoroughly describe the capabilities of students rather than just be based on the value of a particular subject. The purpose of grouping the subject of this study is to reveal the ability of generic science observation gaps between groups of accomplishment. In Table 1 are presented the results of a grouping of high achievement, medium and low of 75 research subjects.

**Table 1:** Grouping achievement of research subjects

No.	Group Achievement	Number	Lowest Achievement Index	High Achievement Index
1	high	13	3.20	3.80
2	medium	54	2.63	3.15
3	Lowest	12	2.18	2.58

Performance Index scores counting results of the research subjects mean achievement results mean index of 2.90 and standard deviation (SD) of 0.30. Chemistry student teachers high achievement group had the lowest achievement 3.20 Index (index mean feat classes + standard deviation) and the highest performance index of 3.80 (13 people). Student groups have lower achievement index, the highest achievement (average grade achievement index - standard deviation), so having an index range of 2.18 -2.58 achievement (12 people). Student achievement group being has feat index range from 2.63 to 3.15 (54 people).

#### 3.2 The Ability of generic science observations

Observation is collecting data on natural phenomena or events by using the five senses or sensory aids. Direct observation can be obtained through everyday lives and or occurred during the experiment. Andree, M [18] reported the results of observations of a phenomenon in everyday life or chemical reactions are useless, if not interpreted. Chemistry student teachers through observing means they have a record of each observation skills separately and then connect the observed results, so found certain patterns in a trial. Ability to find patterns of these observations is the main basis for suggesting the conclusion or inference logic. The ability of direct observation of nature or macroscopic phenomena continue to be developed, an understanding of the macroscopic properties of the chemical will not be strong if it is not supported, for example microscopic understanding of spatial aspects will be particles, atoms, molecules, or symbolic language [19]. In Table 2 presented a description of the results generic science of observation from projective chemistry teacher .

**Table 2:** Analysis of pretest posttest scores, N-gain for generic science of observations capability in different groups of research subjects achievement.

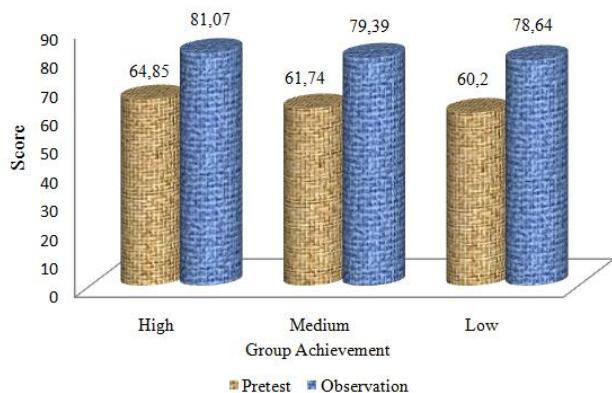
Experiment *	Group Achievement	Pretest Average	Scores Observations	Gain	N-gain	N-gain average
Experiment 1 and 2	high	64,85	81,07	16,220	0,462	0,462
	medium	61,74	79,39	17,650	0,461	
	low	60,20	78,64	18,440	0,463	
Experiment 3, 4, and 5	high	74,41	85,06	8,65	0,367	0,458
	medium	72,52	83,54	11,020	0,392	
	low	69,72	81,59	11,870	0,644	

Scores observations in Table 2 are obtained from the average of (1) scores observations contained in the observation sheet (2) score students 'ability to analyze data and draw conclusions, and (3) scores of students' ability to answer the questions mastery of concepts. Thus the observation that listed scores are the result of the average of the three scores score/ component ratings are balanced observation lecturer observations on the current activities of Organic Chemistry student experiment, scores students' ability to analyze data and draw conclusions, which are tracked through scoring the value of trial reports, and scores ability chemistry student teachers in the mastery of the concept as expressed through direct question when a group of students reported the results of observations of each end of the experiment, when



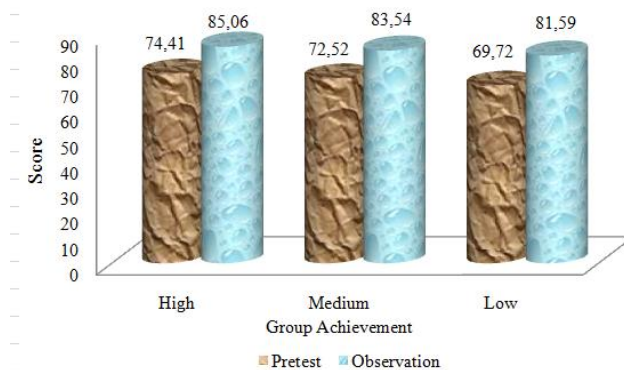
presenting the results of the experiment and the results of post-test scores. In Table 2 presented experiments 1, 2, 3, 4, and 5, which means the trial distillation, solubility and recrystallization, the composition of the hydrocarbon chain, phenol alcohols, ketones and aldehydes.

In Table 2 presents an increase in the ability of generic science observations of the study subjects with an average value of N-gain in the group reaches value N-gain of 0.462 for distillation experiment, solubility tests and recrystallization and N-gain average value for 0.458 for the attempted identification of hydrocarbons, alcohols -phenol aldehydes and ketones identification, so that the price of the N-gain in the range of 0.30 to 0.69 as achieved in this study include the level of achievement was according to Hake [17]. While the group on value of N- gain is high 0.462 - 0.461, and 0.463 for the achievement of high, medium, and low in the distillation experiment, solubility, and recrystallization, and the composition of the hydrocarbon chain. As for the experimental identification of alcohol-phenols, aldehydes and ketones trial data showed an increase in generic skills mastery of science observations by 0.367, 0.392 and 0.644 for value of N-gain for the high achievement group, medium, and low. Improving the ability of generic science observations to the range of 0.30 to 0.69 as in this study include medium category [17]. Results of this study have implications for the need to increase the ability of generic science chemistry teacher candidates, so that the high achievement levels based on value of N- gain is high In Figure 1 served visualization on the analysis of scores for distillation and recrystallization experiment achievement between groups of high, medium, and low.



**Figure 1:** The Ability of generic science for observations distillation and recrystallization from various subjects group achievement

In Figure 2 below will be presented visualization upgrades generic science observations for trial arrangement hydrocarbon chain, alcohol-phenols and aldehyde-ketone experiment subject for research on a group of high performance, medium and low.



**Figure 2:** The ability of generic science for observations chain Hydrocarbon, Alcohol Phenol, and Aldehyde Ketones

By looking at the average value of N-gain ranging from 0.3 to 0.69, the study concluded that organic chemistry experiment emphasizes generic skills of observation in this study have increased mastery observations chemistry teacher candidates significantly. The results showed that the ability of generic science observations chemistry teacher candidates in experimental organic chemistry experiment still moderate category, so this ability can still be developed in an effort to improve the quality of learning chemistry.

### 3.3 The Ability of Generic Science Inference logic

The ability of generic science of logic inference is a very important aspect in developing the process of science. In this study inference logic as a logical consequence of the activity concluded laws or when the former without doing the experiment (Brotosiswojo, 2001). In this study, the ability to think logical inference for research subjects revealed through questions concerning the relationship of quantum numbers and energy levels, as well as the value of electronegativity relationship with the degree of polarity of a compound. In this study, learning approach to enhance the ability of generic inference logic includes a concept map approach, problem solving, and scientific work. Results of the data analysis the average pretest, posttest, N-gain and the level of achievement of the generic capabilities logical inference according to achievement group are presented in Table 3.

**Table 3:** Analysis of pretest, posttest, value of N-gain and the level of achievement for generic science inference logic in various groups achievement

Group Achievement	Pretest Average	Posttest Average	N-Gain	Standard of Achievement
High	4.00	6.38	0.547	moderate
Medium	4.19	5.83	0.420	moderate
Low	4.00	5.83	0.533	moderate

Learning materials as a vehicle for developing the skills of logical inference is a chemistry teacher candidates and the electron structure of the atomic energy levels, charging electrons in the atom, and the dissociation energy, as well as organic chemistry experiment. In Table 3 found the average N-gain skills in classical logic inference is 0.464 as a result the average N-gain high achievement group, medium, low. Thus the model applied can improve the mastery of logical inference ability of generic science research subject at the

level of achievement of the medium [17]. Therefore, it is a challenge for students to be able to increase the ability of generic inference logic, because logic inference capability as part of the science process skills [20].

In Table 3 is known that high achievement group that reaches N-highest gain is 0.547, which means achievement scores were. While the value of N-gain is the lowest achievement group medium have value of N-gain is 0.464. On learning of organic chemistry, the results of inference logica can be proved conclusively through chemical experiments through the activity of thinking conclude from the data obtained from an experimental sample. Activity inference logic is one of the important activities in the activities of the scientific work, because through logic inference can infer new students as a logical consequence of the laws earlier without having to make a new experiment. On learning of organic chemistry, logic inference thinking skills can be developed through the events of organic chemical reactions, for example, if a carboxylic acid compound is reacted with an alcohol acid catalyst, the reaction product is concluded as ester compound and water [21].

An Esterification reaction has been common to all carboxylic acid compounds reacting alcohol compound using an acid catalyst generated product esters as derivatives [22]. Salta [23] states the ability of students to summarize the various terms or concepts History is important to be trained in an effort to improve the ability of logical inference. Logic inference skills of prospective chemistry teachers can be developed through activities such thinking *if ....., then .....* to conclude the observation of a chemical experiments or results of the primary and secondary data analysis of a literature material organic chemistry teaching (textbooks). inference logic skills necessary prospective chemistry teachers, when they formulate the experimental results distillation of a mixture, solubility tests relating to the principle of *"like dissolves like"*, and concludes the characteristics of each type of functional group in the experiment identifying functional groups of organic compounds.

## 4. Conclusion

### 4.1 Conclusion

Based on the results of data analysis and discussion of the results of the study can be summarized as follows:

1. The ability of generic science observations from prospective chemistry teacher practicum for distillation, and recrystallization solubility reaches a value of N-gain average 0,462 and includes a moderate level.
2. The ability of generic science of observation from prospective chemistry teacher to experimental chain hydrocarbons, alcohols phenols, aldehydes and ketones derived reaches value of N-gain average 0.468 and includes a moderate level.
3. The ability of generic science of logic inference from prospective chemistry teacher for high achievement group, medium, and low have value of N-gain of 0.547; 0.420, and 0.533, and in the high and medium levels of achievement.

## 4.2 Suggestions and Implications

Based on these results, the ability of generic science observation and inference logic of the prospective chemistry teacher need to be increased and passed on to his students when doing chemical experiments, thus increasing the quality of teaching chemistry

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## Author Profile



**Sudarmin**, Professor of Chemical Education, He is now a lecturer in State University of Semarang (UNNES)-Indonesia. Her Expertise is in teachinglearning on chemistry. Her recent research is in developing models of teaching chemistry, especially with the learning model ethnoscince, generic science skills, scientific literacy, and scientific attitude.



**Sri Haryani**, Doctor of Chemical Education, she is now a lecturer in State University of Semarang (UNNES)-Indonesia. Her Expertise is in teaching learning on chemistry, Her recent research is in developing models of teaching chemistry, especially with practical problem based learning.