

# Development of generic science skills on determination of mineral chloride levels in packed drink using inquiry guided laboratory

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**Abstract.** This study aims to describe learning activities, to analyze students' ability to complete worksheets, and to analyze students' generic science skills during the determination of mineral water chloride content. The Mohr method is an argentometric titration that can be applied to the determination of the mineral water chloride content. Inquiry Guided Laboratory can be used as an alternative learning model to develop generic science skills of students. IGL adopt learning cycle stages consisting of orientation, exploration, concept discovery, application and finality. Subjects of this study are 57 student of Chemistry Analytical students. The research design used is classroom research. The research instrument consisted of instructional learning observation sheet, psychomotor assessment sheet, worksheet, and report and presentation report sheet that emphasized on generic science skill assessment. The result of the research shows that the learning is done very well, with the average of the implementation percentage is 88,27%. The students' ability to complete the worksheet earns an average of 87.92. Generic science skills developed through learning scored an average of 88.1. The generic science skills generator developed scores above 80, only symbolic language indicators scored 76.6. It shows that inquiry guided laboratory can developed generic science skill on determination of mineral chloride levels in packed drink.

## 1. Introduction

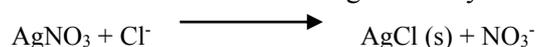
Mineral water is water that through the process of processing or without processing that meet health requirements and can be directly drunk. Quality of mineral water is different, mineral water with poor quality can be caused due to less optimal production process. This causes the mineral water packaging still contains many substances that are not needed by the body. One of the pollutants in bottled mineral water is chloride.

The chlorine element in water is present in the form of chloride ions ( $\text{Cl}^-$ ). Chloride ions are one of the major inorganic anions found in deep natural waters more quantities than other halogen anions. Chloride is usually present in the form compounds of sodium chloride ( $\text{NaCl}$ ), potassium chloride ( $\text{KCl}$ ) and calcium chloride ( $\text{CaCl}_2$ ). Chloride not toxic to living things, even play a role in regulating pressure osmotic cells [1].

Anion  $\text{Cl}^-$  with a silver nitrate solution  $\text{AgNO}_3$  forming a silver chloride precipitate,  $\text{AgCl}$ , which is like curd and white. It is insoluble in water and in dilute nitric acid but soluble in aqueous ammonia solution and in potassium cyanide and thiosulfate solutions [2].



The chloride ion is present in the compound form. Many chemical compounds in life daily containing chloride. The chloride content of each compound is different. For determining the chloride ion content in water can use argentometric method. The titration of argentometry is based on the reaction:



Potassium chromate can be used as an indicator, producing a red color with excess ion of  $\text{Ag}^+$ . More titration can be used is the back titration method [3].

Based on the phenomenon, ideally chemistry students are interested to analyze environmental problems as an effort to apply the knowledge they have, but in general the students focused on poraktikum instructions that already exist in the module without opening insights to analyze problems that occur in the environment.

Based on the results of research conducted by [4] in the chemistry department of FMIPA UNS, stated that students report of the result of lab, still often found the student is not able to interpret experiment data and lack of accuracy in conveying the discussion that has been connected with the theory. Practicum activities conducted more verification, which is to prove the concept or principle that has been discussed in the learning. This does not involve the high-level thinking skills students should have.

Therefore, there should be efforts to develop high-level thinking skills, especially generic science skills of students, one of them through the implementation of guided inquiry laboratory on the practice of determining chloride levels in bottled water.

There has been much research on the determination of chloride ion content in water samples, including wastewater[5], well water[6], and seawater[7]. There has been no research on the determination of chloride ion content in bottled water. Therefore, this study was conducted. The procedure for determination of chloride ions in packed bottled water is prepared based on guided laboratory mercury model to improve students' generic science skills.

## 2. Methods

The method used in this research is classroom research method. The method used is aimed to improve the effectiveness of learning, especially learning conducted in the laboratory. The subjects of this study are the sixth semester students who contracted the subjects of Analytical Chemistry 2 in Chemistry Education Program UIN Sunan Gunung Djati Bandung academic year 2015/2016 class A and B which amounted to 54 people consisting of 9 study groups with each member 6 people.

Researchers use classroom research methods then this research procedure is done with three stages of preparation stage, stage of implementation and final stage. Activities that are done are:

### 2.1. Preparation phase

Activities undertaken at the planning stage are as follows:

- Preliminary study in the form of literature study, Semester Analytical Study Plan (RPS) of Analytical Chemistry 2, study of mastery of science generic concept and skill, guided inquiry study of laboratory and analysis of relevant research journal.
- Analysis of concepts and teaching materials, analysis of indicators of conceptual mastery and generic skills of science and analysis of guided laboratory inquiry stages.
- Determination of problem formulation, objectives, benefits, methods, determination of title and determination of research subjects.
- Analysis of concepts and teaching materials, analysis of conceptualization indicators, generic science skills analysis and inquiry analysis of guided laboratory inquiry.
- Preparation of research instruments that include observation sheet of learning activities, worksheets, psychomotor assessment, assessment report and assessment of presentation.
- Conducting instrument validation to 3 expert lecturers and conducting instrument test in the form of Mohr argentometric titration procedure.

## 2.2. Implementasi phase

Activities at the implementation stage are:

- Research and data collection, at this stage is the practice of determining the chloride content in mineral water through the implementation of guided inquiry laboratory to describe the implementation of stageguided inquiry laboratory on learning to determine chloride content in mineral water.
- Implementation of practicum presentation to know generic skill of science students of Analytical Chemistry Chemical Education program of UIN sunan Gunung Djati Bandung.

## 2.3. Final stage

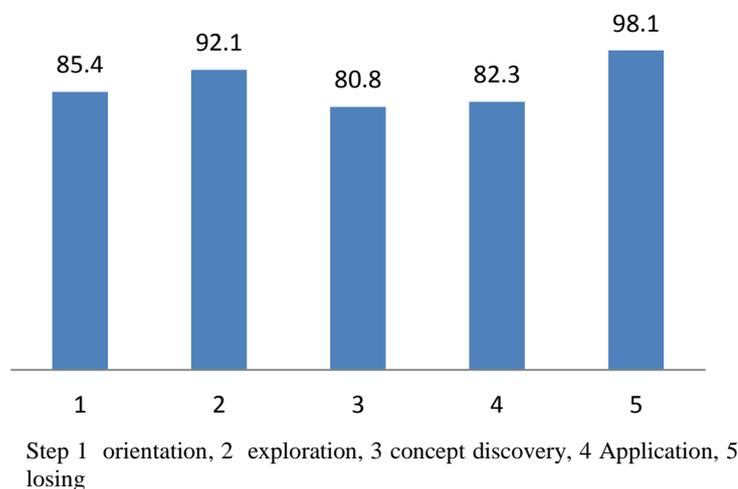
Activities carried out in the final stages are:

- Data collection of research results
- Processing and data analysis of research results
- Discussion of research findings
- Making conclusions and suggestions from the results of research
- Preparation of research results report

## 3. Result and discussion

Guided laboratory inquiry consists of 5 stages referring to the learning cycle stage, which are orientation, exploration, concept discovery, application and finality. Each of these stages is integrated in worksheet preparation. In addition, the learning undertaken aims to develop students' generic science skills. Thus, laboratory-based worksheet that emphasizes the development of generic science skills of students.

Based on the observations listed in the graph in Figure 1, it is known that the implementation of each guided inquiry step of the laboratory runs optimally so that it has a very good category because it obtains a percentage of implementation above 80%. In addition, students tend to be more enthusiastic and passionate about learning.



**Figure 1.** Percentage of implementation inquiry stages in laboratory on determination chloride in mineral water.

Learning has been done both on matters relating to the laboratory and about mastery of the concepts learned based on discussions in the classroom. The role of lecturer at each learning stage is a facilitator. The facilitator accompanies and provides guidance and clarification while the students find the concept by themselves. Thus, this condition forms more discovery learning or better known as inquiry. However, the inquiry does is a guided laboratory inquiry that refers to stimulus question given by the

facilitator especially during laboratory experiments. The stimulus provided aims to make students think scientific when observing the phenomena that occur. This is in line with research on IGL conducted by Russell (2008) [8], clearly execution of IGL enforced lessons learned in the classroom but did very little to enhance critical thinking skills. It is believed that developing laboratory exercises that have a research orientated focus will not only teach science, but will develop students to think like a scientist

At each stage of learning that is done has a different percentage of implementation. Nevertheless, based on the graphic in Figure 1, orientation stage obtained the percentage of implementation of 85.4% with very good category. At this stage, it can not reach 100% because in terms of reality facts not all students are able to answer the initial questions given by facilitators and students who tend to be more active in answering are students who have done LK before carrying out the lab. This is in because, students with high achievement groups already have a good initial knowledge of the concept of titration in general. This is in accordance with research conducted Gerace and Beatey in [4], high achievement group students have the ability of thinking analysis and retention of long-term memory, especially in understanding the concept he has learned. However, it is not yet fully understood that the sedimentation titration is slightly different from the acid-base titration they have studied independently. Thus, this stage aims to find out how far the initial knowledge of students.

In the second phase, which is exploration stage with the percentage of implementation is 92.1% with very good category. In contrast to earlier, this exploratory stage gained a larger percentage than orientation stage. In general, students from all groups can answer better than the orientation stage. As Brickman [9] pointed out that at the exploration stage, students asked to apply what they have learned. Students work in groups to plan, organize, and conduct their own investigations in the laboratory. With the cooperation, it makes learning more optimal because there is a process of sharing knowledge among members of the learning group so that the learning is centered on the students.

Observations at this stage also obtained data on student performance during experiment. Students' skills in the overall experimental exercise scored an average of 95 on a very good category. Nevertheless, the fact is there are some students who at the time of execution is still not optimal in the preparation and execution of experiments they have made. Evident from the psychomotor assessment results listed in table 1, groups III and IV have the same error in the preparation stage.

Furthermore, at the stage of discovery concept obtained the percentage of implementation 80.8% with very good category. This stage is the lowest percentage of achievement among the five guided inquiry labs. This low performance is due to the students ability to answer conceptual questions provided by the facilitator is not fully optimal, and students are not yet accustomed to direct discussions based on direct observation of the phenomena occurring during practice. Thus, the facilitator should try to stimulate students to be active during the discussion during the practicum by giving questions during the lab.

**Table 1.** Psychomotor value data by study group during practicum stages determination of mineral chloride level based inquiry of guided inquiry laboratory.

Group Name	Score for every step			Average	Category
	Preparation	Execution	End		
I	100	91	100	97	Very good
II	100	91	100	97	Very good
III	71.4	89	100	87	Very good
IV	71.4	89	100	87	Very good
V	100	86.4	100	95	Very good
VI	100	89	100	96	Very good
VII	100	93.2	100	98	Very good
VIII	100	91	100	97	Very good
IX	100	91	100	97	Very good
Average	93.6	90.1	100	95	Very good

The fourth stage is the application stage, this stage is the stage done at the second meeting. Activities undertaken at this stage are group presentations. Percentage of implementation at this stage is 82.3%

with very good category. Based on the result of discussion observation and presentation as implementation stage of application, the average of each group establish good cooperation especially in the division of tasks on each member of his group. In addition, there are group members who are able to become facilitators of the group's friends and classmates. Aspects of mastery of the topic, and the ability to communicate has been very good. Even the ability of students in oral communication is much better than communicating in writing. This is evident during the presentation, their ability to communicate the material and discussions in a systematic way and to use their own language so that it is easy to understand. This is in line with the research on IGL conducted by Waters (2012) [10], that one of the advantages of this model in the laboratory is applied is students learn critical thinking and problem solving skills, so that they can explain with clear understanding.

However, there are a few drawbacks: each group whose presentation always exceeds the time. As a result, the presentation takes longer. In addition, there are still groups making inaccurate conclusions or irrelevant to the formulation of the problem or purpose he made. Thus, a presentation time strategy is required so that presentations at the application stage can run optimally.

**Table 2.** Average score of work sheet based on inquiry stages inquiry of guided laboratories.

Group Name	Average score for every step					Average
	Orien tation	Explo ration	Concept Discovery	Appli cation	Closing	
I	80.4	72	75.9	89.5	100	83.6
II	79.2	72	75.9	89.5	100	83.3
III	90.4	86.6	76.4	100	100	90.7
IV	74.2	91.5	77.7	89.5	83.3	83.2
V	100	98.8	86.6	71.1	100	91.3
VI	70.8	87.8	83	89.5	100	86.2
VII	91.3	100	88.4	89.5	100	93.8
VIII	90.8	97.6	76.8	89.5	100	90.9
IX	91.7	100	86.6	78.9	100	91.4
Average						88.3

The final stage of guided labourorium inquiry is the closing stage. Based on table 2, the achievement of the closing stage is 98.1%. This achievement can not be 100% because, there are still students who have not been able to draw conclusions based on the formulation of problems they have made before implementing the lesson. The conclusion of the students made still contains deficiency on the principle of the method used and not to infer the feasibility of mineral water based on the regulation of the minister of health.

The worksheet on the determination of packed mineral water chloride levels in the development of generic science skills is based on the guided laboratory integrated inquiry stages and integrated with generic science skill indicators. Based on the results of the assessment carried out listed in Table 2, the acquisition of the average worksheet for all groups was 88.3. The largest value obtained by group VII with value 93,8 whereas the lowest value obtained by group II that is 83,3. The low value obtained by Group II at the completion of the worksheet is due to the it's value at three stages of guided inquiry laboratories are below the mean of all groups.

Group I scores at the orientation stage of 79.2. The exploration stage only scored 72.0 and the concept discovery gained a score of 75.9. The low worksheet group II values are in the orientation stage, since group II is incomplete in providing explanations given especially when analyzing the concept of argentometric titration, then organizing the data to determine which method is best used in a laboratory based on the availability of tools and materials. This is difficult because students are not accustomed to checking tools and materials independently of the practical work that will be done.

**Table 3.** Number of students on each generic science skill value and indicator based on psychomotor value and individual report.

Score	Student in every generic science skill indicators									Score Category
	A	B	C	D	E	F	G	H	I	
>80	31	54	54	48	48	54	4	46	36	Very good
70-79	10	0	0	6	6	0	0	3	10	Good
60-69	9	0	0	0	0	0	44	2	5	Fair
50-59	4	0	0	0	0	0	6	1	3	Low
<49	0	0	0	0	0	0	0	2	0	Very Low

Based on table 2, worksheet completion capability of all groups get the highest value at the closing stage that is 98.1 and exploration value is 89.4. This proves that the learning done at the time of lab has a great influence on the achievement of learning objectives. Based on Table 3, student performance in completing worksheet has been very good during the learning process. Thus, an inquiry-based worksheet integrated with Generic Science Skills (GSS) strongly supports the development of GSS as it meets its criteria. The last discussion is about generic science skills of students during the process of determining the mineral water chloride level based on inquiry of guided laboratory. Assessment given to the study group is a combination of worksheet assessment, psychomotor assessment, report assessment and presentation assessment.

**Table 4.** The mean grade of generic science skill learning groups on inquiry guided laboratory-based chloride level determination.

Group	Score for GSS Indicator									Average
	A	B	C	D	E	F	G	H	I	
I	73.1	91.3	79.2	86.3	97.2	93	70.3	74.4	78.2	82.6
II	83.1	91.9	81.7	84.1	97.2	93	75.9	92	76.2	86.1
III	83.5	92	81.9	90.7	98.1	89.2	74.5	88	89.3	87.5
IV	87.6	90.3	86.1	85.8	97.2	92	75.9	89.1	87.2	87.9
V	93.1	100	92.5	88	96.3	89	75.9	84.6	85.7	89.5
VI	87.3	94.7	89.1	83.5	71.7	94.4	75.9	81.5	90.6	85.4
VII	84.7	100	92	94.8	96.7	94.4	91.7	92.2	92.5	93.2
VIII	91.4	98.7	89.4	88.1	91.7	92.9	77.2	85.2	92	89.6
IX	91.5	100	93.5	94	90	92.9	75.9	91.5	87.7	90.8
Average	86.1	95.4	87.3	88.4	92.9	92.3	77	86.5	86.6	

Based on table 4, it can be concluded that the average score for the nine generic science skills generator developed is 88.1. The best value of generic science skill development for all indicators is obtained by group VII with 93.2 value while the lowest science generic skill value is obtained by group I with the value 82,6. This is because in group VII there are the most accomplished students in analytical chemistry which is proven based on the observation result both on the implementation of laboratory and in the learning process in the classroom.

Assessment of generic science skill indicator for study group which has the highest average value that is on construct construct with value 95.4 with achievement of skill development of generic science skill optimal because marked by all student have finished on indicator build concept which can be seen on table 5. Although the percentage of implementation of the concept discovery phase in guided inquiry laboratory got the lowest score of 80.8%. However, the generic science skill indicator builds the concept of obtaining the greatest value. This proves that in building the concept of students are able to do it

independently. As [3] stated that the characteristics of adult learning include learning through sharing, self-learning, experiential learning and critical reflection. Thus, independently they are able to build the concept independently by utilizing its potential.

The lowest scores on the science-generic skills indicator are on symbolic language indicator with average score of 77. Thus, the achievement of generic science skills development in symbolic language indicator is not optimal yet. This is because there are unfinished mahasiswa as many as 6 people that can be seen in table 5. The low value of this symbolic language indicator is due to the unequal reaction writing, the use of inappropriate reaction arrows and inaccurate reaction results. The most fatal mistake happens is the result of an inappropriate reaction. Should write correct equation of reaction that is:



In general, students write down the results of  $\text{K}_2\text{NO}_3$  this is proof that students' understanding of the chemical bonding material and science generic skills on the symbolic language indicator is still low.

**Table 5.** Number of Students on the completeness of each generic science skill indicator Based on Psychomotor Assessment and Individual Reports.

GSS Indicator	the number of students who meet the omplete criteria	
	Complete	Uncomplete
A	50	4
B	54	0
C	54	0
D	54	0
E	54	0
F	54	0
G	48	6
H	51	3
I	51	3

Furthermore, concerning generic student science skill assessment is individually generated from the results of generic science-based generic practice reports generated individually and practicum assessment during learning. The results showed that the generic skills of science that has been developed optimally is on mathematical modeling, concept building, observation, logical framework and scale awareness. This is because the value of all students have good category and very good. While generic science skill on abstraction indicators, symbolic language, causal law, and logic inference have not been developed optimally. This is because there are still students who have not completed so the generic science skill are categorized as difficult to develop. The number of student data for the completeness of each indicator can be seen in Table 5, supported by table 3.

Based on table 3, the highest score on the abstraction indicator that is above the value of 80 reached by 31 students while the lowest value is ranged between the value of 50-59 obtained by 4 students. Based on that, the abstraction indicator has not developed optimally because there are still unfinished because its value is still low. The low value of this abstraction indicator is caused by several factors, such as the lack of precise students in making experimental principles and formulation of conclusions.

The next indicator of generic science skill is mathematical modeling indicator, logic framework, observation and scale awareness. The fourth indicator of this development is said to be optimal because all students are said to be thorough as contained in table 5. based on [1] research in the generic skills of cause and effect law are moderate or quite difficult to develop. Logical framework indicators are also optimally developed due to the completeness achieved by all students. This is characterized by the student's ability to draft the experimental procedure of titration of mineral water chloride, explaining the logical reason for the stability of compounds that can be used as standard solutions, both primary and secondary standard solutions. Although there are 6 people who are incomplete in designing the

experiment is the absence of blank titration procedures as one way to minimize the occurrence of errors in the calculation of chloride content. This needs to be further followed up by giving a little picture to the students of things that need to be done before doing the titration, so that the data obtained is accurate.

In the observation indicator, whether it is direct or indirect observation, has been achieved by the students completely. This suggests that the observational generic science skill indicator is easy to develop.

Furthermore, the scale awareness indicator, on this indicator students have very good penguasaannya and all students have been completed in the development listed in Table 5. This is seen during the lab, 39 students are good in carrying out the lab. It's just that there are 15 students who experience inaccuracy in reading the scale. This is due to the mastery of the use of practicum tools that are still low among students. Subsequent generic science skills that is on the indicators of causal law and student logic inference is still not optimal because of the 54 students still have not completed as many as 3 people.

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