The Implementation of Guided Inquiry Model to Increase Student Achievements and Science Process Skill on The Practicum of Analysis and Identification of Cations Ag+, Hg22+and Pb2+

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Abstract. This research was purposed to find out the effect of guided inquiry learning model to increase student achievement and science process skill on the practicum of analysis and identification of cationsAg^{+}, $Hg_2^{2+}$and Pb^{2+}. Experimental research method which named as one group pretest-posttest design was used. This research was done in Universitas Negeri Medan involved Chemistry study program students, which consisted of 35 person. The instrument which was used is essay test, student worksheet and observation sheet. The result of this research which was gained from average test of student process science skill indicated guided inquiry learning model on the practicum of analysis and identification of cations Ag^{+}, $Hg_2^{2+}$and Pb^{2+} was able to increase student achievement and science process skill significantly. The high categorized indicators were ability of planning the practicum and communicating, hypothesizing and applying the concept. The medium categorized indicators were ability of grouping, interpreting, observing and predicting. The achievement of student which was taught by using guided inquiry model on the practicum of analysis and identification of cationsAg+, Hg22+and Pb2+increased from pretest 46.05 became posttest 89.66. The highest percentage of student worksheet was in communicating ability, i.e. 90%..

Keywords: Guided inquiry,science process skill, cations Ag^{+}, $Hg_2^{2+}$and Pb^{2+}.

1 Introduction

The Qualitative Analytical Chemistry Practicum course is one of the compulsory subjects in the Undergraduate Program of Chemistry Department at Mathematics and Natural Sciences Faculty, Universitas Negeri Medan. This course is given in the third semester. This course provides students with knowledge about analysis and identification of cations and anions in chemical-based industries also the food and plantation industries in North Sumatra. However, this course is prepared such that students will able to apply the development of strengthen chemical materials in their daily lives, which support jobs in a chemical-based industry.

Learning by practicum is an important part which undeniable to be separated from teaching and learning activities in analytical chemistry. Practicum is the best media to develop science process skill because learning with practicum may provide opportunities for students to experience or do their own experiences which is processed according to their cognitive abilities (Nugroho et al, 2013 and Juniar et al, 2017). According to Harlen and Elstgeest

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(1999), science process skill is consisted of: (1) observing, (2) asking questions, (3) formulating hypotheses, (4) predicting, (5) finding patterns (relationship), (6) communicating effectively, (7) designing experiments, (8) carrying out experiments, and (9) measuring and calculating. So far, the practicum which is carried out in schools still doing verification only, which is proving the calculate. So far, the practicum carried out in schools was still verification in nature, which is only proving the concept or principle which has been studied (Rahmawati et al, 2014), therefore it is necessary to integrate the learning model with practicum activities for mini research for implementation of assignments which KKNI-based.

One of the effective learning models in mathematics and natural sciences which applicable in the development of chemical learning models is Guided Inquiry which consisted of formulating problems in the form of questions, formulating hypotheses, designing experiments, collecting data, analyzing data and formulating conclusions also developing science process skill. This learning model requires active involvement of students, because it cultivates the basics of scientific thinking in students, such that students learn more independently in the learning process and develop creativity in solving problems (Lawson, 2010 and Abdi, 2014). The influence of Guided Inquiry with Science Process Skills in science learning may increase students' motivation to learn, activity, elaboration and understanding of science learning (Nworgu, 2013 and Juniar et al, 2017). In addition, the influence of guided inquiry model on learning qualitative analytical chemistry is improving students' critical and positive thinking skills both by using video clip strategies, case studies and using popular science rubrics (Gupta et al, 2015) also student activities in the laboratory are more positive, effective and can be improved (Ceylan, 2016).

In the Qualitative Analytical Chemistry practicum with the topic of analysis and identification of cations Ag+, Pb2+ and Hg22+, the implementation of guided inquiry learning may create an atmosphere which is familiar to students so that improving science process skills, transfer skills, motivation and understanding of important concepts in learning and Qualitative Analytical Chemistry practicum which is equipped with LKM (Student Worksheet) (Uma et al, 2015)

2 Research Methodologi

This research was conducted by using experimental method with one group pretest-posttest design. Finding out the increasing of learning outcomes is done by implementing the guided inquiry and qualitative descriptive learning model to determine the effectiveness of the guided inquiry model in developing student science process skills. Research design is given in Table 1.

Table 1: Research design

Pretest	Treatment	Posttest
T_1	X	T_2

Explanation:
T1 : pretest to measure initial capability of students.
T2:posttestto measure final capability of students.
X :implementation of guided inquiry learning model.

This research was conducted at the Laboratory of Analytical Chemistry, Universitas Negeri Medan. The subject of this study is 35 students of chemistry study program who were taking the course of Qualitative Analytical Chemistry Practicum. The procedure is given in Figure 1 below.

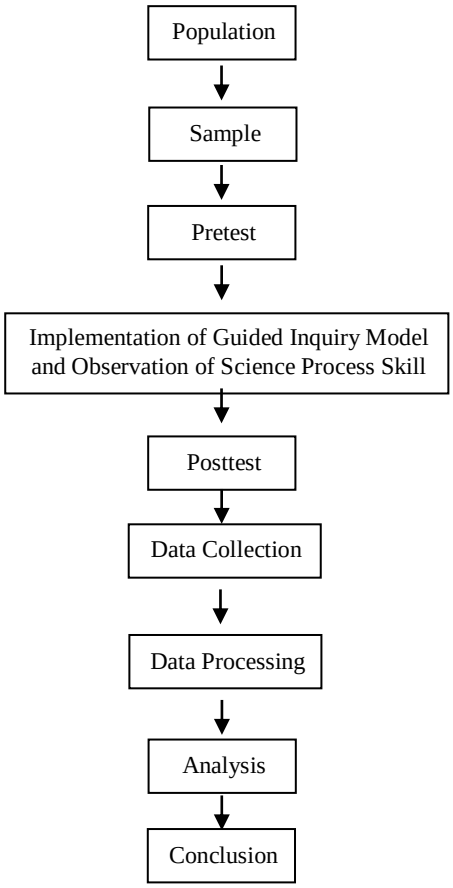

Figure 1:Procedure of research to measure students' achievement and science process skill in the practicum of analysis and identification of cations Ag^{+}, $Hg_2^{2+}$and Pb^{2+}

Data collection of student science process skills is done by using written tests and LKM (Student Worksheets). For the implementation of guided inquiry model, an observation sheet is used. Meanwhile, the data analysis to done by using normalized gain which obtained by calculating the difference in scores between the final test score (posttest) and the initial test score (pretest) divided by the difference between the maximum score and the initial test score. The result of normalized gain is divided in three criterions as follow:

0.00 – 0.29 = low level,
0.30 – 0.70 = intermediate, and
0.71 – 100 = high level.

The development of students' science process skill during the learning process is observed by using observation sheets in the form of rubrics with observers. One observer observed and recorded approximately 10 students. To facilitate the observation of the development of students' scientific process skills, in each learning students must use clearly visible identities. Effectiveness of guided inquiry learning model which is integrated with Student Worksheets in developing science process skills are assessed using formula below.

$$\text{Effectiveness}=\frac{Amount\ of\ Score}{Amount\ of\ Total\ Score}x100\% \quad (1)$$

3 Results And Discussion

The science process skill of students in the Qualitative Chemistry lecture material was measured by using a description test and student worksheet (LKM). This description test consists of 10 questions which carried out twice, namely before giving the treatment is pretest and after being treated is posttest. The question of pretest and posttest is developed according to science process skill (8 indicators). The pretest and posttest questions which were developed were made equal, which was adjusted to the students' understanding needs in the process of practicum analysis and identification of the cations of Ag+, Hg22+ and Pb2+. The results of the assessment of the average pretest and posttest of student science process skill is presented in Table 2.

Table2: Results of the assessment of students

No	Indicators	Pretest	Posttes	Gain
1	Observing	43.34	83.34	70
2	Grouping	45.46	82.20	67
3	Interpreting	45.63	82.57	67
4	Predicting	46.74	84.46	70
5	Hypothesing	44.51	86.34	75
6	Planning the experiment	47.51	89.11	79
7	Implementing the concept	47.46	86.31	73
8	Communicating	47.77	89.66	80
	Average	**46.05**	**85.49**	**72.62**

Based on Table 2 above, the average value of students' science process skill has increased from pretest to be posttest. This means that overall there is an increase in students' science process skill. The diagram that illustrates the improvement of students' science process skill is shown in Figure 2 below.

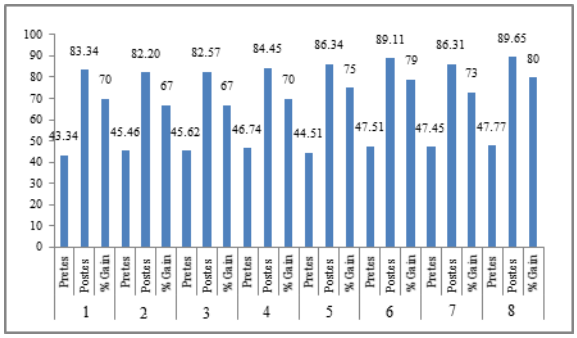

Figure 2:Comparison of pretest, posttest and n-gain result of students' science process skill on the practicum of analysis and identification of cations Ag^{+}, Hg_2^{2+} and Pb^{2+}

Figure 2 shows that skills of communicating the experiment result, planning the experiment, hypothesizing and applying the concept have high criteria meanwhile predicting and observing, classifying and interpreting skills have intermediate criteria. The highest gain is reached in communicating and planning experiment. This is possible because in the implementation of the KKNI curriculum, students have obtained six assignments namely Routine Tasks (TR), Critical Journal Reports (CJR), Critical Book Reports (CBR), Mini Research (MR), Engineering Ideas (RI) and Projects (P). Students also have often been trained in writing separation schemes and identification reactions for the cations of Ag+, Hg22+ and Pb2+such as the following reactions (Slowinski, 1990):

$Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \leftrightarrow AgCl_{(s)white}$

$AgCl_{(s)} + 2\ NH_{3(aq)} \leftrightarrow [Ag(NH_3)_2]^{+}_{(aq)} + Cl^{-}_{(aq)}$

$[Ag(NH_3)_2]^{+}_{(aq)} + Cl^{-}_{(aq)} + 2\ H^{+}_{(aq)} \leftrightarrow AgCl_{(s)} + 2\ NH_4^{+}{}_{(aq)}$

$Pb^{2+}_{(aq)} + CrO_4^{2-}{}_{(aq)} \rightarrow PbCrO_{4\ (s)yellow}$

$PbCrO_{4(s)} + NaOH_{(aq)} \rightarrow Pb(OH)_3^{-}$

$PbSO_{4(s)} + CO_3^{2-}{}_{(aq)} \leftrightarrow PbCO_{3(s)} + SO_4^{2-}{}_{(aq)}$

$Hg_2^{2+}{}_{(aq)} + H_2S_{(aq)} \rightarrow HgS_{(s)} + 2H^{+}_{(aq)}$

$Hg_2Cl_{2(s)} + 2\ NH_{3(aq)} \rightarrow Hg_{(s)black} + HgNH_2Cl_{(s)white} + NH_4^{+}{}_{(aq)} + Cl^{-}_{(aq)}$

$Hg_2Cl_{2(s)} + NaOH_{(aq)} \rightarrow Hg_{(s)black} + HgO$

4 Conclusions

The result of this research especially from the average test on students' science process skill stated that the guided inquiry learning model in the lecture of the practicum of analysis and identification of cations Ag+, Hg22+ and Pb2+could significantly improve student learning outcomes and process science skill. The indicators which are categorized as high: planning practicum and communicating, hypothesing and applying concept. The intermediate categories are the skill of grouping, interpreting, observing and predicting. The student achievement which learned by applying the guided inquiry model in the practicum analysis and identification of Ag+, Hg22+ and Pb2+ was increased from pretest 46.05 to posttest 89.66. The highest percentage of student worksheet is on communication skills which is 90%.

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