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Developing Guided Inquiry-Based Module on Topic Argentometry to Improve Science Process Skills Preservice Chemistry Teachers

Anna Juniar[1,*], Albinus Silalahi[2], RetnoDwiSuyanti[3]

[1]Chemistry Education Study Program Postgraduate SchoolUniversitas Negeri Medan
[2,3]Department of Chemistry Education Universitas Negeri Medan
[*]*Corresponding author. Email: anna.juniar@ymail.com*

ABSTRACT
This research was done in chemistry Education Study Program of Universitas Negeri Medan, which aimed to develop standardize and test of the chemistry module on the topic Argentometry. The research wasbegun by choosing KKNI (Indonesian National Qualification Framework) and then analyzing chemistry book on the topic Argentometry and arranged in draft. The arranged module was standardized by lectures according to the questionaire from Badan Standar Nasional Pendidikan (BSNP). The result showed that developed module met the BSNP criteria with the feasibility of: content (3.52), language (3.52) and performance (3.73) and categorized as valid without revision. Validated module was made in hardcopy and tested to preservice chemistry teachers' 2017A as experiment class (EC), and 2017B as control class (CC) using manual book from FMIPA-Chemistry Education Unimed. Pretest average score of both EC and CC students was 20. After teaching and learning process was done, postest average score increased to be 89 in EC and 78 in CC. Science Process Skills aspect that developed were classified as high and consisted communicating in writing and orally at 95%, formulating hypotheses 90.9%, experimenting 92%, observing 87%, measuring 83% and low stage deciding tools and materials 72% respectively. The implementation of inquiry guided module, support developed module were able to improve preservice learning outcomes by 83.89%.

Keywords: *science process skills, argentometry, guided inquiry, module*

1. INTRODUCTION

The availability of facilities and infrastructure to support the success of learning is sometimes insufficient to carry out the learning process independently [1]. Module is a means of supporting the success of learning chemistry. For this reason, a module needs to be developed in the hope that preservice chemistry teachers are able to plan and carry out practicum independently in accordance with the syntax of guided inquiry to hone science process skills. Therefore, it is necessary to conduct research by developing an integrated guided inquiry module for preservice science process skills [2].

Learning with practicum is an important part of teaching and learning activities, because practicum is the best means of developing science process skills, students are given the opportunity to experience their own experiences which will be processed according to their cognitive abilities [3]. Even though practicum currently there are still many traditional verification practicum activities based on practicum guides that aim to prove existing concepts or theories [4].

Guided inquiry is a teaching model that allows preservice to move gradually from identifying problems, defining hypotheses, formulating problems, collecting data, verifying results and drawing conclusions under the direction of lecturers [5] and [6]. Guided inquiry models can provide opportunities for preservice to learn how to find facts, concepts and principles through their science process skills [7].

Science process skills involves learning competence, procedural competence, social competence and communicative competence [8] and [9]. The abilities that can be developed in KPS are: observing, communicating, classifying, inferring, predicting, identifying variables, designing experiments, analyzing investigation [10-12].

One of the difficult analytical chemistry topics which is taught in preservice chemistry teacher is Argentometry, because this topic has conceptual and algorithmic properties [13]. The difficulty is related to the character of analytical chemistry such as concepts and calculations. In addition, preservice tend to think that learning is a burden, not hobby. This is evidenced by observations made in analytical chemistry at Department Chemical Education, Faculty of Sciences Universitas Negeri Medan.This is supported by data on the final score Analytical Chemistry is low in LPTK North Sumatra which has an average score of 77.53.

The using of guided inquiry-based modules provides an understanding of definitions, facts, concepts, principles and processes of search and concreate action, so that the learning is preservice-centered learning with guided inquiry based modules has been shown to provide good result in improving preservice achievement on argentometry and improving creative thinking skills [14]. So this research is determine: developed inquiry-based module of argentometry can satisfy National Education Standars Agency (BSNP), and how its implementations can improve preservice learning outcomes and science process skills.

2. RESEARCH METHODOLOGY

The type of this research is Educational Research and Development Design which was modified from the development of Borg & Gall learning model [15]. The implementation of validated module was done in Chemistry Education Study Program of Willem Iskandar Pasar V Medan Estate. The subject was preservice chemistry teachers' in fourth semester of chemistry education program who took analytical chemistry subject in the academic year of 2017-2018 Universitas Negeri Medan, on argentometry materials. The sample in this study had 40 people, One Group Pretest-Postest Design with a quasi-experimental method were used in this study. The procedures of this study were conducted following a research procedure that had been done by previous researchers [16-17]. It consisted of several stages, including (1) analyzing the chemistry books of argentometry materials commonly used in chemistry education Unimed; (2) construction and development; (3) standardization, (4) implementation.

The revised module was then printed as necessary to be used in helping preservice chemistry teachers' study the material of argentometry. The developed module was used for argentometry analytical chemistry learning in preservice chemistry teachers 2017A for the experimental group and 2017B as control group. In order to find out the level of initial knowledge, pretest was conducted then learning was done by using guided inquiry learning model with science process skills integrated in experimental group and conventional in control group, learning evaluation (posttest) was done at the end of learning process.

Technique of data analysis used SPSS 22. For testing the increasing percentage of preservice chemistry teachers' learning outcomes, the formula below is used [18]:

$$\%g = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \times 100\% \quad (1)$$

Explanation:
g<0.3 = low,
0.3 <g<0.7 = intermediate, and
g>0.7 = high
For testing the hypothesis in both of sample classes, t-test one tail is used with formula below [19].

$$t_{statistics} = \frac{x_1 - x_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (2)$$

Explanation:
x_1 = average score of students' learning outcomes in experiment class
x_2 = average score of students' learning outcomes in control class
S_1^2 = deviation standar of experiment class
S_2^2 = deviation standar of control class
n_1 = number of sample in experiment class
n_2 = number of sample in control class
$t_{statistics}$ = Value of calculated *t*. Significant level (α) = 0.05
with degree of fredom (df) = (n_1+n_2), H_0 is accepted if $t_{statistics} \leq t_{table}$ and Ha is accepted if $t_{statistics} \geq t_{table}$

3. RESULT AND DISCUSSION

3.1. Result

3.1.1. Module Standardization

Guided inquiry-based module which has been developed was validated by expert validator, they were two chemistry lecturers in Universitas Negeri Medan and one chemistry lecturers in Universitas Sumatera Utara. The result is presented in Table I.

Table 1. Average assesment result of guided inquiry based module on the topic of argentometry

No	Criterion	Assesment Lecturer			Average	Criterion of validation
		1st	2nd	3rd		
1	Feasibility of Content	3.55	3.48	3.55	3.52	Valid, no revision needed
2	Feasibility of Language	3.48	3.55	3.55	3.52	Valid, no revision needed
3	Feasibility of Performan	3.70	3.76	3.73	3.73	Valid, no revision needed

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The assessment result of guided inquiry module on argentometry developed material is presented in Table II.

Table 2. The result of problem assesment on guided inquiry module

No	Assesment Component	Assesment Result	Criteria
1	Reliability	3.83	Valid, no revision needed
2	Curiousity Stimulation	3.66	Valid, no revision needed
3	Communicative	3.51	Valid, no revision needed
4	Dialogical and Interactive	3.50	Valid, no revision needed
5	Technique of Presentation	3.78	Valid, no revision needed
6	Learning Presentation	3.77	Valid, no revision needed

3.1.2. Student Learning Outcomes

Students' learning outcomes which were analyzed in this research were normalized postest score. First stage, before sample was given action, pretest was done in order to know the normality and homogeneity of initial capability in both classes. Second stage, teaching and learning process was done by using guided inquiry-based module in experiment class and manual book from university in control class. Both classes learned same topic, which was argentometry. Based on the calculation science process skills preservice chemistry teachers' are presented in Fig 1 below.

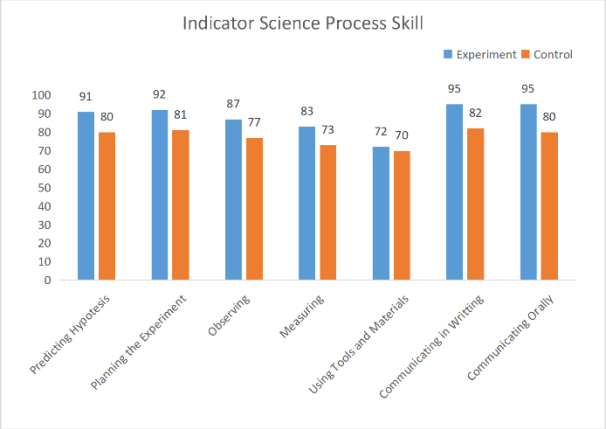

Figure 1. Average Score of Student in Argentometry by Guided Inquiry Module

3.1.3.The effectivityofscienceprocess skill for preservice chemistry teachers' which is gained by analytical chemistrypracticum in argentometry

The preservice chemistry teachers' process skill in argentometry was determined by using essay tests and student worksheets. The score of postest score and pretest score which used is average of the postest scores and average pretest score for each class. The N-*gain* value for experimental class is 0.8389 meanwhile in the control clas is 0.7525. So, we get the effectiveness of model is 1.1148.

3.1.4.Descriptive Analysis of Student Responses toLearning

Student responses to learning that have been carried out in the experimental class are measured by means of a questionnaire. This questionnaire contains 10 statement items. Filling in the questionnaire is given after all learning activities have been carried out. Student responses to inquiry learning are shown in Fig. 2 below.

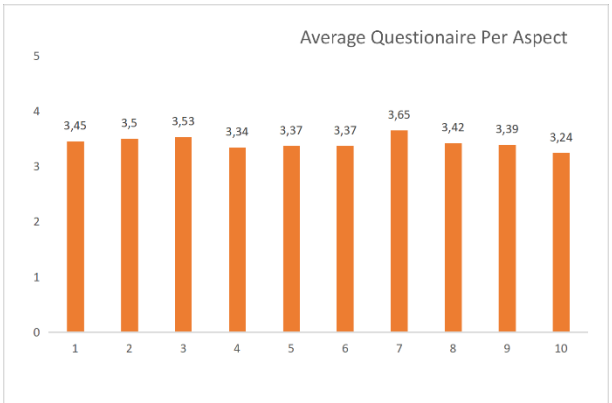

Figure. 2. The average of the questionnaire statement of guided inquiry learning by preservice chemistry teachers'

Information:

1. I am happy and motivated to learn argentometry by using guided inquiry.
2. Implementation guided inquiry learning makes it easy for me to understand argentometry.
3. Implementation guided inquiry learning can increase my curiosity.
4. Learning analytical chemistry with a guided inquiry model gave me the opportunity to think and exchange ideas with friends in discussion.
5. The problem given by the researcher encourages me to gather information from various sources.
6. I feel happy to be able to design my own experiments in practical activities.
7. With the learning model given by reachers, I came to understand some of the chemical concept that are related in everyday life.
8. Implementing learning with guided inquiry models can improve my ability to remember an argentometry concept longer.
9. Implementation of learning with guided inquiry models suitable for argentometry material.
10. Implementation of learning with guided inquiry models needs to be applied to other chemistry subject matter.

3.2. Discussion

In this study, observations were made eight aspect science process skills, namely observation, predicting hypotheses, using tools and materials, planning experiments, measuring, interpreting observations, communicating in writing and orally. The increase in preservice science process skills which is taught with the guided inquiry learning model in the experimental class is higher than preservice chemistry teachers' which are taught with the model conventional.

In general, preservice chemistry teachers' gave positive responses to analytical chemistry using the guided inquiry learning model. This is proven when the teaching and learning process takes place, preservice chemistry teachers' feel happy learning chemistry with the guided inquiry learning model, because in this learning preservice chemistry teachers' are actively involved starting from formulating problems, proposing hypotheses, designing experiments, collecting data, analyzing data and making conclusions. So that the learning activities they do become more meaningful and make it easier for them to understand and remember the subject matter because they can find the concept of subject matter independently. This is in accordance with previous research that science process skills based on scientific inquiry make preservice chemistry teachers' learn to think critically and inquiry is used as a very effective teaching approach that helps preservice chemistry teachers' to understand concepts well [20].

Guided inquiry learning is applied so that preservice chemistry teachers' are free to develop the concepts they are learning, not only limited to material that is recorded and then memorized. In addition, the guided inquiry model can improve concept understanding and learning motivation because preservice chemistry teachers'are actively involved in investigating. This investigation has learning stages that can be used to train science process skills [21].

4. CONCLUSION

Based on the result of data analysis and discussion of research results it can be concluded that guided inquiry learning can improve preservice chemistry teachers' learning outcomes. The developed module meets the BSNP criteria, with feasibility of content (3.52), feasibility of language (3.52) and feasibility of performance (3.73) with valid criteria and does not need to be revised. The effectiveness of the science process skills of the preservice chemistry teachers' obtained through the analytical chemistry lab with the topic of argentometry is 1.1148 with an N-gain value of 0.8389. The aspects of science process skills that can be developed are using tools and materials (72%), measuring (83%), observing (87%), interpreting observations (88%), predicting hypotheses (90%), planning experiments (92%) and communicating orally and in writing (95%).

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