The Effect of Teacher Candidates’ Science Process Skill on Analytical Chemistry Through Guided Inquiry Learning Model

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Abstract. This study was purposed to find out is there any significant difference of guided inquiry and conventional learning model implementation towards Analytical Chemistry practicum courses, particularly on Redox, Argentometry and Complexometry titrations. This study also analyzed the effect of the learning model through quasi-experimental method. There were 28 teacher candidates in experimental class which taught by using guided inquiry (GI) learning model and 23 teacher candidates in control class which taught by using conventional learning model. Based on Mann-Whitney test, p-values for Redox, Argentometry and Complexometry practicum courses were 0.001, 0.012, 0.030 respectively. Since p-values were less than 0.05 then Ha is accepted which means teacher candidates’ science process skill in experimental class is different significantly compared to control class. The effect of model was calculated through N-gain which score 81%, 76% and 80% in experimental class and 55%, 57% and 59% in control class for respective practicum. This means the teacher candidates’ science process skill is better in experimental class (taught by using GI model) than control class (taught by using conventional model). These findings give contribution to chemistry education especially for improving chemistry teacher candidates’ quality and reducing them who often feel difficult to learn Analytical Chemistry.

1. Introduction

Science process skill is physical and mental skill which related to the basic abilities that possessed, mastered, and applied in the scientific activities, such that the researchers able to find something new. Apart from being an approach to learning, science process skill is a basic asset which students needed to understand science. In this case, the formation of knowledge in science is carried out through a scientific process (Harlen, 1999). Through the science process skill, students are expected to be more creative, critical, opened, innovative, also competitive in the current world competition in society. On top of that, science process skill is known as procedural, experimental skill and reliable to investigate the habits of scientific thought (Abungu, 2014). Therefore as chemistry teacher candidates, it is important for them having science process skill such as measuring, classifying, predicting, communicating, controlling variables, providing hypotheses and interpreting data because they need that when doing research and specifically when someday they stand as a chemistry teacher in a class (Zeidan and Jayosi, 2015). Especially in the topic of analytical chemistry which consisted of
qualitative analytical chemistry (cations, anions, and ionic compounds) and quantitative analysis (volumetry and gravimetry), most of the topics need science process skill to more understand the concept and matters. Therefore, this study discussed about how we implement such learning method in quantitative analytical chemistry which consisted of redox, argentometry and complexometry (Skoog, 1994).

Based on the latest observation of chemistry teaching and learning process in Analytical Chemistry subtopics at the LPTK, most courses are loaded with many calculations and applicative discoveries such that most chemistry teacher candidates learn by memorize the formula instead of develop the important concepts. During the last three years, average score of final examination of Analytical Chemistry at a LPTK in North Sumatera had an average value around 77.53 only. By figuring out their learning outcomes, it was revealed that chemistry teacher candidates had difficulty in understanding the concepts so that they learn by memorize the matters and did not understand the relationship between concepts. In this regard, it is necessary to strive for the development of such learning model which able to equip and activate their knowledge, foster thinking skill and strengthening concepts to achieve basic competencies in Analytical Chemistry. Therefore, their science process skill and creative thinking skill are improved and when being a chemistry teacher, they able to find facts, explain concepts and theories to their students with their own scientific attitude (Tawil & Liliasari, 2014).

In this study, we proposed a learning process by using guided inquiry model to provide the opportunity for teacher candidates to have real and active learning experiences such that they are trained to solve problems while making decisions. This is possibly happened because the teacher candidates are given the opportunity to integrate various disciplines to science, so that they are able to achieve a better understanding through exploratory processes and methods to test new ideas (Nurkhamid, 2016). In addition, Malihah (2014) explained that guided inquiry learning model has more advantages in emphasizing the balanced development of cognitive, affective, and psychomotor aspects also giving space for teachers’ candidates to learn according to their learning style. In line with that, Evrim Ural (2016) stated that guided inquiry based on the laboratory applications affected the development of positive attitudes towards the learning environments such that students’ understanding related to the subject or matters are increased and their critical thinking and research skill also improved. In this study we would like to compare the teacher candidates’ science process skill on Analytical Chemistry especially redox, argentometry and complexometry titrations by implement guided inquiry (GI) and conventional learning model. The better result will be recommended to be implemented in the teaching and learning process.

2. Literature Review

2.1. Guided Inquiry Learning Model

Guided inquiry (GI) is one of the inquiry-learning models which have requirement that the teachers’ candidates need to conduct a series of investigation, exploration, search, experiment, and research. This learning is centered on teachers’ candidates able to work in small groups. In implementing guided inquiry, prospective teachers receive guidelines according to the learning they need. Learning with the application of guided inquiry requires prospective teachers to carry out investigations with science process skill which emphasize the learning process, creativity in gaining knowledge and applying it in everyday life (Aristina, 2018). Guided Inquiry learning is also one of the learning which oriented to constructivist theories which gives teachers candidates the ability to search for concepts and meanings and build knowledge individually based on experience in their environment (Pamenang et al, 2019). According to Gilamas, Cherif, Keller and Hansen, the guided inquiry method of teaching and learning able to promote students’ active participation in the process better (Gilamas, 2001).

Guided inquiry (GI) learning model is designed to provide some learning experiences for teachers’ candidates through scientific methods. In this model, teachers’ candidates will ask questions and conduct some investigations to find the answers. Teachers candidates are actively involved in the
stages such as observing, asking questions, making hypotheses, looking for information, discussing, expressing opinions and objections, concluding, and presenting their findings. The process which occurred in this activity is providing us an opportunity to bring up unexpected new ideas (Wahyunii, 2019). According to (Kurniawan, 2013), we revealed that guided inquiry-based learning effectively improves creative thinking skill better because teacher candidates become more actively involved especially in creating biology learning media.

Science Process Skill The science process skill deals with how the individuals look for and process the information through scientific investigation. In Turkey, Aktamis and Ergin (2008) have investigated the impact of implementation of science process skill to improve the students’ scientific creativity and attitudes towards science achievements. Similar with them, Abungu, Okere & Wachanga (2014) also has argued about science process skill is the ability which needed to enhance students’ performance and their scientific skill successfully that influenced to their achievement of chemistry. The explanation is also proposed to achieve very good learning output and optimal performance, educators are required to systematically measure and evaluate students’ science process skill (Cigrik & Ozkan, 2015). The determination of calculation and evaluation of science process skill is significant with references to chemistry education programs, as society and industry that expect science graduates to have a high competence in investigating or addressing the actual problems using the scientific method meanwhile at the same time it is also having an innovation to anticipate the occurrence of ill-structured problems in the next time (Irwan, 2018).

Science process skill is learnable if taught in a formal learning in the class with the usage of good teaching methods. The availability of teaching media and the professionality of teachers as facilitators in the learning is needed to develop process skill in such ways. Some researches proven that the science process skill will be formed by inquiry activities so that many researchers and educators of science also teaching science with process skill which enables teachers candidates to gain authentic experience, thus enabling teachers candidates to learn more meaningful and enhancing teachers candidates’ scientific knowledge (Arantika, 2018).

In Indonesia, one of the purposes of chemistry teaching is to enable teachers’ candidates to apply science process skill in order to understand the concepts, issues and phenomena. In this context, teacher candidates are required to master generic skill and use scientific facts in complex situation (Brown, White, Wakeling & Naiker, 2015). Consequently, if teacher candidates are actively involved in various investigations, they become more confident, mastery science process skill and have a critical thinking. In other word, science process skill able to facilitate teacher candidates to develop higher mental skills. However, if the science process skill is not well developed, then the concept which emerges cannot lead the teachers’ candidates in understanding the world around them. As a result, this can certainly affect their ability in solving problems (Irwan, 2019). Therefore, we need to train teacher candidates’ science process skill with meaningful learning experiences so that they can also develop higher-order thinking.

2.2. Redox, Argentometry and Complexometry Titrations

In this study, the materials discussed were redox, argentometric, and complexometry titrations. The analyte in an oxidation/ reduction titration must be in a single oxidation state at the outset. Often, however, the steps which precede the titration (dissolution of the sample and separation of interferences) convert the analyte to a mixture of oxidation states. For example, the solution formed when an iron(II) and iron(III) ions. If we choose to use a standard oxidant for the determination of iron, we must first treat the sample solution with an auxiliary reducing; if, on the other hand we plan to titrate with a standard reductant, pre-treatment with an auxiliary oxidizing reagent will be needed (Skoog, 1994).

Titrimetric methods are based on silver nitrate which sometimes termed as argentometric methods. Argentometric is used for the determination of halogen, mercaptans, fatty acids and several divalent inorganic anions. The end point produced by a chemical indicator usually of a colour change or, occasionally, the appearance or disappearance of turbidity in the solution being titrated. The
requirements for an indicators for an indicators for a precipitation titration are analogous to those for an indicators for a neutralization titration: (1) the colour change should occur over a limited range in p-function of the reagent or the analyte, and (2) the colour change should take place within the step portion of the titration curve for the analyte (Skoog, 1994) and (Holler, 1996).

The titrimetric method based on complex forms is termed as the complexometric method. This method has been used for more than a century. Most of metal ions react with electron pair donors to form coordination compounds or complexes. The donor species, or ligand must have at least one pair of free electrons available for bond formation, water, ammonia, and halide ions are common inorganic ligands. In analytical applications it is based on a specific class of coordinating compounds called chelates. Chelates are produced when metal ions coordinate with two or more donor groups of one ligand to form a five- or six-membered heterocyclic ring. A titrant, a multidentate ligand, particularly one that has four or six donor groups, has two advantages over its unidentified counterpart. Firstly, they generally react more completely with cations and thus provide a sharper endpoint. Secondly, they usually react with metal ions in a one-step process, whereas the formation of complexes with unidentified ligands usually involves two or more intermediate species (Skoog, 1994).

3. Methodology
This study was one group pre-test and post-test design with a quasi-experimental method. The subject of this study was teacher candidates in the fourth semester of chemistry education program, they also took analytical chemistry lecture in academic year of 2017-2018 at Universitas Negeri Medan. They were consisted of 2 classes which taken using random sampling, namely experimental class with 28 teacher candidates which taught by using analytical chemistry textbook integrated with guided inquiry model as with the science process skill meanwhile the control class consisted of 23 teacher candidates which taught by using conventional model. The teaching and learning process in this study was conducted in ten meetings in the class and three laboratory meetings throughout one semester.

In each practicum topic in both experimental and control classes, we did pre-test at the beginning and end it by post-test at the end of meeting too. The technique of data collection was done by using multiple choice-test which consisted of thirty questions to measure their science process skill such as predicting hypotheses, planning the observation, using tools and materials, measuring, observing, interpreting the observation, and lastly communicating in writing and communicating orally. To convince the researcher, the questions were validated firstly by expert validators before being used.

The data of experiment and control group teacher candidates are pre-test and post-test. To prove there is a significant difference in both classes, we use t-test. However, it needs prerequisite test (normality and homogeneity test). If it is not satisfied, then we use Mann-Whitney test. To calculate the effect of both learning model, N-gain formula is used. To find out the specific science process skill, a direct observation on the redox, argentometric, and complexometry titration practicum were also conducted in the laboratory by using an observation sheet while essay test is used to find out the indirect science process skill. According to (Trianto, 2012) there are six phases needed to implement as below.

Step 1  Present question
In this step, the tutor guides teacher candidates to identify problems and divides into groups

Step 2  Make a hypothesis
In this step, the tutor guides teacher candidates to find relevant information

Step 3  Designing experiments
In this step, the tutor gives the opportunity to teacher candidates find order steps according to the hypothesis

Step 4  Do an experiment
In this step, the tutor guides teacher candidates to get information through experiments

Step 5  Analyzing relevant data
In this step, the tutor gives the opportunity to each group to present the findings

Step 6  Making a conclusion
Tutor guides teacher candidates in making conclusions
4. Results
The data in this study was the score of teacher candidates’ science process skill on redox, argentometric, and complexometry titrations. The science process skill is consisted of predicting hypotheses, planning the experiment, using tools and materials, measuring, observing, interpreting the observation, communicating in writing and communicating orally. The data were taken from the experimental class which was taught by using Guided Inquiry learning model meanwhile the control class was taught by using Conventional model. In summary, total of teacher candidates which being sample in this study was 51, where 28 for experimental class and 23 for the control class.

Firstly, to prove that there is significant difference of teacher candidates’ science process skill in experimental and control class, we need to test whether the data came from normal and homogeneous population. As given in both Table 1 (a) and (b), by using Kolmogorov-Smirnov and Shapiro-Wilk, we found that all p-values (Sig) were less than confidence level 0.05. As result, all data were not normal distributed. Therefore, we tried to approach the analysis by using non-parametric test.

Table 1. The normality test of redox, argentometric, and complexometry titration in

| Test of Normality | Kolmogorov-Smirnov | Shapiro-Wilk |
|-------------------|-------------------|--------------|
|                   | Statistic | Df | Sig. | Statistic | Df | Sig. |
| Pretest_Redox     | .238      | 28 | .000 | .869      | 28 | .002 |
| Posttest_Redox    | .210      | 28 | .003 | .808      | 28 | .000 |
| Pretest_Argentometry | .254   | 28 | .000 | .828      | 28 | .000 |
| Posttest_Argentometry | .275 | 28 | .000 | .634      | 28 | .000 |
| Pretest_Complexometry | .299   | 28 | .000 | .779      | 28 | .000 |
| Posttest_Complexometry | .229  | 28 | .001 | .805      | 28 | .000 |

(a) Lilliefors Significance Correction

| Test of Normality | Kolmogorov-Smirnov | Shapiro-Wilk |
|-------------------|-------------------|--------------|
|                   | Statistic | df | Sig. | Statistic | Df | Sig. |
| Pretest_Redox     | .239      | 23 | .001 | .893      | 23 | .018 |
| Posttest_Redox    | .263      | 23 | .000 | .823      | 23 | .001 |
| Pretest_Argentometry | .244   | 23 | .001 | .818      | 23 | .001 |
| Posttest_Argentometry | .258 | 23 | .000 | .851      | 23 | .003 |
| Pretest_Complexometry | .248   | 23 | .001 | .798      | 23 | .000 |
| Posttest_Complexometry | .191  | 23 | .029 | .867      | 23 | .006 |

(a) Lilliefors Significance Correction

For non-parametric test, we choose Mann-Whitney. Different with t-test, Mann-Whitney tested the difference of median in the data. However, this test also has a prerequisite test, which is homogeneity of data. Therefore, we run the homogeneity test of data. However, the test was held only for the post-test data because in final Mann-Whitney test, we will compare the post-test only. Based on table 2, we see that the significance (p-values) for each practicum topic are greater than confidence level 0.05
(0.916, 0.219, 0.059 for redox, argentometric, and complexometry titrations respectively). As result, the data came from population that have similar variance (homogeneous). Since the data was homogeneous, then Mann-Whitney test is executable.

Table 2. The homogeneity test of redox, argentometric, and complexometry titration in both class

| Test of Homogeneity of Variances | Levene Statistic | df1 | df2  | Sig.  |
|----------------------------------|-----------------|-----|------|-------|
| Redox                            | .011            | 1   | 49   | .916  |
| Argentometry                     | 1.549           | 1   | 49   | .219  |
| Complexometry                    | 3.732           | 1   | 49   | .059  |

Let define H0 as there is no significant difference between experimental and control class meanwhile H1 as there is significant difference between experiment and control class. Based on Mann-Whitney test in Table 3, the significance (p-values) were less than 0.05. As result H0 is rejected and H1 is accepted. This means there is significant difference between experiment and control class. For next part, we will show which learning model which contributed to this significant difference including the effect.

Table 3. The Mann-Whitney test in each topic of redox, argentometric, and complexometry titration

| Test Statisticsa | Redox | Argentometry | Complexometry |
|------------------|-------|--------------|---------------|
| Mann-Whitney U   | .000  | 23.000       | .000          |
| Wilcoxon W       | 276.000 | 299.000  | 276.000 |
| Z                | -6.199 | -5.713   | -6.185        |
| Asymp. Sig. (2-tailed) | .001 | .012     | .030          |

a. Grouping Variable: TC_Group

The effect of each learning model is given in Table 4 below. The following table presents the average value of pre-test, post-test, and N-gain score in redox, argentometric, and complexometry titration materials of chemistry teachers’ candidate. The highest average of pre-test score is 35.43 in control group and 48.39 in experimental group for both for Argentometric material. Meanwhile, the highest average postest is 71.08 in control group for Complexometry and 90.17 in experimental group for Argentometric material. To determine the impact of learning model, we may evaluate the N-gain score. In control class, the highest N-gain is 0.59 (59%) in Complexometry meanwhile in experimental class, the highest N-gain is 0.81 (81%) in Argentometry. Because in each material, the N-gain in experimental class is higher than control class, then we may conclude that the effect of implementation guided inquiry model in experimental class is better rather than conventional learning in control class.

Table 4. The average score of pre-test, post-test, N-gain of redox, argentometry, and complexometry titration

| Materials     | Control Class | Experimental Class |
|---------------|---------------|--------------------|
|               | Pre-test | Post-test | N-gain | Pre-test | Post-test | N-gain |
| 1 Redox       | 29.13    | 69.78     | 0.57   | 44.64    | 86.96     | 0.76   |
| 2 Argentometric | 35.43    | 70.65     | 0.55   | 48.39    | 90.17     | 0.81   |
| 3 Complexometry | 29.91    | 71.08     | 0.59   | 45.17    | 89.28     | 0.80   |
4.1. Science Process Skill on Analytical Chemistry Practicum

Laboratory work is related to scientific skills which should be acquired by teachers’ candidates with purpose to improve their scientific investigation, laboratory skills and problem solving (Arabacioglu & Unver, 2016; Feyzioglu, Demirdag, Akyildiz & Altun, 2012). In the laboratory activity, equipment and tools should not be provided directly, but to give a challenge, the students should be given a situation or problem such that they asked to form a hypotheses, design the experiment, verify, record the data, asses and finally interpret the finding (Gultepe & Kilic, 2015). In the practicum sessions, science process skill of the observation were obtained from the observation sheet meanwhile their science process skill from the score of ability to answer the question, analyse data and state conclusion through the guided inquiry model on the sheet of essay test.

In the redox practicum, teacher candidates learned the phenomenon of chlorine in swimming pools. Calcium hypochlorite or better known as chlorine, is a type of disinfectant commonly used in swimming pool water. Chlorine or Calcium hypochlorite is a chemical compound which has the chemical formula Ca (ClO)₂. This compound is relatively stable and has more free chlorine than sodium hypochlorite. Lastly, chlorine is generally in the form of a white powder that will split in water to produce oxygen and chlorine gas which smells strong. The function of chlorine in swimming pool water is not only to kill pathogenic bacteria that are spread in pool water, but also to purify swimming pool water. The use of chlorine in swimming pools must be adjusted to the required concentration and the safe limits set by regulatory agencies. Lack of chlorine concentration can cause the pathogenic bacteria in the swimming pool not to be cleared away so that it can cause the spread of infectious diseases. Meanwhile, excessive chlorine concentration will cause health hazards due to chlorine gas remaining in swimming pool water. Determination of chlorine in chlorine can be carried out by the oxidation-reduction titration method, as well as by determining the levels of Cu²⁺ and Pb²⁺ ions.

4.2. Science Process Skill in The Observation of Redox Practicum

In the observation of redox practicum in experimental class, we used an observation sheet which consists of eight indicators which consisted of observing, inferring, formulating hypotheses, grouping, planning experiments, interpreting observation, communicate in writing and communicate orally is given through the following Table 5.

| No | Indicators                          | Activity                                                                 | Score | Information       |
|----|------------------------------------|--------------------------------------------------------------------------|-------|-------------------|
| 1  | Observing                          | Based on the picture of the phenomenon shown, students observed the effect of chlorine use in swimming pool water | 90.56 | Very Good         |
| 2  | Inferring                          | From the teacher candidates' answers to the described phenomena, they can predict the use of the appropriate chlorine concentration quantitatively to kill pathogenic bacteria according to the chemical concept. | 84.31 | Very Good         |
| 3  | Formulating a hypothesis           | From the problem formulations made by students, they can make hypotheses from the chloride determination practicum by using their redox titration | 80.76 | Very Good         |
| 4  | Grouping                           | Students can classify what tools and materials are needed to determine the chlorine content in the swimming pool and redox titration | 89.56 | Very Good         |
| 5  | Planning Experiments               | Students can write down the work steps in determining the chlorine content in the water in the swimming pool | 79.35 | Good              |
| 6  | Interpreting Observations          | Tabulated the observational data they obtained during the chloride determination practicum by redox titration | 90.55 | Very Good         |
| 7  | Communicate in writing             | Make reports and conclusions from the results of experiments to determine chloride levels by redox | 94.75 | Very Good         |
Communicate orally

Students present and discuss the results of the experiment to determine chloride levels by redox titration in front of the class

95.56  Very Good

Based on table 5 above, teacher candidates used their skill well and especially satisfied when delivering the redox practice especially when arranging communication orally. However, their planning of experiment needs to be enhanced better. Based on that description, the science process skill ability on redox practicum can be illustrated as below.

![Figure 1](image-url)

**Figure 1.** The teacher candidates’ science process skill on observation of redox titration practicum

### 4.3. Science Process Skill in The Observation of Argentometric Practicum

In the observation of argentometric practicum, there were eight observed indicators in Experimental class, i.e. observing, inferring, formulating hypotheses, grouping, planning experiments, interpreting observation, communicate in writing and communicate orally is given in the following Table 6 below.

**Table 6.** Observation Result of Argentometric in Experimental Class

| No  | Indicators            | Activity                                                                 | Score | Information |
|-----|-----------------------|--------------------------------------------------------------------------|-------|-------------|
| 1   | Observing            | Students observe how contamination of drinking water by micro-organisms, chemical substances either natural or artificial can be reduced by chlorination of the phenomena shown. | 89.81 | Very Good   |
| 2   | Inferring            | From the answers to the observed phenomena, students can predict disinfection systems that are often used by chlorination according to chemical concepts | 88.22 | Very Good   |
| 3   | Formulating a hypothesis | From the problem formulations made by students, they can make hypotheses from the argentometric titration practicum they are doing | 79.23 | Good       |
| 4   | Grouping             | Students can group what tools and materials are needed to determine the chlorine content in water by argentometric titration. | 90.12 | Very Good   |
| 5   | Planning Experiments | Students can write down the work steps in determining the chlorine content in the water in the swimming pool | 95.32 | Very Good   |
Based on table 6 above, teacher candidates used their skill well and especially very good at practising argentometric practicum. They were arranging planning experiment, but when they were formulating a hypothesis needs to be improved. Based on that description, we have visualization as below.

Figure 2. The teacher candidates’ science process skill on the observation of argentometric practicum

4.4. Science Process Skill in The Observation of Complexometry Titration Practicum

In the observation of complexometry titration practicum, we have eight observed indicators in Experimental class, i.e. observing, inferring, formulating hypotheses, grouping, planning experiments, interpreting observation, communicate in writing and communicate orally given in table below.

| No | Indicators          | Activity                                                                 | Score  | Information     |
|----|---------------------|--------------------------------------------------------------------------|--------|-----------------|
| 1  | Observing           | Students observe things that cause water hardness which results in the use of hard water to form a scale in the kettle | 88.55  | Very Good       |
| 2  | Inferring           | From the students’ answers to the phenomena described, they can predict quantitative testing of water resistance according to chemical concepts | 90.12  | Very Good       |
| 3  | Formulating a hypothesis | From the problem statement, they able to create hypotheses from water hardness practicum by using complexometry titration | 85.65  | Very Good       |
| 4  | Grouping            | Students can group what tools and materials are needed to determine water hardness by using complexometric titration | 88.47  | Very Good       |
| 5  | Planning the experiment | Students can write down the work steps in determining water hardness from river water, rainwater and water well water with complexometric titration | 77.56  | Good            |
Interpreting the observation

Tabulated the observational data they obtained during the practicum to determine the water hardness by using complexometric titration

|   | 6 Interpreting the observation | Tabulated the observational data they obtained during the practicum to determine the water hardness by using complexometric titration | 90.35 | Very Good |
|---|--------------------------------|-----------------------------------------------------------------------------------------------------------------|-------|-----------|

Communicating in writing

Make reports and conclusions from the results of experiments to determine water hardness by using complexometric titrations

|   | 7 Communicating in writing | Make reports and conclusions from the results of experiments to determine water hardness by using complexometric titrations | 91.34 | Very Good |
|---|---------------------------|-----------------------------------------------------------------------------------------------------------------|-------|-----------|

Communicating orally

Students present the results of experiments to determine water hardness by using complexometric titration in front of the class

|   | 8 Communicating orally | Students present the results of experiments to determine water hardness by using complexometric titration in front of the class | 95.78 | Very Good |
|---|------------------------|-----------------------------------------------------------------------------------------------------------------|-------|-----------|

Based on table 7, the teacher candidates had finished the complexometry titration practicum very good especially when they were arranging communicating orally. However, we need an improvement in their activity especially when they were arranging the planning of experiment. From the description above, we may illustrate the science process skill of teacher candidates through figure below.

Figure 3: The teacher candidates’ science process skill on observation of complexometric practicum

5. Conclusion and Suggestion

According to the result of analysis and discussions in previous parts, we may conclude that guided inquiry learning able to improve teacher candidates’ learning outcomes and science process skill better rather than conventional learning model on the topic of redox, argentometric and complexometry titrations. Align with (Irwanto, 2018; Guler, 2019 & Afidayani, 2018) in their research, guided inquiry have a role in improving students’ science process skills because students are using their high order thinking skill too in the process of teaching and learning. This is in line with the observation (Aktamis & Ergen, 2008) which investigating the impact of science process skill in improving students’ science and creativity characters towards science including their achievements.

In this practicum of analytical chemistry which applying the model of guided inquiry, we found that teacher candidates’ science process skill especially for logical inference in the observation of redox, argentometric and complexometry titration practicum in the experimental group that we categorize in high level. In addition, the study in classroom on the experimental group especially for redox topic is developed very well in line with the improvement of students’ quality in analytical chemistry learning.

Through this study, we recommend applying guided inquiry learning model since it able to improve teacher candidates’ science process skill on redox, argentometric and complexometry titration no matter it is in the laboratory nor class. For the next period of time, we also recommend applying guided inquiry learning which integrated with science process skill to another topic of analytical chemistry.
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