The learning of metal refinery based on argument-based science inquiry (ABSI)

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Abstract. Chemistry is a branch of science closely related to life. One of chemistry concepts widely applied in life is the application of electrolysis cells, for instance, in metal refinery. In this case, students still have difficulties in understanding the abstract concept of metal refinery. ABSI learning model can be an alternative learning to develop higher-order thinking skills in understanding materials about metal refinery. The purpose of this study is to describe students’ activities during the learning process and to analyze their ability to complete their worksheets. The method used is a classroom research with one-shot case study design. The result obtained from students’ activities during ABSI learning is 95% on average, included in the very good category, while the result obtained from ABSI-based worksheet completion is 81 on average, included in the very good category as well. This is because ABSI learning facilitates students to actively participate in the learning process equipped with practicum and argumentation activities, allowing them to develop their higher-order thinking skills. Therefore, this ABSI learning can be used as an alternative learning to develop higher-order thinking skills of students.

1. Introduction

Chemistry is a branch of science [1] often considered difficult because it has many specific terms and abstract concepts [2], [3]. One of materials considered difficult in chemistry is electrolysis cells [4]. The application of electrolysis cells in daily life, for instance, in the process of metal refinery. [5]. Students’ difficulty in understanding metal refinery is caused by its abstract concept, internal student factors, the media used [6], the lecture process and the textbook used [7].

The learning process of metal refinery involves practicum. The involvement of students in the practicum can develop students’ knowledge and skills [8]. A learning process through a scientific approach consists of five basic learning experiences: observing, asking, collecting data, connecting and communicating [9]. These five basic learning experiences can be done by students through practicum and argumentation activities. During the practicum in metal refinery, changes in the redox reaction can be observed directly, but the explanation of the reason for the change is hard to understand because it is abstract. Therefore, it requires an alternative learning model giving students the opportunity to make arguments [10].

Various studies on the application of ABSI (Argument-Based Science Inquiry), a learning model that can develop scientific writing skills and argumentation activities, have been carried out [11]. This learning model is more effective in improving the quality of argumentation than the traditional method [12]. ABSI model can increase students’ activities and competencies in completing worksheets [13] and also improve students’ conceptual understanding, attitude and argumentation skills [14].
The update presented in this study is the learning process of metal refinery using ABSI-based worksheets. Therefore, the purpose of this study is to describe students’ activities in ABSI learning and the ability of students to complete ABSI-based worksheets on materials about metal refinery.

2. Experimental Method

This study uses a classroom research method with one-shot case study design [15], [16]. The subject of this study consists of 38 second semester students of Department of Chemistry Education at one of state Islamic universities. Since the second semester students come from various high schools, not all of them are accustomed to doing practicum and making arguments. The research stages begin with problem identification, preparation, implementation and reporting. Data of students’ activities is obtained through observations during the learning process by observers. While the data of students’ ability to complete ABSI-based worksheets is obtained through the analysis of worksheet completion by giving a score at each stage of learning in the worksheet.

3. Results and Discussion

The material about metal refinery will be better understood by students if they are directly involved in practicum activities. Their understanding will be much better if after the practicum, there is a discussion session equipped with argumentation activities. The application of ABSI learning model facilitates students’ activities during the practicum and argumentation activities.

Figure 1 shows the observation results of students’ activities from stage 1 to stage 7. The stages of ABSI learning model consist of stage 1: exploring knowledge or understanding before learning; Stage 2: participating in practicum activities; stage 3: writing down individual understanding in practicum activities; stage 4: exchanging ideas and comparing interpretation of data in small groups; stage 5: comparing scientific ideas to textbooks or other sources; stage 6: individually reflecting and writing; and stage 7: exploring the knowledge or understanding after learning.

Based on the observation during the learning process, it can be observed that the seven stages of ABSI learning can be passed very well by students, with an average percentage of 95%. Students are very enthusiastic in carrying out the learning process, but there are differences in the implementation of the activities at each stage of ABSI learning.

The stages of ABSI model with the highest percentage are Stage 2 i.e. participating in practicum activities, stage 3 i.e. writing down individual understanding in practicum activities, stage 4 i.e. exchanging ideas and comparing interpretation of data in small groups, stage 5 i.e. comparing scientific ideas from textbooks or other sources, and stage 6 i.e. individually reflecting and writing.
These five stages reach the percentage of 100%. These stages are considered to be included in the very good category because almost all learning activities can be implemented. Each member of the group is very enthusiastic in carrying out the practicum, interpreting experimental data, comparing the data obtained in the group by answering the questions presented in the worksheets, comparing claims with theory, making argumentation and writing reports. The active involvement of students in practicum activities will have an influence on the formation of student action patterns that are always based on scientific matters [17]. The practicum functions to make real phenomena, raise and maintain students’ interests, and increase logical thinking and reasoning skills [18].

Furthermore, the stage of ABSI model with the lowest percentage is stage 7, namely exploring knowledge or understanding after learning with the percentage of 79%, included in the good category. At this stage, only a few members of the group are active in answering questions from researchers, even some of them are not active at all. This happens because their concentration has decreased after making arguments. A person’s ability to concentrate on taking lessons is during the first 30 minutes after which it will decrease [19]. Lack of concentration during the learning process greatly inhibits the learning process and will affect the learning outcomes [20].

ABSI-based worksheets on materials about metal refinery are developed based on ABSI learning stages. These worksheets serve as a guide for students to perform all activities during the learning of metal refinery [21]. Students answer the questions presented in their worksheets in group. The ability of students to complete ABSI-based worksheets can be seen in Figure 2.

![Figure 2. The Results from the Completion of ABSI-based Worksheets](image)

Based on Figure 2 overall the completion of ABSI-based worksheets is categorized as good with an average score of 80. The highest average score of ABSI-based worksheet completion is obtained at stage 6, i.e. 85, and it can be said that the indicator of ‘creating’ can be well developed. This is in line with students’ activities at stage 6 with the percentage of 100%.

Meanwhile, the lowest average score of ABSI-based worksheet completion is obtained at stage 5 i.e. negotiation shape III: comparing science ideas to textbooks or other printed resources or comparing claims of data to theories and making arguments between groups, with the percentage of 75. The indicator of higher-order thinking skills developed in stage 5 is C5, evaluating. This lowest average score is due to several factors, including students not accustomed to making arguments, students’ level of confidence which is not optimal and communication skills which is not optimal as well.

The lack of confidence is seen when they are going to answer questions given by the opposing group. They actually already have the answer but do not have the courage to express it directly, so they have to tell it first to another friend in their group to finally answer the question. Students’ confidence can be increased through experience, so that students need to get successful experiences in their lives as many as possible, even from small things [22]. Therefore, their level of confidence can
be improved so that there will be more students actively making argument. Thus, during the argumentation activities, researchers try to motivate students to express their opinions confidently.

4. Conclusion

ABSI learning model plays an important role in developing students' activities and abilities to complete worksheets as well as develops students' higher-order thinking skills. The ability of students to make arguments shows that they have to be trained continuously so that they are accustomed to expressing their opinions bravely and confidently.

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