Guidebook of Basic Analytical Chemistry Lecture using Laboratory Inquiry-Based Activity to Develop Multiple Intelligence

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Guidebook of Basic Analytical Chemistry Lecture using Laboratory Inquiry-Based Activity to Develop Multiple Intelligence

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Abstract. This study aims to generate a guidebook of basic analytical chemistry lecture *(Kimia AnalitikDasar (KAD))*using laboratory inquiry-based activity that can increase the Multiple Intelligence of chemistry teacher candidates. Multiple Intelligence which should be developedrelating to the lecture of basic analytical chemistry laboratory improve logical mathematical intelligence, and interpersonal, intrapersonal intelligences. This study uses the design of the 4D model development (define, design, develop, and disseminate), of Thiagarajan et al, (1974). The basic analytical chemistry lecture guidance book applies laboratory inquiry-based activity that was developed and validated by three experts, with the valid result. After obtaining a validated model by experts, it then wasused by 12 students of the 6th semester, with the result that there was little revision on the work instructions, while the contents are understandable enough. After that, the gudance book was brought into the next level of implementation. The result is quite satisfying with the record of reaching 84% -96% of usage. In addition, the usage of the guidebook also contributes toward the development of intrapersonal intelligence rates at the highest of 92% on metacognition indicator, 100% on the indicator of listening to other, and 56% on Logical Mathematic of mathematic operations indicator.

1. Introduction

Any laboratory activities in scientific learning including chemistry must be done through several stages of experience exploration, finding the supporting journals and developing them, preparation of work, and is continued with the observation of data of primary and or secondary involving basic capabilities of inquiry, up to finding conclusions into new knowledge. According to [15] phases of inquiry on laboratory experiments greatly develop students' inter-intrapersonal intelligence (Multiple Intelligence). In addition, [10], [5] also stated that the stage of experiments with inquiry in the laboratory can develop complex thinking, and interpersonal intelligence (Multiple Intelligence).These can be developed further through building the team work in inquiry-based work. This type of work experiment has been developed; with the results of students who take teaching program can improve as well as be able to increase the understanding of the concept [16].

Laboratory activities is one of the approaches in learning chemistry that can improve thinking skills, develop metacognition, work in team and improve communication [5]. According [13], during the learning process of science, it should be done through the exploration phase of its experience, searching for journals supporting and developing, designing work step, and being continued with the observation of primary data involving basic capabilities activity inquiry lab, up to finding conclusions into knowledge new. Laboratory activities will achieve its objectives if it is implemented systematically through the stages of inquiry. Activities of inquiry are started with the search for information from various sources. In this step, the intelligence is associated with the effort to be able to design experiments properly, including developing intrapersonal intelligence / Multiple Intelligence.

According to [12], experiment using experiment guidebook has the tendency of being verificative, therefore it is no longer effective for scientific learning. This opinion is supported with the result of the field study conducted during the odd semester in 2012-2013 for basic analytical chemistry experiment which shows the result of concept understanding of students at 80%; as their scores were under 50 (100 points), while 20% students got scores range between 50-79. This condition was caused by lack of students' understanding. They also commented that even before they do the experiment, such concept was hard to grasp. In contrary conducting an experiment in the laboratory actually clarify

the students understanding toward the concept. The results of study conducted by [15] state that the acquisition of the score is 70 (out of a total score of 100) as 35.31%. The lack of the students' ability in explaining what it does and the symptoms observed is due to the laboratory activity which carried out today is still verificative. Problems related toward the conditions of less useful chemistry lab including analytical chemistry was also expressed by [1]; [2]; [11].

[8] states that every person has a different intelligence with all its potential, both children and adults. Further stated that everyone has an assortment of intelligence (Multiple Intelligence) with the levels of different development. However, no matter of the numerous type of human intelligences, it must be balanced with tolerance towards any differences such as race, ethnicity, religion, and others [14]. [10] identifies eight types of human intelligence. Those eight types of human intelligence includes the mathematical logical intelligence, visual spatial intelligence, musical intelligence, kinesthetic intelligence, interpersonal intelligence, intrapersonal intelligence and naturalist intelligence.

Teachers Beginner's standart competences by Directorate General of Higher Education, 2007 mentions that a teacher candidate must have 4 (four) competences, they are the mastering of the major, students, material, profesionalism and personality.Points of competence in the mastering of teaching are (i) able to plan and conduct educated chemistry learning, (ii) able to comprehend leaning model, strategy, approach and method according to the material and focusing on student-centered learning. In line with the Teachers Beginner's standart competences, Government Regulation of Republic of Indonesia number 19 year 2005 about National Standard of Education verse 28(3) which states that competence acts as the learning agent on the primary and middle education stage as well as early childhood is the pedagogical competence. Relating to the lecturing in the higher education level especially in Educational Institute of Teaching states that teaching is not merely about mastering the learning material but also developing intellectual intelligence called pedagogical intelligence. Pedagogical intelligence provides teachers some provisions on how to manage more effective learning.

Learning process conducted today is merely transferring the existed information in which being tested. Regarding toward this type of learning, there is a common weakness which showing that the students merely become the users or information. This particular learning type also does not develop students' creativity because it tends to lead to being passive and instant. To develop students' creativity, there is an urgent need to improve a new model of learning which can enhance students' multiple intelligence. The development of multiple intelligence is determined by internal and external factors. Internal factors that influence the development of multiple intelligence, among others; the role of genetic, lifestyle, nutrition, and breastfeeding. Meanwhile, external factors that influence the development of multiple intelligence among other; environmental influences, motivation, experience in the learning process, including the stage of inquiry [15].

Based on the description above, it is deemed necessary for the development of basic analytical chemistry lecture guidebooks (KAD) inquiry-based laboratory activities which can develop Multiple Intelligence chemistry teachers candidate.

2. Research Method

The stages in this study follows the model of Borg and Gall, which has been simplified, defined, designed, developed, disseminated. This research was conducted in Chemistry Education Study Program by considering the third semester students of chemistry education which join courses practicum of basic analytical chemistry (KAD). It consists of an experimental class as the test phase which is limited to 12 semester four students to be able to look at the feasibility of guidebooks. In addition, the wider scale testing was performed in first study group with participants as 25 students. They were divided into 8 groups to see the effectiveness of guidebooks in developing Multiple Intelligence of the students.

3. Results and Discussion

This research yields aguidebook of basic analytical chemistry lecture *(Kimia Analitik Dasar (KAD))* using laboratory inquiry-based activity which completed with lecturing scenario. As for sections in the guidebook are problem identification, hypothesis formulation, laboratory equipment and apparatus usage, the guidance of doing experiment, data presentation, discussion, and drawing the conclusion. The book consists of 38 pages which display qualitative and quantitative analysis of chemistry

material. It is composed of seven chapters starting from exercise in identifying cations and anions up to the explanation about gravimetry.

In every activity in the guidebook, students are guided to have the learning model using inquiry-based model. Initially students are guided to read articles that can answer why it is necessary to identify the cations-anions (Chapter I), then students are directed to perform the separation of cations in the class (Chapter II), by making the experimental design itself and keep following the steps of inquiry in the guidebook. There are eight chapters in the guidebook of basic analytical chemistry lecture, representing each activity on a qualitative and quantitative analysis. After reading the direction of questions, students are expected to identify problems and create hypotheses or provisional estimates of the issues mentioned in the "Problems" are provided in the guidebook. Then, students are guided to read the material in the guide books as a source of hypothesis testing that has been compiled. Furthermore, the students are led to prove the truth of the hypothesis by writing explanations and conclusions of these activities in the "Let's Experiment".

The guidebook of basic analytical chemistry lecture *(Kimia Analitik Dasar (KAD))* using laboratory inquiry-based activity has been developed and used in every learning activity during the lecture. Percentage results obtained from this activity can be seen in Figure 1, that almost all the students can follow the instructions of the guide properly, therefore all groups can design experiments of the source journal that they are looking for.

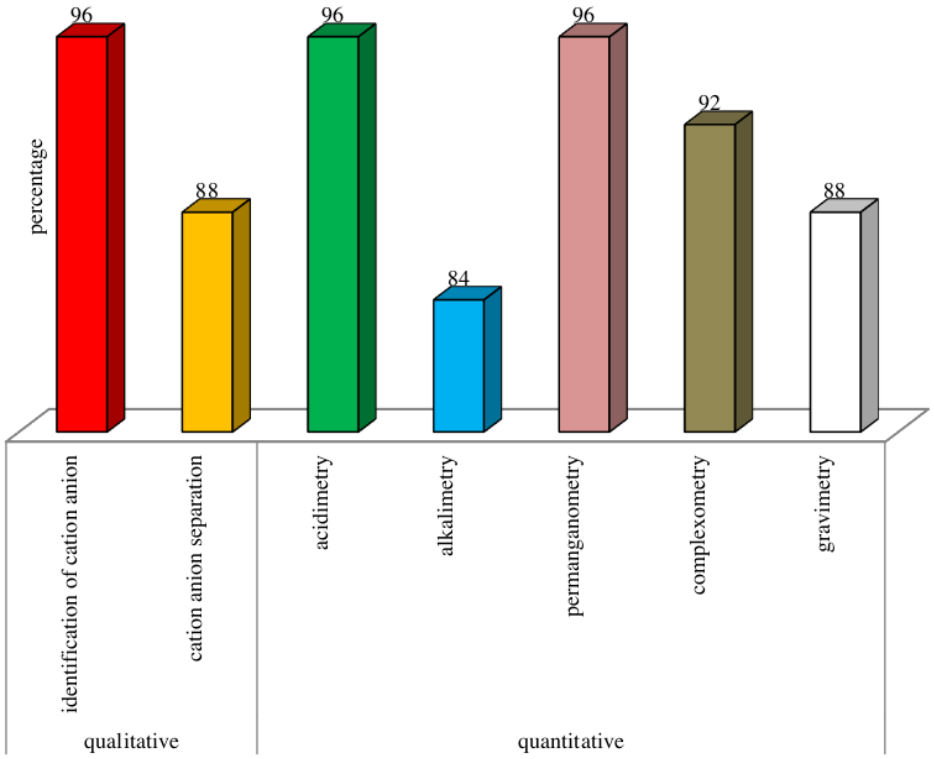

Figure 1. The percentage of the application of the guidebook of experiment using laboratory inquiry-based activity

The percentage of the application of the guidebook of experiment using laboratory inquiry-based activity is shown on figure 1. It means that every section in the book both in the section of qualitative and quantitative analyses can be followed by students properly with the range of result as 84%-96%. The lowest rate of chapter application is shown in the alkalimetry section as the students did a mistake for misapply the sample of baking soda; it did not apply quite well therefore it is needed some

instruction in choosing sample. The highest rate of percentage is achieved on acidimetry and permanganometry as there are quite sample options. It causes these two sections received better and optimum results in the experiment design.

The observation of intrapersonal intelligence development was done through the assessment of design product and experimental report, that was the product assigned in the laboratory inquiry activity based practicum guide. In this first stage, the assessment of intrapersonal intelligence was observed from its implementation side, in which all of the 25 students who engaged in the practicum lecturing of basic analytical chemistry made the experiment design with the inquiry stage as stated in the guide and reported it. Those two products were evaluated with the intrapersonal indicator. The assessment result is presented in Figure 2.

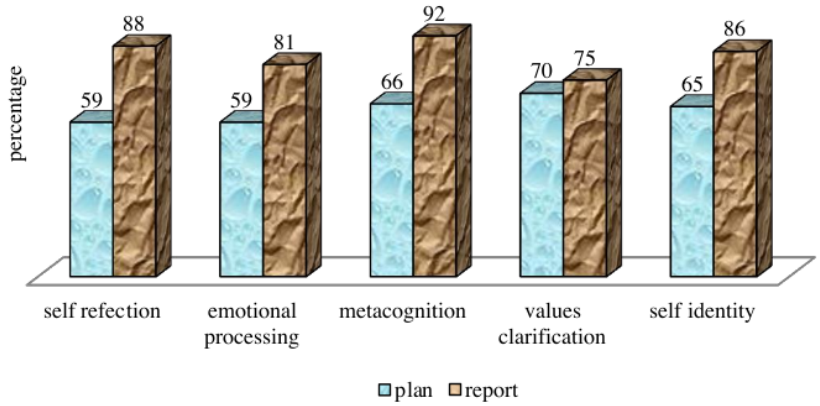

Figure 2. The assessment of intrapersonal intelligence in the design product and experimental report

Figure 2 presents the product assessment result of inquiry activity stage in form of design and experimental report with 10 inquiry stages which should be followed. The implementation of intrapersonal intelligence assessment has been done well since there has been the assessment rubric available. The assessment result of experimental report with five intrapersonal indicators showed the highest result on the metacognition indicator, then self-reflection, and the lowest result was on the value-clarification indicator. This assessment was carried out well since the inquiry stage starting from formulating questions, determining hypothesis, designing experimental stages need metacognition process, self-reflection, value-clarification, and after the experiment, the data should be processed with the journal support which become the concept finding (self-identity), and in order that everything can be done, thus it needs seriousness in doing the inquiry stages, in which the assessment was observed on the emotional processing indicator.

Highest rating was on metacognition indicator since ranging from designing experiment; students have already been trained in looking for resources as a theoretical basis and think whether the step is appropriate or not with the problem, besides the student must also be able to adjust with the equipment available in the laboratory. Metacognition is also potentially developed in stages of designing experiments, analyzing experimental data, report writing, and presentation of results, because when acting on the stage, the students always have to manage their thinking process.

This result is consistent with the opinion of [11], [5], which states that the inquiry-based lab learning can improve student's metacognition. Similar results also stated that the problem-based learning can improve students' metacognition [9]. Similarly, the findings of [16], that in solving complex problems required multiple intelligences including the use of metacognition. Self-identity is one indicator that the increase include high intrapersonal. On this indicator the students were able to connect the facts there to be their own opinions; the students were able to identify the basic concepts with their own personal opinion. This increase occurred very reasonable for such an inquiry activity, students were trained to find references as the basic concept to solve the problem, then analyze the observational data and process it into a new understanding [16].

Observation on the development of interpersonal intelligence was done by assessing the percentage of draft and experimental result report, that is the percentage to get the experimental design and reporting in accordance with the practicum guideline of laboratory inquiry-based activity. In this first stage assessment of interpersonal intelligence observed in terms of its appropriateness, of the 25 students who attended the basic analytical chemistry lecture, all presented the draft and experiment report with the stage of inquiry in the guideline, the presentation made to practice expressing opinions, respond to the opinion of friends, work in group, this activity is expected to explore and develop the interpersonal intelligence, assessment results for each indicator of interpersonal are presented in Figure 3.

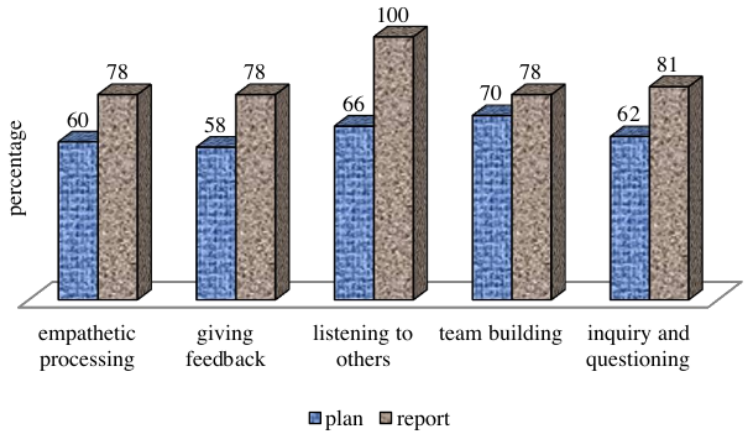

Figure 3. Assessment of Interpersonal Intelligence on the Design Product and Experiment Report

Figure 3 informs the percentage of each indicator of interpersonal intelligence. Test of implementation to each indicator was observed at the time of presentation of the draft and experiment report with the stage of inquiry. The highest implementation percentage increase in the indicator listening to others, i.e. inquiry activities related to receiving friends' suggestions, and taking joint decisions are often made in every step of inquiry. The next increase inquiry and question is a process to be able to identify the opinion of friends in building understanding of the concept and constructing new findings. This process is highly trained when students observe the results of the experiment, analyze and discuss the results. The lowest increase in team building that work together in a group, it is possible because work together in groups are often made. Giving feedback is a process to train students to be able to receive feedback from other friends and connect with their own opinions, and it is already highly trained in a long time to experiment in the laboratory, discussed in groups in order to work in accordance with the draft that has been made well. Afterward, there is also an increase in empathetic processing and listening to others, as it is known to be a process of listening to the opinion of friends quickly (EP) and listen carefully to follow up (LO). Inquiry activities related to receiving friends' suggestions, and taking joint decisions are often made in every step of inquiry.

These results are in line with the findings of [1], [4] study in a group can develop the skills of cooperation, skills of expressing opinion and communication skills in scientific argumentation. Neither the opinion of [12], [5] that the laboratory inquiry-based learning can improve the ability to work together, the ability to communicate, skilful in asking questions and expressing their opinions.

The highest result on IQ occur because in the lecture students are required / are trained to evaluate the basic theory underlying the experiment and in identifying the findings. This resulted in an increased understanding of the concept of the student, so that when students should present the experiment proposal and presentation of experiment results, they can explain what they have done. This means that during the lecture, IQ ability of students can develop optimally. The lowest achievement was on GF indicator that is receiving friends' suggestions and connecting to their own opinions. Although this indicator is also quite trained at the time of discussion of proposals (early) and discussion of the results (final), but the results are less than the maximum because not all students are actively involved in expressing their opinions. The result of the overall improvement of each indicator

by testing different results there is a significant increase, it may be said that inquiry activity can increase interpersonal intelligence.

This finding agrees with the results of research by [18], [5] that the lab inquiry-based learning can develop cooperation in groups, discussion skills in giving feedback and debriefing, confident in discovery research and improve higher-order thinking skills. The assessment of inquiry stages with interpersonal indicator, at the implementation test stage can be performed well, although not optimal, because at the time of assessment, the results of experimental design is still not appropriate, and it takes many observers, there are at least four observers and assessors.

The observation of Mathematical Logical intelligence drilled through the calculation when designing experiments mainly in calculating the standard solution and standardization nor when analyzing the results of the experiment. In this first stage of Mathematical Logical intelligence assessment was observed in the design and reporting, assessment of Mathematical Logical intelligence was through tests to the quantitative analysis material. Its appropriateness, of the 25 students who attend the basic analytical chemistry lab lecture, all has been working on quantitative analysis test, a total of seven questions to the five indicators of mathematical logical. The assessment results are presented in Figure 4.

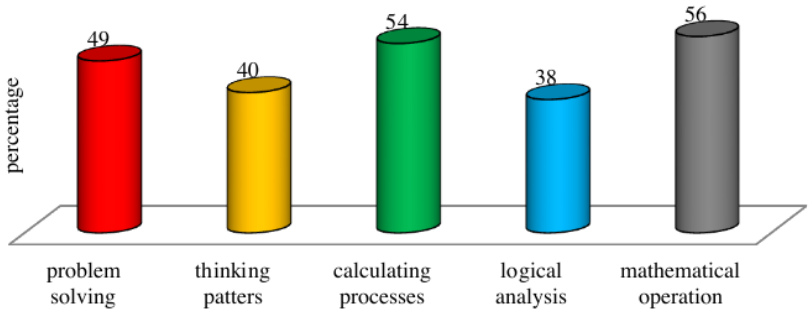

Figure 4. Observation of Mathematical Logical intelligence

Ratings on logical mathematic were generated from the question that has been validated by the validator, seven quantitative analysis questions that already includes five indicators of logical mathematic were used. Those five indicators are problem solving, thinking patters, calculation processes, logical analysis, and mathematical operations. The entire logical mathematic indicator is workable although not optimal, as it is done in the early stages of inquiry, so the percentage of the highest value on the mathematical operations, and then calculation processes, and then followed by problem solving, thinking patters, and logical analysis. This sequence is possible because the inquiry model provides an opportunity for students to be actively involved in the process of making the experimental design, doing the experiment, be directly involved at the time to solve the problem, when testing, logically analyze experimental data, up to report the results of the experiment. Thus, students experience a situation that led to the improvement of logical mathematical intelligence. These results are in line with research results of [7], that the inquiry activity can improve understanding of mathematical and logical mathematical reasoning skills in students. It also related to the students' ability to analyze and scientific reasoning [3], [19] state that it is potential to develop mathematic logical intelligence. These results provide suggestions to the researchers that lab inquiry-based activity KAD lecture model can improve logical mathematical intelligence.

4. Conclusion

Guidebooks of KAD lecture developed is proper for use, with the implementation percentage reaches 84%-96%. Multiple Intelligence development on intrapersonal intelligence reaches the highest at 92% on metacognition indicator, the interpersonal intelligence on the listening to other indicator 100%, Logical Mathematic on the mathematic operations 56%.

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