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An Analysis of Critical Thinking Skills among Students Studying Chemistry Using Guided Inquiry Models

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Abstract. The purpose of this study is to analyze the critical thinking skills of learners. The subjects in this study were 75 students of class X in SMAN 3 Mataram. The research type was a quasi-experiment. A test comprising 14 problems was used to collect experimental data. Five critical thinking indicators were studied: interpretation, analysis, evaluation, inference, and explanation. The research results show that the guided inquiry model is able to develop students' critical thinking skills, especially on indicators of interpretation (70%), analysis (53%), and evaluation (59%).

Keywords: critical thinking skill, guided inquiry models, quasi-experiment, students.

INTRODUCTION

Learning in the 21st century should be more than just memorizing facts and understanding the general concepts of subject matter as was the case in the industrial development era and still is in Indonesia. In this regard, learning should not only comprise listening to explanations by the teacher; rather, the teacher should be able to model the learning process so that learners can observe and learn process skills, problem-solving skills, and thinking skills when developing their knowledge.[1]

One of the demands of the 21st century is that students must have critical thinking skills. According to Facione[2], critical thinking is a mental process, and entails rational thinking to evaluate and understand the information gained, forming the basis for making decisions about what to do. Chemical learning requires good understanding of concepts, providing the foundation for understanding later concepts. The knowledge gained by students is constructed according to their learning experiences, and is linked to their stage of development and the influence of the surrounding environment. One way of gaining success in learning is by linking old understandings with new insights. This process concerns the constructivist perspective, which focuses on the learners, encouraging innovative thinking and enabling optimal development of their potential.[3] Therefore, learning chemistry should emphasize student-centered learning, particularly as chemical learning does not comprise discrete pieces of information that students can memorize: Chemical learning can be applied within a constructivist learning model.

One learning model that can be used to aid students in developing their problem-solving skills through experience is the guided inquiry learning model. This model has been found to be effective in helping train and guide students in understanding concrete concepts, and their ability to construct higher order thinking patterns.[4] Inquiry-based learning aims to teach students the process of researching and explaining an event. The guided inquiry learning phases used in this research are: (i) orientation, (ii) formulation of the problem, (iii) formulation of hypotheses, (iv) data collection, (v) hypothesis testing, and (vi) formulating conclusions.[5] The results of a study conducted by Assiq [6] suggest that learning using inquiry-based models is more effective than learning using conventional learning models (lectures or following textbooks). Furthermore, other studies have shown the effectiveness of inquiry-based learning in developing the critical thinking skills of learners.[7, 8]

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The results of preliminary observations at SMAN 3 Mataram based on questionnaires administered to students in the 2017/2018 academic year are depicted in Table 1. The questionnaire contained items leading to primary visualization of critical thinking skills and prior learning experiences.

TABLE. 1. The Results of the observation

No	Aspects contained in Questionnaire	Alternative Options	Percent of Answers (%)
1	Obtaining information about critical thinking skills	Never	81.82
		Ever	18.18
2	Implementation Indicator critical thinking skills	Ever	33.98
		Often	5.83
		Never	60.19
3	Learning experiences that train learners to solve problems	Ever	18.18
		Often	9.09
		Never	72.73

Based on the observational data in Table 1, it can be seen that teachers are not developing students' thinking skills in accordance with the development of the 21st century learning, which requires learners to have high-level thinking ability. The values for the report cards results also show that only a small portion of learners can implement all of the critical thinking indicators. The purpose of this study is to analyze the critical thinking skills of learners who are taught using the guided inquiry learning model

EXPERIMENTAL DESIGN

This research was conducted in class X at SMAN 3 Mataram in the second semester of the 2017/2018 academic year. The chemical material taught in this research concerned electrolyte solution, and the reaction of reduction and oxidation (redox). The research type was quasi-experimental, with a non-equivalent post-test only control group design. Purposive sampling was applied, selecting the classes that met the criteria of the similarity of the teacher and the uniformity of the initial data. The research sample comprised 75 students.

In this research, the independent variable was the guided inquiry learning model and the dependent variables were critical thinking skills, measured using five indicators: (i) interpreting the problem, (ii) analyzing the problem, (iii) evaluating, (iv)inferencing, and (v) giving explanations. [2] The steps in the instruction model were those previously identified for inquiry-based learning [5]. Learning was supported using student worksheets as a learning resource. Data collection was conducted through observation and a test containing 14 problems. The data were analyzed using the Rasch model.

RESULTS AND DISCUSSION

The data on critical thinking skills were analyzed descriptively with the aim of measuring the extent of students' critical thinking skills for each indicator, and also to identify the values for critical thinking skills obtained by student on each indicator. The percentages of students' critical thinking skills for each indicator are presented in Table 2.

TABLE 2. The percentage of students' critical thinking skills for each indicator

Indicator of critical thinking skills	Percentage %	Criteria
Interpretation	70	Critical
Analysis	53	Quite Critical
Evaluation	59	Quite Critical
Inference	45	Less Critical
Explanation	54	Less Critical

From the data of Table 2, it can clearly be seen that the guided inquiry model is able to develop critical thinking skills of students. Similar findings have also been reported by several studies, which have found the guided inquiry model can develop critical thinking skills. [7–13]

The steps in the guided inquiry learning model give students the opportunity to train their critical thinking skills. In the learning process, inquiry-based learning is able to foster students' ability to think and work scientifically, and develop a strong scientific attitude. Guided inquiry learning is designed to train students in conducting research and asking questions based on facts. Inquiry-based learning is guided through implementation of five learning stages: (i) identifying a question or problem; (ii) formulating a hypothesis; (iii) collecting data; (iv) testing the hypothesis; (v) formulating generalizations.[14-16] Learning activities using guided inquiry will familiarize students with actively seeking information by conducting an experiment to solve a problem. Students will become accustomed to answering questions based on accurate analysis, thus maximizing the results of learning.

Table 2 shows that the interpretation indicator has the highest percentage among the critical thinking skills. In the data collection stage of guided inquiry, students are trained in how to read data derived from the experiment.[10] Individuals who have critical thinking skills will be able to make decisions and think rationally, drawing on some of the views they hold with regard to different contexts. This means that critical thinking is needed by students to address the problem faced. Kholifah further claims that a critical thinker will be able to make deductions based on what he/she knows, will know how to use information to solve problems, and will seek sources of information that are relevant. [10]

The next analytic indicators show the significance of the criteria for critical thinking skills. Critical thinking develops from the first stage of implementation in the guided inquiry learning model. Teachers should be able to prepare questions concerning a population problem close to the student environment. In an experimental class taught through guided inquiry, learners are trained in how to obtain information to resolve the problem and how to evaluate this information. They need to be able to explain the steps taken in solving the problem and be responsible for the answer to each given problem, seeking information from various sources in solving the problem, and explaining each answer to the given problem. The students in the experimental class have no difficulty in solving various problems, although the problems presented are different. In contrast, in the control class students are not required to seek information but wait for the information to be provided by the teacher, so that if a problem is presented that requires different information, the student will find it difficult to solve.

This study shows that the guided inquiry learning model has advantages over conventional learning in terms of enhancing critical thinking skills. In guided inquiry, students will be involved in learning, and will be trained to solve problems related to the environment. The results of this study are in line with those of previous studies. [13, 17–18] They suggest that through inquiry-based learning, the critical thinking ability of the students develops step by step in the learning, namely through the stages of identifying and formulating problems, formulating hypotheses, designing and conducting experiments, and formulating conclusions based on the experimental results. Guided inquiry builds knowledge through a process of discovery in the classroom, so that the answers to the problem proposed are found directly by the students and knowledge is thus acquired. Guided inquiry encourages scientific thinking habits among students, encouraging them be more open to new ideas in the group, and training them in critical thinking as the teachers engage in question and answer, and guide students to formulate the related facts. [14] Students think about the process not just the end result. [15]

However, not all indicators of critical thinking present good values. Table 2 shows that the indicators for inference and explanation have lower criticality. Factors inhibiting the implementation of the guided inquiry learning model may responsible for this result, namely the students' difficulties in preparing work procedures to solve the given problem, teachers' less than optimal classroom management (managing students who are noisy, chatting, and playing with the equipment and materials). Such factors are not conducive to the learning process. [8]

CONCLUSION

In conclusion, the guided inquiry model can be used to develop the critical thinking skills of students, especially in chemistry subjects. The guided inquiry model facilitates and maximizes the students' ability to interpret data, to analyze information, and to evaluate the results of experiments.

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