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The effectiveness of guided inquiry-based student worksheets on students' generic science skills

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Abstract. The generic skill of chemistry is the ability to think and act according to the chemistry obtained. The purpose of this study was to determine the effectiveness of guided inquiry-based student worksheets on students' generic science skills. The effectiveness of learning outcomes is seen in the acquisition of the N-Gain value of learning outcomes. The approach used experiment was using one group pretest-posttest design. The sample consisted of 62 students year eleven from two secondary schools in Banda Aceh, Indonesia. The data were collected through generic science skill observation sheets and learning results test. The results showed that generic science skills of the first school were developed on indicators of direct and indirect observation, logical consistency and logical inference. As for the second school were developed on direct observation indicators, logical consistency, and logic inference. Both schools had generic science skills indicators with good criteria. The value of N-gain learning outcomes of the first school was 0.54 and the second school was 0.47 with the medium category and t-test results were significantly different. Thus, the guided inquiry-based student worksheets effectively could be used as an alternative teaching material on acid-base material practice.

1. Introduction
Generic science skill (GSS) is a terminology given for the certain skills in the learning process. Every country might have different basic skills which according to the country's conditions [1]. In Indonesia, basic skill is also called the generic science skill with ten skills indicators: direct and indirect observation, scale awareness, symbolic language, logical framework, logical consistency, causality, mathematical modeling, concept constructing and abstraction [2].

Curriculum changes occur around the world, the development of generic skills has become an important issue for educational success [3,4]. There are several important levels of generic skills that are considered important, such as communication skills followed by integrity and professional ethics, and teamwork [5]. In addition to these skills, there are other skills such as the ability to summarize and analyze, teamwork, problem-solving, proficiency in information and technology, entrepreneurship, creative and critical, leadership, and self- qualities [6]. In other words, students will have a significant advantage in developing generic skills for their studies and professional lives in helping to develop their common skills [7].

People realize that GSS is important, but its implementation is not as expected. Particularly in Aceh, based on observations at two secondary schools in Banda Aceh, Indonesia, students' generic science skills have been not developed well because students are rarely trained to practice GSS, including on the topics of acid-bases. Those chemistry topics are still problematic because many

concepts of the topics are failed to master, particularly in the interpretation of pH indicator tables [8]. The lack of generic skills of students in learning is also influenced by less varied learning models [9]. One of the efforts to improve the students' GSS is by applying the guided inquiry learning model.

GSS can be trained using guided inquiry learning model. Furthermore, the results of usage of inquiry models can improve students' learning outcomes of cognitive aspects [10]. The advantages of this learning model for learners are to improve their ability to write, analyze and find the truth about a problem systematically and directed according to the purpose; then the learners can also develop their critical thinking to have good reasoning ability [11]. Based on research that has been conducted shows that the guided inquiry student worksheets are very feasible to be applied [12]. Further, the results of another study also showed that the development of guided inquiry student worksheets could train the students' skills in conducting experiment [13]. Based on these descriptions, the researchers consider it necessary to do a study with the title of the effectiveness of guided inquiry-based student worksheets on students' generic science skills.

2. Methods

This research was a research application based on research and development that has been done before. Development model used is the research model developed by Borg and Gall's [14]. The resulting product of development was a guided inquiry-based student worksheet. The percentage of eligibility value to the guided inquiry-based student worksheet was averaged 86.67%; it was considered eligible to implement in a class. The validated guided inquiry-based student worksheets were implemented in chemistry classes of regular and private high schools. The effectiveness of the guided inquiry-based student worksheet was applied to the experimental method using one-group pretest-posttest. This design research diagram can be seen in table1 [15].

Table 1. The study designs one-group pretest-posttest.

O_1	X	O_2
Pretest	Treatment	Posttest

The sample of the study was chosen by purposive sampling technique which was determined based on the students' ability. School research was chosen based on the value of national examination of students according to students' absorbance of acid-base material. The sample of this study consisted of 30 students of year eleven from regular secondary school (the first school) and 32 students year eleven from private secondary school (the second school). The research instrument was used generic science skill observation sheets and learning results test. The data collected in the study were analyzed by calculating the normalized N-gain values of the pretest and posttest results. Generic science skill observation data were analyzed by calculating the overall percentage of the generic science skill indicators of each student.

3. Results and discussion

Activities undertaken by learners during a practicum were reading and executing instructions in student worksheets, investigating information on natural substances as acid-base indicators, designing work procedures, and discussing accomplishing the tasks in student worksheets. The activities of students during learning can be seen in Figure 1. Furthermore, learning by using student worksheets based guided inquiry is expected to train generic science skills of learners to understand the various acid-base indicator of natural materials through acid-base material practice.
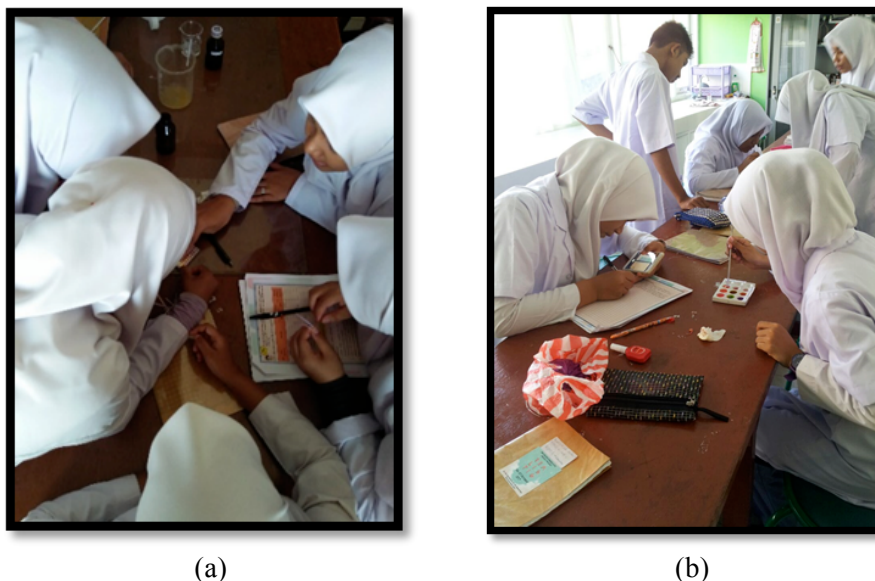
(a)   (b)

Figure 1. The activity of students to use student worksheets that are based on guided-inquiry practice: (a) students learn the student worksheet instructions, and (b) the students conducted an Acid-Base material experiment practice.

Figure 1 shows the students activities as follow: (a) the students read and study the worksheet practice guideline to determine any solution that can be used as Acid-Base indicator according to the colour of the solution; (b) the students conduct experiment to determine the acid-base indicator and write the observation results obtained into a table that have been provided in the student worksheet.

The GSS score of students is presented in table 2.

Table 2. GSS scores of students at two secondary schools in Banda Aceh, Indonesia.

No	The indicator of generic science skills	Score (%)	
		The first school	The second school
1.	Direct observation	98.75	91.80
2.	Indirect observation	82.08	79.30
3.	Cause and effect	64.17	58.59
4.	Logical consistency	92.50	88.02
5.	Logical inference	85.42	82.04
	Total	422.92	394.27
	Average	84.58	78.85

Table 2 shows that an assessment of GSS of students at two secondary schools in Banda Aceh, Indonesia, the scores were 84.58% and 78.85% on average and was categorized as a good category. This suggests that the practical implementation can build GSS of learners. Then, with the application of student worksheets, it can also build participation of learners so that learners' generic science skills increased. The previous research mentioned that their generic skills in participatory learning strategies could put the students at the center of the learning process and also the community [16].

The GSS scores of students at the first school were different from the second school; significant assay results indicate that significant 0.000<0.05 indicates a significant difference. This is because the learners both school prepared to have generic skills are conceptualized as skills that help them understand the advantages and disadvantages, helping to independent, analyze the situation from a different perspective and can take advantage of the resources at their disposal to address the problems with the challenges that exist in future [17]. So that, the implementation of this generic learning skills

will support students in the higher education curriculum. The reason that supports shows that students that have the generic science skills will be better, the capabilities needed in a variety of job requirements, and the discipline will assure itself as the best graduate [18].

The results acquired were supported by a study showed that the average gain in the experimental class <g> on direct observation indicator of 0.38, which was consistent and logical framework indicators 0.34 [19]. Then, the results of data analysis questionnaire showed that nearly all learners had good skills in the application of guided inquiry learning. The logical inference indicators show that learners were able to deliver the results that have been studied. Research that has been conducted shows that the average yield of 88.50 percentage inference logic was a very good category. So, it can be interpreted that the use of student worksheets based guided inquiry can improve the ability of logical inference learners. Learners were able to explain in accordance with the reference, and also can draw the conclusion properly [20]. Skills convey this information is not restricted to mass communication. The key to effective oral communication is to know how to do, listen to, and requires intelligence to the overall process of communication activity [21].

The effectiveness of the implementation of student worksheets based guided inquiry tested the *N-Gain* and t-test after pretest and posttest the practical implementation of acid-base materials at two secondary schools in Banda Aceh, Indonesia. As for some forms of student worksheets that have been filled can be seen in Figure 2.
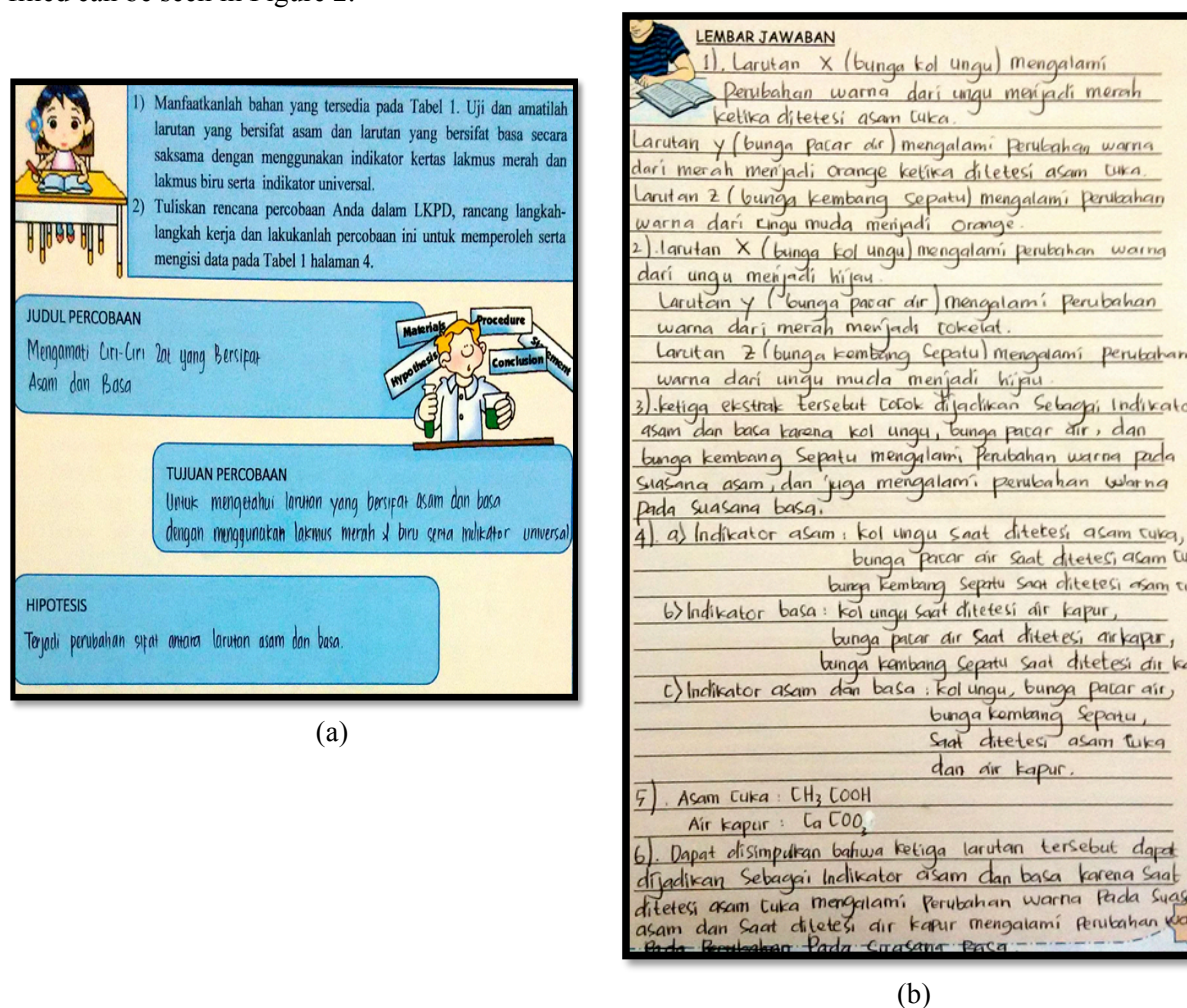

(a)

(b)

Figure 2. Representative image of student worksheets based on guided inquiry, (a) Student activity guide sheets; and (b) answer sheets and student discussions report.

Figure 2 part (a) shows practice guideline of a student worksheet that containing some important aspects including problem topics, the title of the experiment, experiment objectives, experimental hypotheses, and the availability of tools and materials according to learning indicators. The problems given in the student worksheet are the characteristics of guided inquiry learning. Based on the guided inquiry learning, the students will analyse the problems provided by teachers using self-made experimental design and procedures [22]. While the Figure 2 part (b) shows student answer sheet consisting of all students' answers based on the questions given in the student worksheet. This sheet contains the discussion of student's activities related to the solution colour's description after the experiment, the characteristics of each solution colour obtained, acidic and basic solutions grouping, the chemical formulas for each ingredient used, and the summary of the experiments results.

Test *N-Gain* had an increase in the study of students. A t-test was conducted to determine the significance of the study of students. Figure 3 *N-Gain* in both researched schools is shown here.
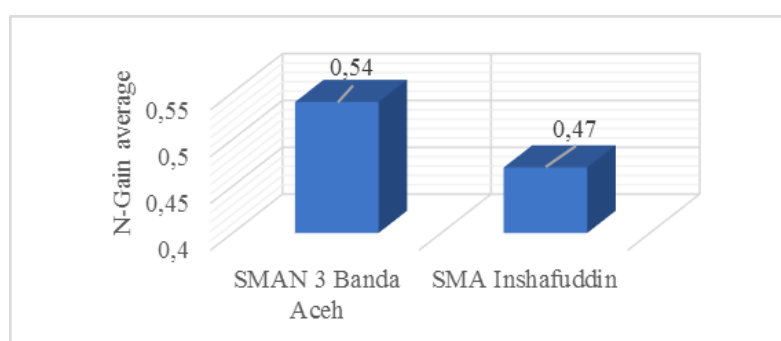

Figure 3. Average graph of N-Gain.

Based on Figure 3, it shows that the average N-Gain in both schools were 0.54 and 0.47 with medium criteria. This indicates that learners at two secondary schools in Banda Aceh had different capabilities. a The results of the analysis of the t-test for equality of two average values pretests had significant results 0.096 > 0.05 meaning that the average value of pretest ability learners in the first school was not significantly different from the second school. However, after the implementation of student worksheets based guided inquiry, the results of t-test analysis for differences in the average value of two posttests showed significant 0.036 <0.05 meaning the ability of learners in both schools on acid-base materials in terms of practical implementation using student worksheets based guided inquiry had significantly different capabilities, but both of the schools had different school passing standard grades in chemistry subject chemical learning (KKM) that was 75 in the first school and 70 the first school. So, based on hypothesis testing concluded that the implementation of learning chemistry lab on acid-base materials using student worksheets based guided inquiry was effective in improving student learning outcomes. This confirmed the results of this study support previous research showing that colloidal module based guided inquiry can effectively improve cognitive learning outcomes of students shown by the analysis of N-*Gain* from acquisition pretest and posttest, score capabilities cognitive learning outcomes of learners at 0.688 categorized as a gain medium [23]. Furthermore, other studies show that learners had a better understanding of the basic concepts of acids and bases as well as a more positive attitude to the application of guidelines on teaching materials based guided inquiry [24]. In addition, by using a model of guided inquiry is able to maximize the learning process that shows an increase in cognitive abilities of students in the cycle I and II both classical and average class [25]. As well as the relevant results showed that the analysis of the effectiveness of assisted instructional materials show that can improve generic skills such as oral and written communication, teamwork [26].

4. Conclusions

Learning outcomes of students at two secondary schools were in medium level with both N-Gain is 0.54 and 0.47, science generic skill values were 84.58% and 78.85% with a good category. Thus, student worksheets effectively can be used as an alternative teaching material on acid-base material practice.

Acknowledgment

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