The effectiveness of guided inquiry learning based on contextual to improve chemistry literacy ability of senior high school students

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Abstract. This research aims to determine the effectiveness guided inquiry learning based of contextual to improve chemistry literacy ability of students. This is an experimental research with pretest-posttest control group design and cluster random sampling as sampling techniques. The samples of this research are two different classes of X MIPA. The ability of chemistry literacy is tested using chemistry literacy test and questionnaire. Data analysis uses T-test, N-gain, classical learning pass, and questionnaire data descriptive analysis. The result of this research provided average score of posttest of chemistry students literacy of experiment group 72.86 and 63.42 for control group. Classical learning pass of experiment group is 78.57% and control group is 38.71%. N-gain analysis result provided the ability of chemistry literacy in every aspect of experiment group is better than control group. T-test result are t_count 3.66 and is bigger than t_table 2.00, it means that the ability of chemistry literacy of students in experiment group is better than the one in control group. Questionnaire analysis result provided around 68% in good category. Based on research results, it can be concluded that by using guided inquiry learning based of contextual, students’ chemistry literacy ability is improved significantly.

1. Introduction
Along with the development of era, human resources are required to master science and technology. Education has an important role in creating human resources that have high quality to advance the nation. The function of education according to Article 3 UU Number 20 Year 2003 about Indonesian National Education System one of them is developing students' abilities in order to educate the life of the nation. Students' abilities can be developed through a learning process that familiarizes students with thinking, finds the concept of knowledge independently, and involves the activeness of students in their learning (student centre). Student centre-based learning can be carried out with scientific approach.

One of the scientific learning is inquiry learning model. Inquiry learning is part of constructivism learning that facilitates students to construct their own knowledge in relation to the real world [1]. Characteristics of inquiry learning models are suitable if applied to concepts / materials that enable active students to analyse and solve problems systematically [2]. The activity of students can be encouraged through the process of asking questions, investigating, explaining, and interacting with problems [3]. However, inquiry learning needs to involve teacher guidance because students are not accustomed to using this learning model, so the suitable learning to be implemented is guided inquiry learning. In addition, chemistry teachers encountered some difficulties when applying open inquiry,
including insufficient learning time, class becoming crowded, classroom management problems, and worrying about experiencing misconceptions [4].

By using guided inquiry, students are trained to develop their thinking ability, teamwork and make it easier for students to learn. Explaining the guided inquiry learning model allows students to move step by step starting from identifying problems, defining hypotheses, formulating problems, collecting data, verifying results, and drawing conclusions under the direction or guidance of the teacher [5]. In guided inquiry learning the teacher provides examples of specific topics and guides students to understand the topic. The teacher is in charge of designing learning activities so that students are able to find their own concepts from the material being studied and in the process the teacher keeps the interaction between students and students or students and teachers by way of asking and answering so students can be stimulated and encouraged to find concepts [6]. The discovery of concepts independently makes student learning more meaningful (meaningful learning).

Guided inquiry learning can be applied by involving contextual learning. In context-based learning, context is used as a starting point for developing scientific thinking [7]. Contextual learning is a learning concept where the teacher presents the real world into the classroom and guides students to make a connection between the knowledge they have and their application in life. The main purpose of learning based of contextual is to present scientific concepts to students through selected activities in daily life, which can increase their motivation so that they are interested in learning science [8].

One of chemistry material in X grade that has many examples of applications in everyday life are materials for electrolyte and nonelectrolyte solutions, such as power outages during floods, isotonic drinks, water battery, etc. For example, the teacher can use isotonic drinks as a learning resource to explain the concept of the solution conductivity test in electrolyte and nonelectrolyte solution materials. Associating material with examples of applications in life in the learning process, needed to foster an attitude of student concern for the environment, while supporting students' scientific literacy abilities.

Scientific literacy according to PISA is the ability to associate issues related to science and science ideas. Students who are literate in science are able to apply concepts or facts obtained in classroom learning to solve natural phenomena that occur in everyday life [9]. In addition, students who are literate in science are able to develop scientific abilities and skills creatively, which are associated with everyday life in solving problems, and are responsible for decisions they take [10]. The important thing that must be considered to train scientific literacy is that learning is done not only in the form of discussion and presentation, but requires the teacher to be more creative to develop problem-based questions that will be solved through scientific methods.

Someone that has scientific literacy must understand the basic concept of science, like chemistry which is the branch of science [11]. Scientific literacy built in this study is chemistry literacy, because chemistry learning is part of the learning of science so that chemistry learning is also responsible for achieving the students' chemistry literacy. Chemical literacy includes understanding of the nature of particle material, chemical reactions, chemical laws and theories, and general chemical applications in everyday life [12]. To be able to achieve chemical literacy and scientific literacy, students must actively participate in the learning process. Scientific literacy including appropriate chemistry literacy is implanted in students if supported by guided inquiry learning. This was supported by Almuntasheri, et al., Who explained that guided inquiry-based learning material was effective to improve students' literacy skills [13].

SMA Islam Sudirman Ambarawa is one of schools that have not applied guided inquiry learning in their everyday learning. It is known based on the results of observations of learning process in the classroom and interviews with one of the chemistry teachers. Material for electrolyte and nonelectrolyte solutions at SMA Islam Sudirman Ambarawa is taught by using direct lecture and question and answer methods, and rarely practicing. The fact is that students are more dominant memorizing electrolyte and nonelectrolyte solutions. This is supported by Lin et al who explained that in general, students tend to gain knowledge about material concepts through memorization without understanding the concept it self, as a result students have difficulty in associating material with scientific concepts in everyday life, and lack of understanding the meaning. The delivery of material that tends to introduce less science as
a process, content, and application of science results in the disinterest of students in studying chemistry which causes students' chemistry literacy to be lacking. Based on this background, this study aims to determine the effectiveness of guided inquiry learning contextual based to improve students' chemistry literacy abilities.

2. Methods
This is an experimental research with pretest-posttest control group design and cluster random sampling as sampling techniques. Cluster random sampling is a group random sampling technique. This research is done in SMA Islam Sudirman Ambarawa in January 2019 with 70 students of two different classes of X MIPA as sample. There are 3 variables in this research. Firstly, free variable in this research is guided inquiry learning based of contextual in experiment group and guided inquiry learning in control group. Tied variable is students’ chemistry literacy ability and control variable is curriculum, same teacher, material the same amount of learning hours. Learning process in control group and experimental group is using guided inquiry learning which consisted on 5 steps namely orientation, problem formulation, hypothesis arrangement, data tabulation and making conclusion. However, in experiment group, the guided inquiry learning is supported with contextual based learning.

Data collection method in this research is test and questionnaire. Questionnaire of students’ responses is used here. Chemistry literacy test is used to determine the ability of chemistry literacy in knowledge aspect, context, and competency. Questionnaire responses are used to determine students' responses to the learning. Analysis of research data is divided into two stages, namely analysis of population data and analysis of research data. Analysis of population data consists of tests of normality and homogeneity. The test results show that the data are normally distributed and homogeneous. Data analysis of the research results consisted of N-gain test, classical pass test, t test, and descriptive analysis of student response questionnaire data.

The application of guided inquiry learning in this research is effective if: (1) students; classical pass > 75%; (2) the average result of scientific literacy ability of experiment group is higher than control group. The criteria for evaluation of the effectiveness of learning are as follows: (1) the effectiveness of learning is high if the classical pass is >75%; (2) the effectiveness of learning is average if the classical pass is 50%-75%; and (3) the effectiveness of learning is low if the classical pass is <50%.

3. Results and Discussions
Chemistry literacy ability is analysed using pre-test and post-test data. The following are the results of the pre-test and post-test of the experimental group and the control group, presented in Figure 1.

![Figure 1. The average of pre-test-post-test result](image)

The pretest and posttest questions used are adjusted to the indicators of chemical literacy so that when the score of learning outcomes is high, hence students' chemical literacy skills are also good. Figure 1 shows that the pre-test and post-test average results of experimental group is better than the control group, this is because experimental group learning is equipped with contextual based learning. Contextual learning can have a major influence on student learning outcomes because students are
trained to look for problems, collect data, solve problems and then develop and analyse the problem to find a solution [14]. The N-gain results obtained by both group is in the medium category. This is supported by the theory described by Lundgren, that the application of guided inquiry learning has several advantages, one of them is to improve student academic achievement. Research by Khan also explained that guided inquiry learning can improve student achievement in chemistry material. Classical pass test is determined after knowing individual completeness based on minimal pass score criteria set. The results of classical pass are presented in Figure 2.

![Figure 2. Classical pass result](image)

Figure 2 stated that the experimental class has reached the indicators of determined learning effectiveness, it is >75%. Therefore, it can be interpreted that guided inquiry learning is effectively applied to the experimental group. Classical pass result in control group is 38.71% because there are still many students who cannot pass the minimal score. The failure of learning is mainly because students still have not mastered the learning concepts. The average result of pre-test and post-test, N-gain result and classical pass result acquired are supported with T-test analysis to see the effectiveness of guided inquiry learning based on contextual that is applied. T-test result analysis is provided in Table 1.

| Data     | Tcount | Ttable | Criteria       |
|----------|--------|--------|----------------|
| Pre-test | 0.765  | 1.996  | Ho accepted    |
| Post-test| 3.658  | 2.002  | Ho rejected    |

Table 1 provided T-test result analysis of post-test comparison > t_table therefore Ho is rejected, and Ha is accepted. It means that the average results of students' chemical literacy ability in the context, competency, and knowledge aspects taught through contextual inquiry-based learning have better results than students taught with guided inquiry learning. It can be conclude that the application of guided inquiry learning based on contextual has a positive influence on students' literacy abilities in aspects of context, competence, and knowledge. Chemistry literacy ability consists of three aspects, namely knowledge aspects, context aspects, and competency aspects. The competency aspect consists of three indicators, namely explaining phenomena scientifically, interpreting scientific data and evidence, and evaluating and designing scientific investigations. The post-test results were analysed to determine the increase in chemistry literacy ability of each aspect with the N-gain formula. Analysis of N-gain results in the chemistry literacy ability of each aspect is presented in Figure 3, 4, and 5.
Figure 3 provided N-gain results of chemistry literacy in context aspects of experiment group are better than control group. It means that experiment group students are able to associating material concepts with examples of applications in everyday life. Johnson explained that learning that associates concepts with applicable contexts and close to real life can make it easier for students to understand the concepts being learned, so that they can remember this concept better and not easily forget [15].

Figure 4 provided N-gain result of chemistry literacy in knowledge aspect in experiment group is better than the control group. The result shows that experiment group students are better to analyse the application of their knowledge into the context described in the problem. This result is supported by Carlson that stated guided inquiry learning has the potential to improve student scientific literacy seen from students' understanding of the concept of material. The learning process that applies guided inquiry invites students to know more about electrolyte and nonelectrolyte solutions in everyday life, even about what they drink or eat. Therefore, it makes students understand about some chemical concepts related in everyday life [16]. Efforts to improve chemical literacy skills require independent learning strategies that include real concepts in accordance with the daily lives of students.

Figure 5. N-gain result of chemistry literacy on competency aspect

Competency aspects refer to the ability of students to use their knowledge in answering a question or solving a problem. Figure 5 shows N-gain result of chemistry literacy ability of competency aspect in every indicator. In explaining the phenomenon scientifically indicator, experiment group obtain better N-gain results compared to the control group, it is because the guided inquiry learning process in the experimental group is complemented by contextual learning, where learning is carried out associated with examples of phenomena/applications in everyday life. Therefore, students in the experimental
group are better to explain a phenomenon that is associated with the concept of the material being studied. The ability to explain phenomena is scientifically shown by students with abilities to recognize the key issues and characteristics of the phenomena contained in the problem.

In interpreting scientific data and evidence indicator, N-gain result obtained by the experimental group is better than the control group, as stated in Figure 5. However, the N-gain results are not significantly different. This is because both classes together carry out discussion activities in which there is a process of analysing data or information. The achievement of chemistry literacy on interpreting scientific data and evidence indicators is also illustrated by the students' ability to interpret scientific evidence and draw conclusions by interpreting the data contained in several tables and images on the test questions used in this study. In addition, in the learning process researchers also encourage students to be creative and work together to gather information to construct their knowledge independently through discussion of seeking information from various learning sources. In guided inquiry learning students conduct many investigations using a variety of learning resources so that it will stimulate students' chemical literacy abilities, namely the ability to identify, analyse and draw conclusions from a phenomenon encountered so that students will understand the influence of science on technological development and its implications for life [17].

In the indicators of evaluating and designing scientific investigations, N-gain results of the experimental group were better than the control group. It can be analysed from one of the questions that is used in this research, the question directed students to write down the correct steps in testing solutions using electrolyte test equipment. Most of the students can answer the question in this indicator. The students already understand what the right sequence of steps is, because in the learning process in addition to discussion, students also carry out practical conductivity test solutions. Therefore, it can be interpreted that guided inquiry learning can facilitate students in improving chemistry literacy ability, especially in the aspect of competency indicators in evaluating and designing scientific investigations.

The test results obtained are supported by questionnaire data on students' responses towards learning. Questionnaire of student responses towards learning aims to determine the extent to which students' understanding of the learning process with guided inquiry models based on the material of electrolyte and nonelectrolyte solutions. There are 15 items in the student response questionnaire. The results of the percentage of student responses to the application of learning are presented in Figure 6.

![Figure 6. Percentage of Student Responses towards learning](image)

The overall percentage is 68% with good categories. This shows students are enthusiastic in participating in learning. The application of guided inquiry learning is a new thing for students that provide a different atmosphere. This learning also provides space for students to learn according to their learning styles. The percentage results obtained also show that students need a guided inquiry learning model because it increases the enthusiasm of learning, so students are more motivated and as innovations in the learning process. Over all the questionnaire responses of students get a good response and can be accepted by students.
4. Conclusion

Based on research result, the average of students’ chemistry literacy ability in experiment group is better than the one in control group, with classical pass more than 75%. N-gain result analysis of chemistry literacy ability in knowledge aspect, context aspect, and competent aspect shows that experiment group got better result than control group. Those result is supported with T-test result of one of the right where t_{count} 3.66 more than t_{table} 2.00. From T-test result, it can be concluded that by using guided inquiry learning based of contextual, students’ chemistry literacy ability is improved significantly.

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