Guided inquiry assisted by edmodo application to improve student critical thinking skills in redox material

R K Dewi* and S Wardani

1Department of Postgraduate Chemistry Education, Universitas Negeri Semarang, Indonesia
2Lecture Department of Postgraduate Chemistry Education, Universitas Negeri Semarang, Indonesia

*corresponding author: ratnakumaladewi@students.unnes.ac.id

Abstract. Guided inquiry is a learning model that encourages students to practice their thinking skills by asking questions and getting answers on the basis of curiosity. The Edmodo application is an E-Learning based media designed to manage classes and assignments online so students can connect directly with their teachers and classmates. The purpose of this study was to determine the increase in students' critical thinking skills towards the implementation of guided inquiry model assisted by Edmodo application on Redox material. The sample uses cluster random sampling, namely 3 classes from X MIPA in SMA Negeri Semarang. The variables studied were indicators of students' critical thinking skills with experimental design pre-test and post-test. The improvement test used a Normalized Gain Test (N-gain) the amount of N-gain in the control class is 0.6 in the medium category, and 0.7 in the high category in experimental class 1, and 0.72 in the high category in experimental class 2. The influence between variables produced a large correlation coefficient of cognitive learning outcomes of the experimental class 1 of 0.319 and in experimental class 2 of 0.408. The influence between variables produces a biserial correlation coefficient of experimental class 1 amounting to 0.319 and experimental class 2 of 0.408. The influence between variables produces a coefficient of determination of the experimental class 1 of 10% and experimental class 2 of 17%. The results of the study showed an increase in students' critical thinking skills in both the control and experimental classes. The critical thinking skills students who were given the guided inquiry assisted by the Edmodo application in the experimental class were better than students who were given guided inquiry without the Edmodo application in the control class on the Redox material.

1. Introduction

Industrial revolution era 4.0 is closely related to 21st-century skills. In the 21st-century literacy learning media in Chemistry lessons are needed to increase student motivation and learning outcomes [1]. Learning media innovation in the 21st-century requires skills in problem-solving, collaboration, communication, and critical thinking skills to create new things [2]. Critical thinking skills developed in 21st-century skills are the ability to analyze, evaluate, convince, decide, and argue in deciding opinions [3]. Learning Chemistry in schools requires students' critical thinking skills especially in redox material [4].
Critical thinking is one of the assets that students must possess as a provision in facing the development of science and technology at present [4]. Efforts to practice students' critical thinking skills receive less attention from the teacher. This is evident from the learning activities carried out by Chemistry teachers at Semarang State High School at the time of observation giving more information through lectures, followed by discussions and exercises with very limited frequency so that the lack of students' critical thinking.

Critical thinking skills get with a fun process requires an interesting learning model such as the guided inquiry learning model [5]. The guided inquiry learning model is one of the learning strategies that can improve critical thinking skills so that maximum student learning outcomes will be obtained [6]. Guided inquiry learning is a learning model that requires students to think about their findings. Guided inquiry learning will encourage students to find and understand difficult concepts and be able to discuss the problem with their peers [7].

The guided inquiry model can change the focus of science education from memorizing concepts in subjects to learning through inquiry which involves students actively using the science process, critical and creative thinking skills such as finding answers to questions asked [8]. Through this learning model, students are expected to be able to formulate their findings with confidence so that they can improve their learning outcomes and thinking abilities at Semarang State High School.

The results of observations of Chemistry learning conducted at Semarang State High School indicate that student learning outcomes and thinking abilities towards Chemistry material are still low. This is indicated by the average end-of-semester test scores that are still below the KKM (Minimum Completion Criteria), which is 75. Besides, students assume that learning in the classroom pays little attention to freedom of thought, much memorization, and seems to pursue the curriculum.

Based on observations of learning conducted at Semarang State High School, textbooks are oriented and teacher centered, so learning is less active. This is because learning in the classroom is dominated by the teacher and has not emphasized the active activities of students (student centered) in developing concepts [9]. The importance of student-centered learning rather than teacher-centered [10]. The best learning is when students are actively involved in learning activities in class such as in Chemistry lessons [11].

One material in learning Chemistry that requires a lot of explanation and supporting media in its achievement is the Redox material. Redox material is quite difficult material for grade X students because there are macroscopic, submicroscopic and symbolic levels [12]. Redox material will achieve good learning outcomes if students can think logically and process their thinking skills, not only memorizing the material but also processing students' critical thinking skills [13]. In class X Redox material needed a special strategy in teaching one of them by utilizing learning media [14]. One of the appropriate media based on e-learning that fosters the existence of social media is Edmodo [15].

Edmodo is a free and secure educational learning network that is used to provide teachers with a simple way to create and manage online class communities and enable students to connect and work with their teachers or classmates anywhere and anytime [16]. The results of this study are in line that Edmodo is a private social network that is claimed to provide a safe learning platform for students and teachers by using an appropriate learning model [17].

The use of Edmodo media in the learning process of Redox material will foster creativity, effectiveness, learning activities more fun, and can increase critical thinking skills of class X students [18]. Edmodo Media can facilitate communication between teachers and students and parents. The learning system can continue to be monitored because it uses electronic media so that learning is of higher quality and can stimulate critical thinking skills of class X students.

Based on the above problems, the purpose of this study is to determine the effectiveness of guided inquiry learning models supported by Edmodo application of Redox material on critical thinking skills of class X students in Semarang State High School.
2. Method
Research was conducted at one of the state high schools in Semarang on Redox and Nomenclature Compound material. The study used a pretest-posttest control group design and cluster random sampling. The sample in this study was selected randomly from four classes with cluster random sampling techniques. Two classes were selected as the experimental class, namely X class MIPA 3 and X MIPA 4 and one class as a control class that is class X MIPA 1.

The independent variable in this study is the guided inquiry learning model. The treatment variations in the control class were determined with the guided inquiry learning model without the assist of Edmodo application while the experimental class was determined with the guided inquiry learning model assisted by the Edmodo application. In the class folder on edmodo there are 4 folders, each consisting of activity 1 which is the activity at the first meeting, activity 2 activities at the second meeting, activity 3 activities at the third meeting and activity 4 is the activity at the fourth meeting. Each folder consists of Redoks e-module teaching materials, student worksheets, Redox learning videos, and practice exercises. The dependent variable in this study was students’ critical thinking skills on Redox and Compound Names. The control variables in this study are the curriculum, number of hours of study, and subject matter. From the test results are then calculated the validity of the test, level of difficulty, distinguishing features, and reliability.

The method of data collection is done by the method of tests, observations, documentation, and questionnaires. The test method uses pretest and posttest to measure students' critical thinking skills, the observation method is used to find out the attitudes and psychomotor aspects of students, the documentation method is used to obtain data about the list of students in the population, and the questionnaire method to determine the responses of the experimental class students during the learning process.

The instrument used in this study was a test instrument in the form of a pretest and posttest, the test instrument before being used was tested to find out its validity, different power, difficulty level and reliability. The observation sheet and questionnaire instruments before use were validated by expert lecturers and chemistry teacher in Semarang State High School. Research implementation instruments include: Syllabus, Learning Implementation Plan, Edmodo application, Student Worksheet, Posttest pretest questions, affective aspect observation sheets, psychomotor aspects observation sheets and student response questionnaires to students in Semarang State High School.

3. Result and Descution
The indicators of critical thinking skills in this study refer to Ennis which consists of five indicators namely providing simple explanations, building basic skills, concluding, giving further explanations, and managing strategies and tactics. These five indicators are contained in the pretest and posttest questions which amount to 20 questions. The form of the problem is a multiple-choice reasoned with five answer choices.

Data will be normally distributed if $\chi^2_{\text{count}} \leq \chi^2_{\text{table}}$ with a significance level of 5% and degrees of freedom $df = k-3$. The normality test results for the pretest and posttest values are in Table 1.

| Inform | Control Class | Experiment 1 Class | Experiment 1 Class |
|--------|---------------|--------------------|--------------------|
|        | Pretest       | Posttest           | Pretest           | Posttest           |
| $\chi^2_{\text{count}}$ | 6.91          | 6.52               | 5.70              | 7.30              | 4.70              | 6.84              |
| $\chi^2_{\text{table}}$ | 7.81          | 7.81               | 7.81              | 7.81              | 7.81              | 7.81              |
| Inform | Normal Distribution | Normal Distribution | Normal Distribution | Normal Distribution | Normal Distribution | Normal Distribution |

Table 1. Test Normality Test Results for Pretest and Posttest Values
Analysis of each aspect of indicators of students' critical thinking skills is used to determine aspects that have increased or not as a result of the treatment carried out. The control class uses the guided inquiry model without the assist of Edmodo application while the experimental classes 1 and 2 use the guided inquiry model with the assisted by Edmodo application.

Edmodo's feature in redox learning is complemented by several learning activities, such as quizzes, assignments, polls, grade books, libraries, award badges, and parent code. Edmodo supports teaching materials in the form of files, links, and videos so that teachers and students can be connected anytime and anywhere in the learning process. The teacher can post grades, assignments and quizzes that students must work on. Students can submit homework and view student grades and comments. The teacher can also create a forum for discussion between students. Teachers can differentiate and individualize learning through the creation of subgroups so that it can improve students critical thinking skills.

3.1 Provides a Simple Explanation

Students' critical thinking skills indicators in this aspect are identifying a question or problem that is the focus so that they can provide a simple explanation of the main problems raised in Redox material. There are 4 question indicators listed in the pretest and posttest questions including: providing a simple explanation of the Redox concept appropriately in terms of combining and releasing oxygen, releasing and receiving electrons, giving a simple explanation of the Redox reaction and not Redox based on the equation of the reaction, giving a simple explanation of one of the causes of spoons and forks made from iron is never rusty, and about the browning of apples in the Redox reaction. The results of the analysis of critical thinking skills of indicator students provide a simple explanation in each class based on the score of each aspect can be shown in Table 2.

| Indicator          | Class        | Average Students Critical Thinking Skills | Pretest | %     | Category | Posttest | %     | Category |
|--------------------|--------------|---------------------------------------------|---------|-------|----------|----------|-------|----------|
| Provide a Simple   | Control      |                                             | 9.33    | 58.33 | Less     | 13.41    | 83.50 | Good     |
| Explanation        | Experiment 1 |                                             | 9.33    | 58.33 | Less     | 13.36    | 83.85 | Good     |
|                    | Experiment 2 |                                             | 8.97    | 56.07 | Less     | 14.33    | 89.58 | Very Good|

The highest score on this aspect is the experimental class 2 with an average percentage of the total score of 89.58% with a very good category followed by experimental class 1 83.85 very good category, and the control class 83.50 good category. This shows that students who are taught with guided inquiry learning models can provide simple explanations in solving problems in a focused and directed way in redox material. Students' skills in providing simple explanations are listed in the guided inquiry learning model in terms of problem-solving.

3.2 Building Basic Skills

Students' critical thinking skills indicators in this aspect are asking and answering questions that are presented to find solutions to the main problems raised in Redox material. The basic skills of students in asking and answering questions can be observed during the learning process. There are 4 question indicators listed in the pretest and posttest questions include: building the basic skills of the Redox concept of the iron ore processing industry that causes FeS + O$_2$ $\rightarrow$ Fe + SO$_2$, acid rain, changes in Cl oxidation in the process of discolouring clothing with bleach-containing NaOCl solution in the following reaction: NaOCl + H$_2$O $\rightarrow$Na$^+$ + Cl$^{-}$ + 2OH$^-$, builds the basic skills of the Redox concept of Vitamin C added to prevent browning of apple, and builds the basic skills of correctly determining the name of the Redox compound according to the IUPAC rules. The results of the analysis of critical thinking skills of indicators of students building basic skills in each class based on the score of each aspect can be shown in Table 3.
Table 3. Analysis Results Building Basic Skills

| Indicator          | Class         | Average Students Critical Thinking Skills |
|-------------------|---------------|-------------------------------------------|
|                   |               | Pretest % Category Posttest % Category    |
| Building Basic    | Control       | 8.75 54.68 Less 13.75 85.93 Very Good     |
| Skills            | Experiment 1  | 8.11 50.69 Less 14.47 90.45 Very Good     |
|                   | Experiment 2  | 8.66 54.16 Less 14.27 89.23 Very Good     |

The highest score on this aspect is the experimental class 1 with an average percentage of a total score of 90.45% with a very good category followed by the experimental class 2 89.23% very good category, and the control class 85.93 good category. This shows students who are taught with guided inquiry learning model can build basic skills in solving problems in a focused and directed way. Students' skills in building basic skills are listed in the guided inquiry learning model in terms of making hypotheses or tentative assumptions. In this aspect the experimental class scores higher than the control class because the experimental class uses Edmodo application so students often practice redox questions anytime, anywhere.

These results prove that the experimental class is more able to build basic skills than the control class. Edmodo-based e-learning makes students more responsible for assignments, makes students happy because learning is not monotonous, more active in learning to increase student motivation [19].

3.3 Summing up

Students' critical thinking skills indicators in this aspect are showing a critical attitude in responding to explanations and opinions about the phenomenon of reduction and oxidation to find solutions to the proposed problem. Conclusion skills can be observed during the learning process. There are 4 question indicators listed in the pretest and posttest questions include: concluding that rust that occurs in iron is an oxidation reaction, concluding further explanation of changes in bilox S in the event of sulfur solids in volcanic regions caused by the reaction between H₂S gas and SO₂ gas, Conclude the treatment of organic wastewater by an activated sludge process, and conclude the concept of oxidizing and reducing agents between the Zn metal and H₂SO₄ solution. The results of the analysis of critical thinking skills of indicator students concluded in each class based on the scores of each aspect can be shown in Table 4.

Table 4. Concluding Analysis Results

| Indicator | Class         | Average Students Critical Thinking Skills |
|-----------|---------------|-------------------------------------------|
|           |               | Pretest % Category Posttest % Category    |
| Concluding| Control       | 9.30 58.15 Less 12.77 79.86 Good          |
|           | Experiment 1  | 8.027 50.17 Less 13.41 83.85 Good        |
|           | Experiment 2  | 8.38 52.43 Less 13.47 84.20 Good         |

The highest score on this aspect is the experimental class 2 with a mean percentage of a total score of 84.20% with a good category followed by the experimental class 1 83.85% good category, and the control class 79.86 good category. This shows students who are taught with guided inquiry learning model can make conclusions in solving problems in a focused and directed way. Students' skills in inferring are listed in the guided inquiry learning model in terms of making conclusions. These results prove that the experimental class is more able to infer than the control class.

3.4 Provide Further Explanation

Students' critical thinking skills indicators in this aspect are asking and answering questions that are presented to find solutions to the main problems raised in redox material. The basic skills of students in asking and answering questions can be observed during the learning process. There are 4 question indicators listed in the pretest and posttest questions include: Provide further explanation of the concept of reduction and oxidizing agents in the iron corrosion process, Provide
further explanation of the differences in the disproportionation reaction, Redox reaction, and non-Redox reaction correctly, provide further explanation regarding Redox reactions in air pollution, and provide further explanation of substances that act as oxidizing and reducing agents in the battery shock process. The results of the analysis of critical thinking skills of indicator students provide further explanation in each class based on the score of each aspect can be shown in Table 5.

| Indicator             | Class       | Average Students Critical Thinking Skills | Category | Pretest | %   | Category | Posttest | %   | Category |
|-----------------------|-------------|-------------------------------------------|----------|---------|------|----------|----------|------|----------|
| Provide Further Explanation | Control    | 8.83                                      | Less     | 12.91  | 80.72| Good     |
|                       | Experiment 1| 9.77                                      | Less     | 13.69  | 85.59| Very Good |

The highest score on this aspect is the experimental class 2 with an average percentage of a total score of 88.02% with a very good category followed by the experimental class 2 85.59% very good category, and the control class 80.72 good category. This shows students who are taught with guided inquiry learning model can provide further explanation in solving problems in a focused and directed way. Students' skills in deducing are listed in the guided inquiry learning model in terms of collecting data. These results prove that the experimental class is more able to provide further explanation than the control class.

3.5 Managing Strategies and Tactics

Students' critical thinking skills indicators in this aspect are organizing strategies and tactics to find solutions to the main problems raised in Redox material. The basic skills of students in asking and answering questions can be observed during the learning process. There are 4 question indicators listed in the pretest and posttest questions including: arranging strategies and tactics about the sequence of bilox Br from the smallest to the largest correctly, arranging strategies and tactics in determining substances that are reducing agents in some chemical reactions, managing strategies and tactics what ingredients can replace vinegar to dissolve copper oxide, and arrange strategies and tactics regarding bathroom cleaning solutions on the market based on the Redox concept. The results of the critical thinking skills analysis of indicator students set the strategies and tactics in each class based on the score of each aspect can be shown in Table 6.

| Indicator       | Class       | Average Students Critical Thinking Skills | Category | Pretest | %   | Category | Posttest | %   | Category |
|-----------------|-------------|-------------------------------------------|----------|---------|------|----------|----------|------|----------|
| Setting Strategy and Tactics | Control    | 8.472                                     | Less     | 12.91  | 80.72| Good     |
|                 | Experiment 1| 8.38                                      | Less     | 13.69  | 85.59| Very Good |
|                 | Experiment 2| 8.11                                      | Less     | 13.52  | 84.54| Good     |

The highest score on this aspect is the experimental class 1 with the average percentage total score of 85.59% with a very good category followed by the experimental class 2 84.54% the good category, and the control class 80.72 the good category. This shows that students who are taught with guided inquiry learning models can manage strategies and tactics in solving problems in a focused and directed way. Students' skills in managing strategies and tactics in guided inquiry learning models in conducting experiments. These results prove that the experimental class is more capable of managing strategy and tactics than the control class.

Significantly increasing students' critical thinking skills can be identified by using the Normalized Gain (N-gain) test. The results of increasing students' critical thinking skills in the control and experimental class are shown in Table 7.
Table 7. Categories for Improving Student Critical Thinking Skills

| Class         | Pretest Average | Posttest Average | N-Gain <g> | Category |
|---------------|-----------------|------------------|------------|----------|
| Control       | 55.86           | 82.22            | 0.6        | Midde    |
| Experiment 1  | 54.55           | 85.80            | 0.7        | High     |
| Experiment 2  | 53.96           | 87.12            | 0.72       | High     |

The results of the analysis of the influence of the variables of students' critical thinking skills on the subject matter Redox and Nomenclature Compounds can be seen in Table 8.

Table 8. Results of Analysis of Influence between Variables from Critical Thinking skills

| Data             | S_y | p   | Q  | Z   | rb   | Criteria     |
|------------------|-----|-----|----|-----|------|--------------|
| Experiment 1     | 8.01| 0.51| 0.49| 0.02| 0.319| \(H_0\) rejected |
| Experiment 2     | 6.89| 0.51| 0.49| 0.02| 0.408| \(H_0\) rejected |

Calculation of the analysis of the influence between variables produces the coefficient of biserial cognitive learning outcomes of students (rb) experimental class 1 of 0.319 and experimental class 2 of 0.408. The price of the biserial correlation coefficient obtained is positive so that it shows the influence of guided inquiry learning model assisted by Edmodo application on the results of students' critical thinking skills on the material Redox and Nomenclature Compound. The magnitude of the contribution of the variable is calculated using the coefficient of determination (KD). Guided inquiry models supported by Edmodo media applications contribute significantly to students' critical thinking skills.

In the class folder in Edmodo there are 4 folders, each of which consists of activity 1 which is the activity at the first meeting, activity 2 activities at the second meeting, activity 3 activities at the third meeting and activity 4 is the activity at the fourth meeting. Each folder consists of Redoks e-module teaching materials, students' worksheets / worksheets, Redox learning videos, and question exercises as in Figure 1.

Figure 1. Display Student Activities in Edmodo

Assessment of affective and psychomotor aspects uses an observation sheet or observation sheet conducted by an observer. This assessment is carried out when students carry out discussions and practicum. The results of the analysis of the average of the three classes are included in either category. The results of overall student responses indicate that learning with the application of guided
inquiry learning models assisted by Edmodo application in experimental classes 1 and 2 makes students better understand in Redox material and Nomenclature Compound.

In the experimental class 1 (X MIPA 3) the percentage of the total score of 75% is in the category of agreeing with the good criteria. In the experimental class 2 (X MIPA 4) the percentage of the total score of 71.86% was in the category of agreeing with the good criteria. Most students in the experimental class agreed with the application of guided inquiry learning models assisted by Edmodo application on Redox and Compound Names.

Features in Edmodo are equipped with several learning activities, such as quizzes, assignments, polls, grade books, libraries, award badges, and parent code. Edmodo supports teaching materials in the form of files, links, and videos. The quiz feature is used to provide online evaluations in the form of multiple choice, short entries, and question details. Quiz can only be made by the teacher, while students only do it. This feature is equipped with a deadline for processing, information about the quiz to be made, the quiz title and quiz display. The score calculation for each item in the quiz is done automatically for multiple choice questions and short questions, while scoring the description questions must be checked by the teacher first. The quiz given is a critical thinking skiing quiz on Redox material with multiple choice answers as shown in Figure 2.

The guided inquiry learning model is divided into five stages. The five stages have used the material in the assessment of guided inquiry aspects, namely formulating problems, making hypotheses, collecting data, analyzing data, and making conclusions [20]. The guided inquiry learning model is essentially a process of discovery or investigation [21]. The main goal is to encourage students to develop thinking skills by giving questions and getting answers based on their curiosity. The learning process changes from teacher dominated to teacher dominated by students (student dominated), because in the guided inquiry learning model, the more active learning is students (as learning subjects), while the teacher acts as a facilitator or supervisor only.

Based on the results of the calculation of student response data it can be concluded that students in the experimental class prefer learning Redox materials by applying guided inquiry learning models assisted by Edmodo application media because it is more fun, interesting, and makes students more easily understand the concept of material, this can be seen from students' curiosity who are increasing in learning Redox material and they are more motivated to actively study both individuals and groups.

Based on the results of research and discussion of guided inquiry models assisted by Edmodo application can be alternative learning for chemistry teachers in Semarang State High School. This is done to make variations by using new learning models and media so that students are more interested and active in learning chemistry learning materials, especially Redox and Nomenclature Compound material, and can maximize the multimedia facilities available at Semarang State High School.
4. Conclusions
The application of guided inquiry learning model assisted by Edmodo application is effective in improving students’ critical thinking skills in Redoks in Semarang State High School. The results of the discussion and practicum showed the average student learning outcomes in the affective and psychomotor aspects of experimental class 1 and 2 were in the very high category while the control class was in the high category. The results of student responses to the guided inquiry learning model assisted by Edmodo application in experimental classes 1 and 2 were categorized as good and agreed to apply the guided inquiry learning model assisted by Edmodo application. Edmodo is a social learning media for teachers, students and parents. The teacher can post grades, assignments and quizzes that students must work on Redox and Compound Names. Students can submit homework and view grades and comments from the teacher. The teacher can also create a discussion forum between students related to Redox and Composition Names. The teacher can invite students to think critically by using Edmodo media. Edmodo application gives teachers to send files, pictures, videos and links to students. Teachers and students can be connected anytime and anywhere in the learning process.

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