Analysis of critical thinking skills in chemistry learning by using mobile learning for level x

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Abstract. This study aims to analysis of critical thinking skills in chemistry learning of the topics electrolyte solution and oxidation-reduction reaction by using mobile learning media. The subjects of this study at 3 Bogor High School West of Java. The research was conducted in December 2016 - July 2017. The research method used is qualitative method. Data analysis techniques were performed with data reduction, data display, conclusions and verification. The quality standard used is trustworthiness with the criteria of credibility through prolonged engagement, persistent observation, progressive subjectivity and member checking. Research data obtained through observation during learning, critical thinking skills tests, interviews, and questionnaires. Indicators of critical thinking skills in question are asking and answering questions, focusing questions, considering the credibility of a source, making observations and considering observation reports, making inductions and considering induced results, defining terms and considering definitions, deciding an action, and interacting with others. The results showed that eight critical thinking indicator tends to awaken and develop on learning with mobile learning media. Based on the results of critical thinking skills tests of each indicator studied include a score of 82% - 88% which can be categorized in good category.

1. Introduction

Mobile learning is a form of experience and opportunity provided by the evolution of educational technology including learning that can be done anywhere and anytime with a source of learning tools in accordance with the desire to acquire knowledge [1]. This is in line with the statement of UNESCO that mobile learning is a learning using smartphone technology or a combination of information technology and other communications that allow to learn anywhere and anytime. Its unlimited use of place and time has led many researchers to do research on mobile learning.

Many aspects are influenced by the use of mobile learning, one of which is the effectiveness of its use in the learning process. The study of mobile learning has now become the center of research of educational researchers. Many mobile learning studies are focused in terms of student motivation and effectiveness. Many surveys conducted by researchers show that students strongly support the use of mobile learning in learning, students believe that its use will enhance their learning experience [2]. The use of mobile learning combined in the form of games can improve students' chemical learning outcomes in groups of students who have high learning independence [3]. Based on research conducted by [4] the use of mobile learning in the form of games that collaborated with cooperative learning can encourage students' critical thinking skills. That students enjoy technology and become more active in learning when using smartphones in the classroom [5]. The state of students who enjoy learning with mobile
learning can be due to the age and the time they are getting familiar with the technology. High School students with a range of ages 15-17 years is a very sensitive age to technology so this is an advantage to using mobile learning in the classroom learning [6].

Innovative mobile learning makes learning easier and more effective for learning [7]. States that mobile learning brings many benefits, namely overcoming the problem of teachers in terms of time management and improve students' independence to understand the learning materials. The use of mobile learning media benefits students because students can repeat the learning materials to fill the leisure time whenever and not limited by time and place [7]. The use of mobile devices in education is better than when using a desktop computer or not using a mobile device as a supporter [8]. Revealed that the attitude of students and educators who use mobile learning is better when compared with students and educators who do not use mobile learning in the learning process [9]. Mobile games based learning on mobile devices is an educational game in learning devices that can be used by students as a tool to enhance the student interest in learning chemistry, as a learning resource or as a student reference. Such as those reported by [10]. Critical thinking skills is one of the capabilities students must face in the 21st century competition and competition in the digital age. The grade V elementary students who have high critical thinking skills will have high scientific literacy skills as well [3]. Basically students have critical thinking skills in learning such as questioning skills, hypothesis, classification, observation, and interpretation. However, these skills sometimes do not develop well. Therefore, it is necessary that the learning is able to develop students' critical thinking skills in chemistry learning. One effort that can be done to develop critical thinking skills is through mobile learning. This is supported by Norouzi's research [11] showing quantitatively learning by mobile learning can make students think more critical in language learning and look at a significant difference compared to control classes. Mobile learning is able to develop students 'critical' thinking skills and after learning with mobile learning there is an increase in students' attitudes as well as their creativity[12]. Mobile learning is able to change the way students behave and mobile learning is a form of modern learning that is able to provide learning critical thinking [13]. That learning with mobile learning can stimulate students to think critically and can present a unique and different learning [1].

Suggests critical thinking has an important role for students in assessing source credibility and data collection via electronic devices (smartphones) [14]. Mobile learning devices provide a container for self-reflection as well as communicating individually or in groups. The successful implementation of mobile learning requires a clear definition of critical thinking, methods for evaluating, and tactical patience to enable better quality learning in the classroom. High-level mobile learning can build critical thinking skills, communication skills, and be able to encourage challenged students to find many ideas [14].

Mobile learning can be brought to learning in the classroom with a more unique presentation so that teachers can observe how students' thinking ability[14]. Study encourages in-depth research on mobile learning on how critical students think skills such as through group or individual interviews because most other studies measure from the quantitative side [11]. In addition, students' critical thinking skills that may arise from the use of mobile learning media may be influenced by other factors.

Therefore, based on the background that has been described, it is necessary to do research on the analysis of students' critical thinking skills in chemistry learning on the topic of electrolyte solution and oxidation-reduction reactions through the use of mobile learning media.

2. Research methodology
The research started from December 2016 - July 2017. The sample used for the research is the X class of High School 3 Bogor West Java. The research method used in this research is qualitative method. Qualitative research is a multimode in focus, including an interpretive and naturalistic approach to the subject, the researcher studying everything in its natural setting, trying to understand or interpret the phenomenon in terms of the meanings that people give to the phenomenon. Stages of research are; (1) Preparation of instrument and application installation, (2) Implementation of learning, and (3) Data analysis.
Data collection techniques include: (1) Questionnaire of critical thinking ability, (2) Interview, (3) Observation, (4) Reflective journal, and (5) Test of critical thinking ability. The data obtained were analyzed by technique according to Miles and Huberman namely (1) data reduction, (2) display data, (3) conclusion and (4) verification. The quality standard used is trustworthiness with the criteria of credibility through prolonged engagement, persistent observation, progressive subjectivity and member checking.

3. Result and discussion

The lessons are held during five meetings consisting of four teaching meetings and one meeting for critical thinking skills tests. The first meeting begins with the material of electrolyte and non-electrolyte solutions. This meeting students to observe and discuss the articles associated with the material using mobile learning that has been provided. In addition, the students conducted video observation of experimental test of electrolyte and non electrolyte solution in mobile learning. The second meeting, students carry out the lab according to the video they have observed and understood at the previous meeting. Students explore their ability and creativity in practicing practice. The results of the lab were discussed using mobile learning and students presented the report on the results of the lab. The third encounter enters a new material of reduction reaction and oxidation. This reduction and oxidation reaction is understood through mobile learning media combined with the Student Worksheet. Students discuss and practice the reaction of reduction and oxidation on the media with enthusiasm. The fifth meeting held a discussion about the reaction of reduction and oxidation in everyday life. Students are eager to link the concept of reduction and oxidation in mobile learning to events in the worksheet. Closing learning is done by doing the quiz that is in the media. This learning meeting concludes with the test of students' critical thinking skills.

Lesson learned with mobile learning shows excellent student enthusiasm in learning to use smartphone. In addition, students look more developed in asking questions, answering questions, and analyzing events related to learning materials.

3.1. Analysis of critical thinking ability

This study analyzes students' critical thinking skills developed during learning using mobile learning. There are eight indicators of critical thinking ability observed in this research are: (1) Asking and answering questions; (2) Focusing questions; (3) Consider the credibility of a source; (4) Conducting observations and considering observation reports; (5) Making inductions and considering induced results; (6) Define the term and consider a definition; (7) Decide an action; and (8) Interact with others.

After the learning process by using mobile learning media, the questionnaire distributed students' critical thinking ability. This questionnaire aims to provide data related to students' critical thinking skills. The questionnaire contains 20 statement points categorized in the eight critical thinking indicators observed. In order to deepen the data obtained then the next conducted interviews to students. Interview aims to obtain reinforcement information and explanation directly about students' critical thinking skills.

3.2. Media testing

During the lesson, the indicator asks and answers questions growing. Based on the results of the questionnaire 94.4% of students felt learning using mobile learning gave them many opportunities to ask questions and answer questions. The ability of this indicator to develop is characterized by an active student in answering questions, questions, and in-depth student questions. Which states that the use of mobile learning or cellular technology can improve students' thinking ability of high level, so that students feel challenged to continue to learn that is in the media. Based on the overall data obtained seen that students feel encouraged and more daring to ask and answer questions due to learning mobile learning fun. Fun learning will generate curiosity in students. Therefore, students will gradually try to satisfy their curiosity through asking questions, answering questions, and providing further explanation.
3.3. *Focusing question indicator*

The next critical thinking ability indicator is the ability to focus the question. This indicator has three indicator criteria: identifying problems/questions, maintaining the state of mind, and formulating criteria for considering possible answers. The indicator of focusing questions is the ability of students to focus on learning so that they can answer the questions given properly and correctly. Based on the results of questionnaires 91.4% of students agree that mobile learning helps them in focusing their thoughts on learning and providing illustrations about learning. The results of the questionnaire above gives an idea that most students can focus in thinking because mobile learning can provide an overview of the material to be learned. In addition to helping students maintain the state of mind it turns out most students feel more able to associate material to environmental problems due to learning using mobile learning media through the identification problem.

Based on the overall data obtained, the indicator of students' critical thinking ability in focusing questions looks good and evolves. During the course of learning, the average student follows the lesson well and focuses in responding to each question posed. Almost all students feel that mobile learning media can be used as one-stop learning media because it includes material, quiz, and practicum videos that can make them more focused in learning. With the special materials in mobile learning allows students to provide an overview of the material they will learn and the ease of mobile learning access anywhere and anytime. The concepts contained in mobile learning combined with the application of chemistry in everyday life resulted in students becoming more interested and focused in learning. Focus on learning resulted in the students will be responsive and focus also in answering questions posed by teachers and friends.

3.4. *Consider a source’s credibility*

The indicator of critical thinking ability observed is the ability to consider the credibility of a source. This indicator has two indicator criteria that is considering the suitability of a source and procedure and knowing other sources that can be used for learning. In this study students are expected to be trained to choose a variety of reliable sources.

Based on the results of the questionnaire 94.4% of students felt able to collect material from various sources and ensure the truth when learning to use mobile learning media. Students believe that learning with mobile learning media in addition to fun can actually train them to independently seek other learning resources. Students also appear self-sufficient when practicing a test solution by self-determining the materials used and the sequence of experimental procedures.

The results of the analysis of various data obtained showed the curiosity of students and the desire of students to find out more when learning with mobile learning media. Students are able to collect material from various sources because mobile learning is inside the smartphone that allows students to search for information from various sources on the internet.

3.5. *Observe and consider observation reports*

This indicator is seen based on the observation sheet where students perform video observations and lab work very well. Mobile learning provides space for students to collect information either individually or in groups and get involved in the review of information, recording activities, and reflections that lead to creative and critical thinking [14]. Based on the results of the questionnaire, all students believe with the existence of mobile learning media to facilitate them in carrying out practicum and make practical reports. In addition, students' observational skills were seen when students compared the results of the lab with the results in the practicum video.

3.6. *Making induction and considering induction result*

This indicator has 3 indicator criteria that understand the topic, put forward the conclusion, and reveal the reason in conclusion. Based on the results of the questionnaire showed all students agreed and strongly agree to their ability to express conclusions based on the facts they get during learning using mobile learning media. The result of the analysis of students' critical thinking ability on the indicators
made induction and considering the induction result showed that learning with mobile learning media was able to develop the ability. Mobile learning is something new for students to increase student enthusiasm during learning. In addition, students feel the presence of mobile learning media makes it easier for them to learn. In other words, students begin to think critically in various contexts and even develop deeper reflections that are supported by maintaining a mobile learning journal. The journal is an event video recording, a sound recording of the mind, or a small note text for reflection with a friend [14]. They can repeat the learning anytime and anywhere then the quiz in mobile learning media to make students can who they have created.

3.7. Defining terms and considering result of definition
Based on the results of the questionnaire, 97.2% of students are able to make definitions and provide further explanation of the definition when learning to use mobile learning media. This indicator is seen from the results of observations that show the liveliness of students in giving definition accompanied by pictures or examples that can clarify the definition.

This indicator develops during learning because the concepts in mobile learning media are easy to understand and concise. Therefore students are more courageous to express the definition as per their understanding.

3.8. Deciding an action
This indicator has three indicator criteria that is expressing the problem, considering possible solutions, and deciding an action. The results of the questionnaire indicate that all students can express problems encountered when learning or practicum. However, not all students are trying to find a solution to their problems during learning and practicum. This is evident from the 5.6% of students feel unable to find a solution of the problem. During the students’ learning the problems they face directly to the researchers and discuss with their friends. According to the data on the observation sheet the longer the more students who dare to express the problems encountered when learning.

Based on the data obtained, the analysis of the ability of critical thinking on the indicator to determine an action developed along with the use of mobile learning media. Students look enthusiastic in learning and dare to uncover the problems they face.

3.9. Interacting with others
This indicator has three indicator criteria: expressed opinions, responded to others' responses, and worked together. The ability to interact with others is seen from how students think, value the opinions of others, and work together. Activities designed in this lesson enable students to practice their interaction skills with others. The results of questionnaires showed 52.8% of students strongly agreed, 36.1% agreed to discuss and cooperate with friends or groups when studying in class or in the LINE group. In addition to cooperation also obtained data where students feel he can appreciate and respond to statements or questions. This is also reflected in the questionnaire showing all students agreeing with the statement.

Students feel helped by the mobile learning media which is a new thing for them and gives the view that the smartphone is very useful for learning. Active learning activities through discussions and quizzes in mobile learning resulted in students feeling more able to argue and appreciate the opinions of others. That the use of mobile learning in chemistry learning can produce good confidence for students in learning chemistry and generate a sense of satisfaction is good against the process of learning chemistry[3].

3.10. The Critical Thinking Ability Test
The critical thinking skills test was conducted at the fifth meeting after the learning of the electrolyte-non-electrolyte solution material and the oxidation-reduction reaction was completed. Problem consists of Nine items that refer to the ability of critical thinking indicators to be observed. Table 1 shows the classification of students' critical thinking skills.
Table 1. Results of student critical thinking ability test.

| Critical Thinking Indicators                        | Question Number | Average Feasibility | Category |
|-----------------------------------------------------|-----------------|----------------------|----------|
| Focusing Questions                                  | 4               | 88.2%                | Good     |
| Consider A Source’s Credibility                    | 2               | 82.8%                | Good     |
| Observe and Consider Observation Reports            | 3               | 83.9%                | Good     |
| Making Induction and Considering Induction Results  | 1 and 5         | 86.3%                | Good     |
| Defining Term and Considering a Definition          | 6 and 9         | 83.2%                | Good     |
| Deciding an Action                                  | 7 and 8         | 88.9%                | Good     |

The test results of critical thinking ability in each indicator tested shows the percentage of scores in the coverage of 82% - 88%. This coverage can be categorized that students' critical thinking skills are in either category. The results of this test are used as data to support the results of research from learning with mobile learning media that has been implemented. This good category shows that all students are able to meet the critical thinking ability indicator being studied by the researcher. The results of this test are in line with the results of data obtained from the observation sheet, journal reflective, and interview.

Learning with mobile learning has a good impact on students' critical thinking skills. This is in line with some pre-existing research. If students use critical thinking skills, they gain a clear and bright view in depth, they are more interested in ways, they understand in a more sensible way and they become more critical [15]. On the other hand, underline critical thinking are marked by careful determination whether to accept, reject, or postpone conclusions [16]. Mobile learning media that can be accessed anytime and anywhere enables students to more easily open the subject matter. Media is easily accessible, seen once students are enthusiastic to learn to use this media because the media is a new learning variation for them. Besides being equipped with compact material, mobile learning media is also equipped with quizzes and practicum videos that support learning. Increased student enthusiasm leads to a pleasant learning atmosphere and critical thinking skills of students are encouraged to develop during learning. The use of mobile learning in learning chemistry can produce enthusiasm and good attention and students become more interested in learning chemistry [3].

4. Conclusion

Based on the results of research and discussion, it can be concluded that learning with mobile learning media able to build and develop students' critical thinking skills. (a) Consider the credibility of a source, (b) Make observations and consider observational reports, (c) Make inductions and consider induced results, (d) Question and answer questions, (e) Define a term and consider a definition, (f) Decide an action, and (g) Interact with others. This critical thinking skill evolves with the enthusiastic appearance of students in asking, the quality of in-depth questions, the student's initiative in finding sources, and the curiosity of the developing students. In addition, based on the results of students' critical thinking skills test scores obtained 82% - 88% included in either category.

Mobile learning media (not limited by space and time) allows students to easily open subject matter. It increases students' enthusiastic learning. In addition, mobile learning media is equipped with compact material, learning animation, quizzes (exercise questions), games and practice videos that support learning. Increased student enthusiasm leads to a pleasant learning environment, increased ability to ask questions, in-depth question quality, student initiative in finding sources, and curiosity of developing students. In addition, students' critical thinking skills test scores are 82% - 88% in either category. So that students' critical thinking skills are encouraged to develop during learning.
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