Developing ChemonDro Application on Redox Concepts to Improve Self-Regulated Learning of Students

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Abstract. This research aimed to produce an android-based learning media called ChemonDro (Chemistry on Android) application on the concepts of oxidation-reduction (redox) reaction and to identify the improvement of students' self-regulated learning. The development research procedures were adapted from the Gall, Gall & Borg development model consist of four phases: planning, product development, formative evaluation and revision, and summative evaluation. ChemonDro validations were conducted by two lecturers. ChemonDro assessments were conducted by five chemistry teachers and five peer reviewers. ChemonDro evaluations were conducted on senior high school students grouped into one-to-one evaluation on 6 students, small group evaluation on 10 students, and field test evaluation on 32 students. Field test evaluation was conducted to determine the effect of ChemonDro used on self-regulated learning. Instruments used in this study include a questionnaire of media assessment and a questionnaire of self-regulated learning. The media assessment questionnaire was given for a media expert, a materials expert, reviewers, peer reviewers, and students. Questionnaire of students’ self-regulated learning was given to students before and after the learning process. The results showed that the ChemonDro on redox concepts developed can improve the chemistry self-regulated learning of senior high school students.

1. Introduction
The increase of rapid technological developments is pushing the application of media and digital technology in various fields. One thing that seems real is the development of the use of technological tools such as smartphones, tablets, or laptops to simplify the various affairs. In the field of education, the use of these technological tools has been beginning to be integrated into every subject, including chemistry subject. These strategies are possible to be effective considering the subject of chemistry in high school contains many difficult concepts for the students to understand. Furthermore, chemistry is often full of abstract concepts [1] and it may lead to a misconception among students [2]. For that reason, the selection of learning strategies will be influential in the process of understanding the concepts of chemistry by students.

Technology integration allows student-centered learning so that it can lead them to learn more independently according to their levels of ability. Technology-integrated learning method, like learning using multimedia, is still rarely done [3]. In addition to create a better learning process, the use of multimedia in learning can also encourage the development of self-learning attitudes of students [4]. One type of multimedia that can be used in the learning process is a smartphone-based learning media.
Smartphone-based learning media, especially for an android operating system or commonly called the android-based learning media, contains many benefits. In addition to adding value to the functionality and benefits of smartphones [5], the academic performance of students can also be improved [6, 7]. One of the academic performance that needs to be developed in the students is the self-regulated learning. The self-regulated learning influences the process of material mastering in learning [8] and then affects learning outcomes [9, 10].

Self-regulated learning is defined as a thorough process of self-design and monitoring of cognitive and affective processes in completing an academic task [11]. Students who have good self-regulated learning can be interpreted as able to plan, monitor, and assess their own learning process [10]. The characteristics of self-regulated learning are the concern with learning objectives, learning resources and mediums used, learning places, learning time, tempo and rhythm of learning, the way to learn, and evaluations of independent learning outcomes [12].

Based on the description of the importance of self-regulated learning and the variety of benefits that can be obtained from android-based learning media, this study aims to develop chemistry android-based learning media to improve the chemistry self-regulated learning of senior high school students. This instructional media is devoted to the concept of oxidation-reduction reactions. The data of UN 2012/2013 academic year show that the competencies of the redox reaction are low [13]. The value achieved indicates that students are still having difficulty in understanding the concept of reduction-oxidation reactions. Students' difficulty to understand can also be due to the way of presentation is still abstract. One of the learning strategies that can be used is the use of android-based learning media. This media is also in accordance with one of the suggested learning patterns in the 2013 curriculum.

Android-based learning media called ChemonDro (Chemistry on Android) application on the concept of oxidation-reduction reactions is developed to improve the self-regulated learning of students. ChemonDro application on the redox concept can be used as a learning resource for students. This application can also be used by the teacher as a learning media in the classroom. The use of this application as android-based learning media will make the learning process centered on the students.

2. Method

2.1. Development Model

The research method used was educational research & development (R&D) through development procedure in the adaptation from Gall, Gall, & Borg [14]. Development phases were grouped into 4 main steps: (1) planning, (2) product development, (3) formative evaluation and revision, and (4) summative evaluation. The development procedures were illustrated in figure 1.

![Figure 1. The development procedure of Gall, Gall & Borg model](image-url)
2.2. Assessment Design
The formative evaluation consisted of experts review (validation phase), one-to-one evaluation, small group evaluation, and field test evaluation [15]. Experts reviewed the ChemonDro application on redox concepts with or without the presence of the evaluator. At one-to-one evaluation, ChemonDro application was evaluated and responded by students along with evaluators. At small group evaluation, evaluator and some students tried out the ChemonDro application on redox concepts to know the students’ performances and responses. At field test evaluation, the evaluator observed the ChemonDro application on redox concepts being tried out in the learning process with a group of students.

Validations of ChemonDro application on redox concepts were done by a lecturer as a media expert, a lecturer as a material expert, 5 chemistry teachers as reviewers, and 5 peer reviewers. At this phase, ChemonDro would be assessed and revised based on the advice given. Instruments used in validation phase were questionnaire of media assessment for a media expert, a materials expert, reviewers, and peer reviewers.

After the revision in the validation phase, the learning media was evaluated by students through one-to-one evaluation, small group evaluation, and field test evaluation. Instruments used in this phase were a questionnaire of media assessment for students and a questionnaire of self-regulated learning. The questionnaires of self-regulated learning were given to students before and after the learning process. The one-to-one evaluation was conducted on 6 students and small group evaluation was conducted on 10 students. Field test evaluation was conducted on 32 students aimed to know the performance of the ChemonDro application on redox concepts in the learning process. In addition, field test evaluation was also intended to determine the effect of using ChemonDro on redox concepts on the self-regulated learning of students.

The field test evaluation was conducted by the quasi-experimental method with the Nonequivalent Control-Group Design [16] illustrated in table 1.

| Class    | Pretest | Treatment | Posttest |
|----------|---------|-----------|----------|
| Control  | $A_1^a$ | $X^c$     | $A_2^b$  |
| Experiment | $A_1^a$ | $Y^d$     | $A_2^b$  |

* $A_1$ is pretest score
* $A_2$ is posttest score
* $X$ is non-using the ChemonDro application on redox concepts
* $Y$ is using the ChemonDro application on redox concepts

2.3. Data Analysis Technique
Chemistry learning media that developed was considered valid if obtaining at least good-quality category. These media quality categories were obtained from media validation data in the form of quantitative data with 1-5 in scale. Then, the mean scores obtained in each aspect of media validation were compared with media quality categories shown in table 2.

Students' self-regulated learning data on control and experiment classes were quantitative data with 1-5 in scale then the data were converted into values using the following equation.

$$Value = \frac{Achieved\ _Score}{Maximum\ _Score} \times 100\% \quad (1)$$

Improvement of students' self-regulated learning was analyzed based on the number of normalized gain values obtained. The normalized gain values were grouped into 3 categories i.e. high ($g \geq 0.70$), medium ($0.30 < g < 0.70$), and low ($g \leq 0.30$). The normalized gain value was derived from the Hake equation [17].

$$g = \frac{S_f - S_i}{100 - S_f} \quad (2)$$
Note:

$S_f = $ final test (postest score)

$S_i = $ initial test (pretest score)

$g = $ normalized gain

| Table 2. The Conversion of Quality Score of Learning Media |
|--------------------------------------------------------|
| Aspects                                      | Score Range       | Category     |
|------------------------------------------------|-------------------|--------------|
| Display                                      | X > 46,2          | Very Good    |
|                                              | 37,4 < X ≤ 46,2   | Good         |
|                                              | 28,6 < X ≤ 37,4   | Quite Good   |
|                                              | 19,8 < X ≤ 28,6   | Bad          |
|                                              | X ≤ 19,8          | Very Bad     |
|                                              | X > 37,8          | Very Good    |
|                                              | 30,6 < X ≤ 37,8   | Good         |
| Material                                     | 23,4 < X ≤ 30,6   | Quite Good   |
|                                              | 16,2 < X ≤ 23,4   | Bad          |
|                                              | X ≤ 16,2          | Very Bad     |
|                                              | X > 21            | Very Good    |
| Media Operation; Learning; Material and Learning | 17 < X ≤ 21       | Good         |
|                                              | 13 < X ≤ 17       | Quite Good   |
|                                              | 9 < X ≤ 13        | Bad          |
|                                              | X ≤ 9             | Very Bad     |
|                                              | X > 42            | Very Good    |
| Display and Media Operation                  | 34 < X ≤ 42       | Good         |
|                                              | 26 < X ≤ 34       | Quite Good   |
|                                              | 18 < X ≤ 26       | Bad          |
|                                              | X ≤ 18            | Very Bad     |

3. Result And Discussion

3.1. Display of Product Development

The resulting product was an android-based learning media on the redox reaction material and it is used to support students' self-regulated learning. ChemonDro was operated with a smartphone that can be accessed anytime and anywhere. Other advantages of this application include easy to operate, interesting, motivate students and become one of the students' self-regulated learning resources.

3.1.1. Main Menu. The main menu page, shown in figure 2, contains six menus such as Guide, Material, Evaluation, Profile, Score of Evaluation, and Competency. Each menu is represented by a link button.
3.1.2. **Guide Menu.** The guide menu is shown in figure 3. The guide menu is a feature of the ChemonDro application applied when the students are having problems or want to find out how to operate this application.

![Figure 3. Display of “Guide” menu](image)

3.1.3. **Competency Menu.** The competency menu contains descriptions of competency standards, basic competencies, and indicators. This page, shown in figure 4, contains the competencies that required to be fulfilled by students after using the ChemonDro application.

![Figure 4. Display of “Competency” menu](image)

3.1.4. **Content Menu.** The content menu, shown in figure 5, contains the exposure of the redox concept. The theory of redox is not only presented in textual form but also in the animation form. Examples of redox reactions are shown in animation form in order to facilitate students in understanding the concept of redox reactions. The animations help students to determine redox reactions.

![Figure 5. Display of “Content” menu consists of (a) textual form and (b) animation form](image)
3.1.5. Evaluation Menu. The evaluation menu, shown in figure 6, contains two types of games: the “labirin” game and the “ant-strike” game. The games were added in this application to attract students’ interest in chemistry learning, especially redox material. These games have special purposes to evaluate students’ understanding about redox concepts. Students that play the game will find some questions about redox reactions. Each game consists of 3 levels with a special password that automatically appears if the students complete the game in the previous level.

Figure 6. Display of “Evaluation” menu consists of (a) type of games, (b) login, (c) the “ant-strike” game, (d) the “labirin” game, (e) evaluation test, and (f) password of game level

3.1.6. Score of Evaluation Menu. The score of evaluation menu, shown in figure 7, is used to display the track record of the game results based on the highest score ever obtained.

3.2. Analysis of Data Development

Media quality was assessed on the media and material aspects. The media aspects were assessed on the display and media operation. While the material aspects were assessed on the material and learning. Table 3 shows the recapitulation of media validation results.

| Table 3. Recapitulation of Media Validation |
|---------------------------------------------|
| Aspects                        | Score | Category |
| Maximum | Total | Average | |
| Display | 55<sup>a</sup> | 51<sup>a</sup> | 4,64<sup>a</sup> | Very Good |
| Media Operation | 25<sup>b</sup> | 23<sup>b</sup> | 4,60<sup>b</sup> | Very Good |
| Material | 35<sup>c</sup> | 31<sup>c</sup> | 4,43<sup>c</sup> | Very Good |
| Learning | 35<sup>b</sup> | 30<sup>c</sup> | 4,29<sup>c</sup> | Very Good |

| Media Operation | 55<sup>c</sup> | 43,11<sup>b</sup> | 3,92<sup>b</sup> | Very Good |
| Material | 25<sup>b</sup> | 22,89<sup>b</sup> | 4,58<sup>b</sup> | Very Good |
| Learning | 35<sup>b</sup> | 30<sup>c</sup> | 4,29<sup>c</sup> | Very Good |

<sup>a</sup> validation score from media expert<br>
<sup>b</sup> validation score from reviewer and peer reviewer<br>
<sup>c</sup> validation score from material expert

Based on validation results performed by a media expert, material expert, reviewers, and peer reviewers at every aspect assessed the ChemonDro application is categorized as very good. Thus, ChemonDro on redox concepts met the criteria to be tested on the students.

Media assessment by students conducted at the one-to-one evaluation, small group evaluation, and field test evaluation. Aspects assessed at this phase were the material and learning, and the display and media operation. Table 4 is the recapitulation of the media assessment at the field test evaluation.

| Table 4. Recapitulation of Media Assessment |
|---------------------------------------------|
| Aspects | Score | Category |
| Maximum | Total | Average | |
| Material and Learning | 25<sup>a</sup> | 19<sup>a</sup> | 3,8<sup>a</sup> | Good |
| Display and Media Operation | 50<sup>a</sup> | 40,83<sup>a</sup> | 4,08<sup>a</sup> | Very Good |
| Material and Learning | 25<sup>b</sup> | 18,9<sup>b</sup> | 3,78<sup>b</sup> | Good |
| Display and Media Operation | 50<sup>c</sup> | 40<sup>c</sup> | 4<sup>c</sup> | Very Good |
| Material and Learning | 50<sup>b</sup> | 39,7<sup>b</sup> | 3,97<sup>b</sup> | Very Good |
| Display and Media Operation | 50<sup>c</sup> | 39,38<sup>c</sup> | 3,94<sup>c</sup> | Very Good |

<sup>a</sup> score from one-to-one evaluation<br>
<sup>b</sup> score from small group evaluation<br>
<sup>c</sup> score from field test evaluation

Figure 7. Display of track record the high score
The average score of media assessment obtained from one-to-one evaluation, small group evaluation, and field test evaluation is used to determine the category of each aspect of the assessment. Based on Table 4, the material and learning aspects are categorized as good. The display and media operation aspects are categorized as very good. Based on test results, ChemonDro on redox concepts can be applied in the learning process.

The influence of ChemonDro on redox concepts on the students' self-regulated learning was obtained from the questionnaire. Self-regulated learning questionnaire was given before and after the learning process using ChemonDro on redox concepts. Based on the normalized gain values obtained as shown in Table 5, there is differences level of students' self-regulated learning between control and experiment classes. The students' self-regulated learning level in the experiment class had the medium category. The students' self-regulated learning level in the control class had the low category. In other words, the improvement of students' self-regulated learning in the experiment class is higher than the improvement of students' self-regulated learning in the control class.

| Table 5. Data of Self-Regulated Learning |
|------------------------------------------|
| Description                              | Control          | Experiment     |
|                                          | Pretest          | Posttest       | Pretest          | Posttest       |
| Average                                  | 59,41            | 67,66          | 62,97            | 75,84          |
| Maximum score                            | 67               | 80             | 75               | 89             |
| Minimum score                            | 52               | 54             | 51               | 62             |
| gain                                     | 0,203            |                | 0,350            |                |
| Category                                 | Low              | Medium         |

An assumption test applied was normality and homogeneity tests. Normality test was conducted to prove that the normalized gain value of self-regulated learning on the control and the experiment classes fulfilled the normal distribution. The results of normality test are shown in Table 6.

| Table 6. Normal Distribution Test |
|------------------------------------|
| Class                              | Kolmogorov-Smirnov | Conclusion |
|                                    | Asymp. Sig. (2-tailed) |           |
| Control                            | 0,575              | Normal     |
| Experiment                         | 0,708              | Normal     |

Normality data was obtained by the Kolmogorov-Smirnov test. Based on the result, the normalized gain data on control and experiment classes fulfill the normal distribution. Homogeneity test shows that the value of Sig. (Levene’s test) of 0,529 indicating that the normalized gain value data of self-regulated learning on control and experimental classes come from the homogeneous population. Furthermore, hypothesis testing was conducted to determine the effect of ChemonDro on redox concepts applied on the students' self-regulated learning.

| Table 7. Test of Hypothesis |
|-----------------------------|
| Test Data                    | Self-Regulated Learning | Conclusion |
| F                            | 16,110                  | There was a significant difference in improvement of self-regulated learning between the control and the experimental classes |
| Asymp. Sig. (2-tailed)       | 0,000                   |           |

Based on the result of the hypothesis test shown in Table.7, there was a significant difference related to the students' self-regulated learning between experiment class using ChemonDro on redox concepts and control class which do not use it. Students using the ChemonDro application on the redox concept as one of the self-regulated learning resources get a higher level of self-regulated learning than the students who did not use. Moreover, this application was easy to use. Redox material
presented with animation can improve students' understanding. It can be concluded that ChemonDro on redox concepts developed effectively improves students' self-regulated learning. This is in accordance with research conducted by Ariwandini [18], Priyambodo & Sulistyani [3] that the use of multimedia in chemistry learning can effectively improve students' self-regulated learning. Other studies on technology integration in the learning process also show positive results on students' self-regulated learning [19].

4. Conclusion
The android-based learning media called ChemonDro on redox concepts successfully developed and applied in chemistry learning in senior high school. Based on the learning result using ChemonDro on redox concepts, it was found that there is a significant difference related to the self-regulated learning between the experimental class using the ChemonDro on redox concepts and the control class that did not use the ChemonDro as learning media. ChemonDro application on redox concepts can be used by students anytime and anywhere. The animated features and games on this app can attract students' learning interest and improve their understanding of redox reaction concepts. Furthermore, ChemonDro on the redox concept can be one of the students' self-regulated learning resources.

These android-based learning media can be implemented in chemistry learning or used independently by students. In addition, further research on the effect of other academic performance variables can also be practiced.

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Further research of the influence of ChemonDro on redox concepts on student learning outcomes has been done.