Computer-based interactive multimedia development to increase students' learning outcomes in electrolysis

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Pengembangan multimedia interaktif berbasis komputer untuk meningkatkan hasil belajar siswa dalam elektrolisis

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Abstract. This study aims to determine the feasibility of interactive multimedia as learning media in electrolysis based on assessment from respondents are chemistry teacher and two chemistry lectures and the increasing of student learning outcomes class XII IPA SMA N GLAGAH. The research method that used is research and development (R & D) that consist of: 1) the preliminary study that covers the assessment of potential and problem as well as collecting the data; 2) the development study that involve the product design, product validation, product revision, and the trial test. The data collection methods using questionnaires and tests of learning outcomes. The research instruments that used are reviewer sheet that analyzed qualitatively and validation sheet, student questionnaire responses sheet, and trial test sheet were analyzed quantitatively. Based on the results of the study indicate that the interactive multimedia computer in the subject electrolysis is feasible used in the learning process.
Keywords: Interactive Multimedia, Electrolysis, Learning Media

1. Introduction

The constitution of Republic Indonesia of 1945 stated that the national education system should be able to guarantee equal distribution of education, improve quality and relevance and efficiency of education management to face the challenges according to the demands of local, national and global life changes so education changes should be planned, directed and continuously [1]. Educational reform is carried out through changes in learning patterns that currently use multimedia-based learning patterns. This becomes important for teachers to equip their learning devices with multimedia, especially in material that is difficult to explain by lecture method.

Many students stated that chemistry is a difficult subject [2]. From the results of research conducted on 32 students of Senior High School can be concluded that chemistry subjects are still difficult subjects for 75% of students and 60% of students still have difficulty in learning electrolysis material because 59% of students stated that there are a lot of memorization in electrolysis topic. This was due to the lack of optimal utilization of facilities, 84% of students say that printed books are the most frequently used media in chemistry learning, especially on electrolysis topic, so 81% of students could not understand chemical topic well. From this study it can be concluded that the teacher had not optimized school facilities and conducting interactive learning to explain the electrolysis process in a simple way so that students could easily understand without having to memorize.

Johnstone divided chemistry into three representation levels; the macroscopic, microscopic and symbolic. Microscopic concepts and theories understanding has a higher level of difficulty than macroscopic concepts understanding which are can be observed (visible), because the understanding of a microscopic concept requires a stronger logic to solve the problems that cannot be observed directly [3]. In electrolysis topic students need to understand the movements of ions and electrons during the microscopic electrolysis process which makes them difficult.

Meanwhile, students' difficulties in studying chemistry come from difficulties in understanding the concept of chemistry that is abstract and complex, while students are required to understand the concept thoroughly [4]. Chemistry that is abstract requires students to be able to visualize concepts in the form of images in mind. Meanwhile students have short-term memory with very limited capacity when dealing with new information [5]. But on the other side students have long-term memory effectively and indefinitely holding cognitive schemes with various complexities [6]. Thus, limitations on students' short-term memory can be overcome by the development of effective instructional designs that can reduce unnecessary cognitive load in short-term memory, thus supporting to improve learning efficiency by optimizing long-term memory. The way to handle limited short-term memory capacity can be expanded effectively by utilizing both visual and auditory.

Difficulties in electrolysis topic can be overcome by using interactive multimedia in the process of teaching and learning. Multimedia helps students to visualize abstract chemical processes using applications in multimedia [7]. Explanation or description of material at the microscopic level and multiple processing through visual and auditory can be done by providing visualization of the learning process through interactive multimedia. Interactive multimedia is an effective tool for learning process in order to create a better and optimal teaching and learning process through providing concepts or information by considering the cognitive load of students.

Flash interactive multimedia can provide abstract and complex concepts on electrolysis topic which are mostly on microscopic and symbolic level. Flash can also provide concepts in the form of visualization and auditory so it can expand the capacity of a limited working memory capacity so the teaching and learning process will optimally implement.

Based on the background, researchers offer the title "Development of Computer-Based Interactive Multimedia in Improving Student Learning Outcomes on Electrolysis Subjects"

2. Methods

This research type was development research that developing computer-based interactive multimedia to increase learning outcomes of electrolysis subjects regarding the macroscopic and microscopic reaction processes and their applications, also contains evaluation questions that can be used as training for students. The development research was developed from the Research and Development (R & D) method proposed by Sugiyono.

Data sources in this study were lecturers, teachers, and 15 high school students in class XII who had participated in media trials.

The object of this research was interactive multimedia which contains concepts and practice questions on electrolysis topic that was packaged in Flash program (offline media).

The steps for developing interactive multimedia referred to the modified Research and Development (RnD) research method, including (1) potential and problems (2) data collection (3) media design (4) review (5) media revision (6) validation (7) media trial.

The research instrument that used in this study is a questionnaire sheets which were included a review questionnaire sheet, validation questionnaire and student response questionnaire, and learning outcome test sheets.

Data collection methods that used in this study were questionnaire methods and learning outcome tests.

Data analysis method that used in this research were quantitative and qualitative descriptive analyses. Quantitative data analysis method is used to analyses the results of validation questionnaires, student response questionnaires and learning outcomes, while qualitative data analysis was used to analyses the results of the study.

The results of the validation questionnaire data obtained were presented based on the calculation of scores from the Likert scale. To calculate the percentage of feasibility of each indicator, the following formula is used:

$$P = \frac{F}{N\ xI\ xR}\ x\ 100\%$$

The percentage calculation results from the validation of the teacher and chemistry lecturer were interpreted into the score interpretation criteria. Based on the criteria, interactive multimedia developed was feasible if the percentage is ≥ 61% with strong criteria.
The results of the students' response questionnaire data were presented based on Guttman's calculation. To calculate the percentage of feasibility of each indicator, the following formula was used:

$$P = \frac{F}{N\ xI\ xR}\ x\ 100\%$$

The calculation results of the percentage of students' responses were interpreted into the score interpretation criteria. Based on the criteria, interactive multimedia developed was feasible if the percentage is ≥ 61% and categorized as strong criteria.
The results of the learning outcome test which included pre-test and post-test data were analysed by using gain score analysis normalized to measure the increasing of student learning outcomes after participating in learning activities by the following formula:

$$NG = \frac{Spos - Spre}{Smaks - Spre}$$

Based on the criteria, the interactive multimedia that developed was feasible if the normal gain category is high, which is ≥ 0.7.

3. Results and Discussion

1) Validation by Chemistry Teachers and Lecturers
Based on the results of validation by chemistry teachers and lecturers, the interactive multimedia that developed has passed feasibility criteria with an average percentage of the overall aspects was 84.645% and categorized very feasible. The details can be seen in table 1 below:

Table 1. Validation Result

No	Aspect	Score Presentage (%)	Category
1	Concept	85,417%	Very feasible
2	Presentation	85,185%	Very feasible
3	Language	83,333%	Very feasible
Average		**84,645%**	**Very feasible**

a) Conceptual Aspects
According to the feasibility of the electrolysis concept, interactive multimedia that developed has very feasible category with a percentage 85.417%. This showed that the developed media was compatible with the learning objectives and can be used as an alternative learning media. Animations, videos, and images in interactive multimedia clarify the concepts that can be accepted by students through the sense of hearing (audio), visual (visual). A learning process

will have a major influence on students' understanding if combines intellectual activities and uses all senses.

b) Presentation Aspects
According to the aspect of presentation, interactive learning multimedia that developed has very feasible category with a percentage 85.185%. Multimedia was presented with accompanying music that makes comfortable learning. The design, size and colour of the text that matches the composition can be read well and clearly. The existence of navigation buttons that function properly helps students more easily operate and use multimedia. Using the right user control (next, pause, previous) provides student learning opportunities.

c) Language Aspects
According to the aspect of presentation, interactive learning multimedia that developed has very feasible category with a percentage of 83.333%. This showed the grammar and spelling that used was good and has correct language rules. The language was also in accordance with the age of students so it was easy to understand. The used of good and correct language is a good learning multimedia requirement because students will easily understand the information set that the media maker wants to convey

2) Student Response
Based on the results of student responses, interactive multimedia that developed has passed the eligibility criteria with an average percentage of all aspects of 93.306% with very feasible criteria. The details can be seen in table 2 below:

Table 2. Result of Student Response

No	Aspect	Score Percentage (%)	Category
1	Presentation	91,373%	Very feasible
2	Attractiveness	95,238%	Very feasible
Average		**93,306%**	**Very feasible**

a) Presentation Aspects
The students' responses to the presentation aspect showed that the material in interactive media was in accordance with the development of science and technology due to the layout of text, images, and animation that was made to help students understand the material and be presented in a harmonious manner supported by buttons in the interactive media that functioned well. Besides that the existence of practice questions helped students to hone their ability to understand electrolysis material

b) Aspects of Media Attractiveness
Students' responses to the media's attractive aspects showed that the images and animations in interactive media were attractive to students so they can facilitate students in independent learning and students more easily understand electrolysis material

3) Improving Student Learning Outcomes
Based on student learning outcomes, interactive multimedia that developed passed the eligibility criteria with a score gain of 0.702 with a very high category. The details can be seen on table 3.

Table 3. Improving Student Learning Outcomes

Student	Score		Gain Score (g)	Category
	Pre-test	*Post-test*		
1	10	70	0.667	Medium
2	40	80	0.667	Medium
3	10	90	0.889	High
4	10	70	0.667	Medium
5	10	70	0.667	Medium
6	10	70	0.667	Medium
7	10	70	0.667	Medium
8	20	70	0.625	Medium
9	40	80	0.667	Medium
10	50	80	0.600	Medium
11	30	90	0.857	High
12	20	80	0.750	High
13	40	80	0.667	Medium
14	90	100	1.000	High
15	70	90	0.667	Medium
Average	**30.667**	**79.333**	**0.702**	**High**

The results of the pretest showed that many students cannot answered the questions correctly and the average test score was very low. While students have learned the subject of electrolysis in the previous class learning. It was caused by there was no effective way to teach electrolysis material to students. Learning with printed media that has been used has guided students to memorization. When learning using printed media students find it difficult to understand the information provided in the form of text because of the difficulty of visualizing concepts in the form of images in the mind. In addition, the existing printed media cannot provide a microscopic electrolysis process to help students understand electrolysis. While through the practicum students are only shown how to conduct electrolysis and the results can be observed directly.

There was a significant increase in test results after students learned by using multimedia. Multimedia allows students to visualize abstract chemical processes using applications in multimedia (Lee & Kamisah, 2012). Explanation or description of material at the microscopic level and multiple processing through visual and auditory channels can be done by providing visualization of the learning process through interactive multimedia. Thus the interactive media is an effective tool for updating the learning process in order to create a better and optimal teaching and learning process through the delivery of concepts or information provided by the teacher by considering the cognitive architectural burden of students

Conclusions

Based on the results of the research data analysis obtained, it can be concluded that computer-based interactive multimedia on the electrolysis subject that was developed has been feasible to be used as a learning tool because it meets the following requirements:

1. The media has material validity 87.86%. These results was indicated that the material contained in interactive multimedia that has been developed is feasible to be used in learning on the subject of electrolysis for class XII SMA.
2. The media has presentation validity 85.19%. These results was indicated that technically and the interactive multimedia display that developed has been feasible to be used in learning on the subject of electrolysis for class XII SMA.
3. The media has language validity of 83.33%. These results was indicated that the language used in interactive multimedia developed has been appropriate to be used in learning on the subject of electrolysis for class XII SMA.
4. The media has obtained a positive response from students with very feasible categories with average percentage of 93.306%. The students' responses were based on the presentation criteria and media attractiveness, respectively were 91.337% and 95.238%. These results indicated that the interactive multimedia that developed can be accepted and used by students as a learning medium.
5. The media has given a positive influence on student learning outcomes. This can be marked by an increase in student learning outcomes with a gain score of 0.702 in the high category. These results indicated the media that developed can help students learn better electrolysis subjects.

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