ORBITAL: JURNAL PENDIDIKAN KIMIA
Website : jurnal.radenfatah.ac.id/index.php/orbital
ISSN 2580-1856 (print) ISSN 2598-0858 (online)

Development of Interactive Multimedia Based on Android Integrated Problem Based Learning (PBL) to Improve Students's Mastery of Concepts

Bintarti[1*], Roza Linda[2], and Rasmiwetti[3]

[1,2,3]Universitas Riau, Riau, Indonesia

[*]E-mail: bintartimuthmainnah@gmail.com

ARTICLE INFO

Article History:
Received March 2024
Revised June 2024
Accepted June 2024
Published June 2024

Keywords:
Android-based interactive multimedia;
Concept mastery;
Problem Based Learning (PBL);
Redox and electrochemistry;

ABSTRACT

The results of the pre-research concept mastery test showed students' low mastery of redox and electrochemical concepts. The aim of this research is to produce an Android-based interactive multimedia product integrated with PBL that is valid, practical and effective in the form of an APK. The research method is Development Research referring to the ADDIE development procedure. The research was conducted in the odd semester of 2022/2023. The research sample are 70 students of class XII MIPA SMA N 10 Pekanbaru. Data was collected through multiple choice tests, essays, questionnaires. The developed product was validated by 3 material experts, and 3 media experts. The practicality tes was carried out by 4 chemistry teachers, 11 students in the one to one and small group stages. The implementation test was carried out at SMA Negeri 10 Pekanbaru. The average validation results by material experts were 94.8% with very valid criteria and the average validation results by media experts were 95.8% (very valid). Practicality results for 4 chemistry teachers, it was 91.3 in the very practical category and 88.8% for 11 students in the very practical category. The n-gain test results showed an increase in concept mastery in the experimental class, namely 0.7 in the medium category and the control class with an n gain value of 0.3 (low). Based on the research results, it was concluded that the product that had been developed could increase students' mastery of concepts.

INTRODUCTION

An important investment for the nation's generation as a baton for future leadership in a better direction is education (Fahmi & Hernani, 2023). It was progressing quickly in technology and information, which was one reformation of the curriculum in education that happened continuously, time by time. As we know, the reformation of the curriculum started from the KTSP and continued to the 2013 curriculum. The curriculum aimed to make Indonesian children a generation that is ready to compete in the future and appropriate with time development. The 2013 curriculum contains four competitions that students must have. The skills are critical thinking, creativity, communication and collaboration. Four of the skills in the 21st century will be if the students are capable of mastery of chemistry concepts. Chemistry is a part of sciences that was learned in senior high school or vocational high school. Chemistry explores structures, composition and transformation of the subject as a natural or experiment (Ratulani, 2017). The students are to be charged with mastering the chemistry concepts that they have learned so that they can continue to the next subject, chemistry. For example, the students must master the concept of redox before they learn about redox and electrochemistry. Mastery of chemistry is very needed so that students can reach the competition of the 21st century, which has become the background of Indonesian education.

Chemistry is an abstract concept, so it requires media to visualize abstract concepts properly (Ariska et al., 2023). Chemistry contains three aspects: macroscopic, microscopic, and symbolic (Harianto & Khery, 2017). The sub-topic of chemistry in senior high school that contains abstract concepts is redox and electrochemistry, which is why redox and electrochemistry are so hard to understand (Aisyah et al., 2019). The topic can be taught to students to help them understand the process of redox reaction that involves the transfer of electrons. In the naked eye, the electron is abstract because it is not intangible. However, in a redox reaction that happened spontaneously, the conduct of electricity happened because of the transfer of an electron from the cathode to the anode. The students can understand the subject as well if they have mastery of the concept of redox in X grade of Science.

The importance of mastery concept skill to the students can help them to solve the problem when they was learning as in online learning or outside of network. The students can easy to solve the problem in daily activities that related to chemistry if they capable mastery of chemistry subject very well. Based on of the result of the questionnaire that have been shared to 39 of students show that thes students are hard to understand of chemistry subject for online learning. The mean of the questionnaire result show that 32,7 % students is hard to understand redox and electrochemistry subject. Students' mastery of concepts is low because teachers tend to use the lecture method so students tend to wait for information provided by the teacher as a result students tend to have more difficulty understanding and mastery chemistry learning concepts (Wira et al., 2019). Based on the background above, the author is interested in conducting research with the title "Development of Android-based Interactive Multimedia Integrated Problem Base Learning as an Effort to Increase Student Mastery of Concepts in Class XII Science Redox and Electrochemistry Material". This research is development research that aims to produce interactive multimedia based on android integrated Problem Base Learning (PBL) that is valid, practical and effective.

METHOD

Research Design

This research is development research that follows the ADDIE development procedure (Analysis, Design, Development, Implementation, and Evaluation). This research applies a non-equivalent control group design method, where the selection of experimental and control groups is not random. In this experiment, the two groups involved were an experimental group and a control group, with each receiving a different treatment.

Table 1. Non Equivalent Kontrol Group Design

Class	Pretest	Treatment	Postest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Research Target

This research involved 6 expert respondents, namely 3 material expert respondents and 3 media expert respondents, who assessed the validity of the interactive multimedia base android-integrated Problem Base Learning being developed. Four chemistry teachers were respondents to find out the practicality of interactive multimedia, 3 students at the one-to-one stage and 8 students at the small group stage. The research target during the large-scale trial was Pekanbaru 10 Senior High School students with a total of 70 people.

Research Data

This research produces qualitative and quantitative data. Quantitative data consists of scores obtained from validators and concept mastery test data, while qualitative data is in the form of suggestions from material expert validators and media experts and suggestions from students during one-to-one and small-group tests.

Research Instruments

Researchers used instruments in the form of validation questionnaires for material experts, media experts, and concept mastery test questions totaling 30 multiple-choice questions and 4 essay questions.

Data Analysis

Data from validation test questionnaires for material experts and media experts were analyzed using a Likert scale with score criteria of Strongly Agree (4), Agree (3), Somewhat Agree (3), and Disagree (1). After obtaining the test scores, expert validation results are carried out, and calculations are carried out in the form of percentages, which are shown in Table 2.

Table 2. Validity Criteria for Material and Media Validator Assessment Questionnaire Data

Percentage	Criteria
81-100	Very Valid
61-80	Valid
41-60	Less Valid
21-40	Not Valid
< 20	Very not Valid

(Arikuonto, 2018)

The practicality of interactive multimedia-based android integrated with problem-based learning is shown in Table 3.

Table 3. Teacher and Student Response Questionnaire Assessment Categories

Skor	Kategori Penilaian
81 % -100 %	Very Practical
61% - 80 %	Practical
41% - 60%	Enough Practical
21% - 40%	Less Practical
0% - 20%	Very not practical

(Riduwan, 2019)

Hypothesis

a. Ability to mastery of concepts

Ho: There was no striking difference in concept mastery between students who used Android-based interactive multimedia in their learning process and those who studied without applying Android-based interactive multimedia combined with Problem-Based Learning (PBL).

Ha: There is a striking difference in mastery of concepts between students who use Android-based interactive learning multimedia applications that are synchronized with Problem Based Learning (PBL) compared to those who do not use them.

Hypothesis testing

Independent Sample T Test

The researcher carried out normality and homogeneity tests first before carrying out the Independent Sample T Test. Hypothesis testing is carried out on data that includes students' mastery of concepts. This research relies on SPSS version 22 software for the independent sample T-test. The test criteria are as follows.

1) If the significant value is > 0.05, then Ho is accepted, and Ha is rejected.

2) If the significant value is < 0.05, then Ho is rejected, and Ha is accepted.

To understand the students' developments, a comparison is made between their initial scores (pretest) and final scores (posttest), using the normalized N-gain analysis method based on the formula proposed by Hake, namely:

$$g = \frac{S\,Post - Spre}{Smax - Spre}$$

Table 4. Normalized N Gain Categories

N- Gain Score	Criteria
$0,7 \leq g \leq 1,00$	High
$0,3 < g \leq 0,7$	Middle
$0,00 \leq g \leq 0,30$	Low

RESULTS AND DISCUSSION

The product produced in this research is Android-based interactive multimedia integrated with PBL on the subject of redox and electrochemistry in the form of an APK. Researchers follow ADDIE development procedures in developing products, namely:

1. Analysis Phase (Analyze)

This analysis stage consists of 4 stages, namely needs analysis, student characteristics analysis, material analysis and learning environment analysis (Yunita et al., 2023). The analysis phase is the earliest phase carried out in this research. The analysis carried out in this research includes:

a. Needs analysis

Needs analysis was carried out through interviews with chemistry teachers with 3 chemistry teachers and through the distribution of questionnaires to students via Google Forms. From the results of interviews involving 3 chemistry teachers, it can be concluded that there is a need to develop interactive multimedia applications for learning redox and electrochemistry, which are equipped with virtual laboratories for redox and electrochemistry experiments. This is because redox and electrochemical material is abstract material, which requires visualization of the movement of electrons from the anode to the cathode when presenting this material. Apart from that, the tools and materials in the laboratory are incomplete, so teachers tend not to carry out experiments on redox and electrochemical materials. Therefore, Android-based interactive multimedia equipped with a virtual lab is really needed as a learning medium. Virtual laboratories are used as an alternative to real laboratories because of the constraints of limited time, inadequate facilities and inadequate infrastructure in schools (Rohmah et al., 2019).

b. Analysis of Student Characteristics

The researcher carried out a pra research test to determine students' mastery of concepts in redox and electrochemistry material. Students have previously studied redox and electrochemistry material. The results of pre-research student cognitive tests on redox and electrochemistry material show that the average student mastery of chemical concepts is very low, namely 29.16%.

c. Material Analysis

Material analysis was carried out by reviewing the 2013 revised 2018 curriculum, namely redox and electrochemistry material for class XII MIPA SMA.

2. Design Phase (Design)

The design phase is carried out after the analysis phase. The design phase is carried out by designing interactive multimedia displays, materials, and questions and compiling product instruments (Astuti et al., 2021). The steps taken are determining the software used in designing the product, namely using Adobe Animate CC, making flow charts and storyboards, conducting literature studies, preparing concept mastery test question instruments, and making teacher response questionnaires and student responses, create validation sheets for material experts and media experts.

3. Development Phase (Development)

The development phase is the stage in developing a design that has been previously designed.

a. Create a design

Create a design that has been designed in a storyboard using Adobe Animate CC application. The following is a display of interactive multimedia:

1. Loading page

The loading page is an opening page that introduces the name of the institution where the researcher is studying and developing products, namely the FKIP Postgraduate Program in Chemistry Education, Riau University.

2. Start menu/Title Page

Title Page Contains the title and start button to open Android-based interactive learning multimedia.

3. Author Profile

The author profile contains brief biographical information about the author, including name and email address.

4. Main course

The main menu contains several items, such as instructions, KD, materials, virtual lab, videos, exercises, pretest/posttest, and bibliography. Instructions for Using Interactive Multimedia and Basic Competencies (KD). The instructions menu explains how to use interactive multimedia. The basic competency menu contains KD, which is included in interactive multimedia. There are 8 basic competencies, namely KD 3.3, 3.4, 3.5, 3.6, 4.3, 4.4, 4.5, 4.6.

Material

The material in the interactive multimedia application or REA (Redox Electrochemistry Application) is packaged in 9 meetings, which are integrated with problem-based learning (PBL) steps, as seen in Figure 1.

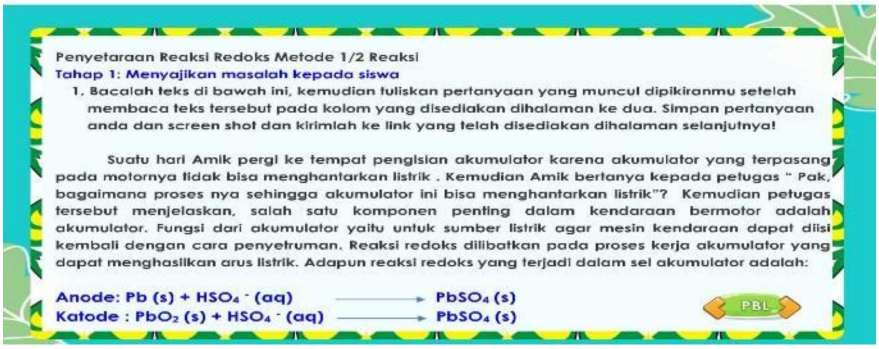

Figure 1. Material for Meeting 1 Balancing Redox Reactions

Virtual Lab

The virtual electrolysis cell lab explains the processes that occur during electrolysis. The virtual lab for voltaic cells and electrolysis cells can be seen in Figure 2.

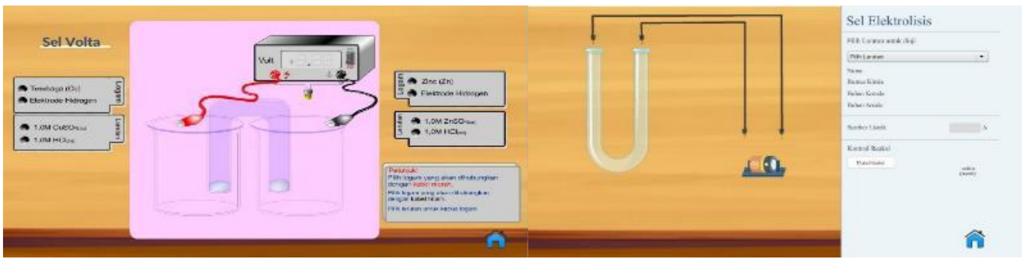

Figure 2. Virtual Lab for Voltaic Cells and Electrolysis Cells

Videos

There are 4 learning videos available, namely videos on balancing redox reactions. The redox reaction balancing video explains how to balance redox reactions using the ½ reaction method and the oxidation number method. The video designing Volta Cells from natural materials explains how to design Volta cells from natural materials. The metal gilding video explains the process of metal gilding, and the corrosion incident video explains a building collapse caused by a corrosion event.

Exercise

The practice menu contains practice questions on redox and electrochemistry material.

Pretest/Posttest

The pretest and posttest questions consist of 30 multiple-choice questions and 5 essay questions. Students can click the multiple-choice button to access the multiple-choice questions, and students can click the essay questions button to access the essay questions.

Bibliography

The bibliography contains references that are sources of reference for researchers in developing Android-based interactive multimedia.

b. Validate

Validation was carried out by 3 media experts and 3 material experts. The purpose of validation is to determine the validity of the product and the level of feasibility of the product before the product is tested at small-scale, medium-scale, and large-scale levels. Interactive multimedia was validated by 3 material experts and 3 media experts. Validation was carried out twice. Publish files in apk form so they can be opened on Android phones. The following are the accumulated results of validation by material experts shown in Table 5.

Table 5. Accumulated Interactive Multimedia Validation of Material Experts

No	Rated aspect	Percentage (%)	
		Validation 1	Validation II
1	Content	71,9	89,1
2	Language	75,0	83,3
3	Virtual Lab	75,0	100
4	Audiovisual	75,0	100
5	Picture Properties	66,7	100
6	Originality	67,0	83,3
7	Information Access	75,0	100
8	Mastery Concept Indicator (C1-C5)	75,0	100
	Average	72,3	94,8

Material validation was carried out twice. In the first validation, the researcher made improvements in accordance with suggestions from material experts. The first material expert validation obtained an average percentage of 72.3% with the Valid category. After the researcher carried out revisions in accordance with suggestions from the material validator, the validator then provided an assessment for the second validation. The results of the assessment by the material validator for the second interactive multimedia were declared very valid, as shown in Table 5. Table 5 states that the average percentage of material expert validation scores on Android-based interactive multimedia integrated with PBL material substance aspects is 94.8%, and the criteria are very valid. This is in accordance with research conducted by (Pradana, 2020), which shows material validation results with a percentage of 95% with very valid criteria. The results of research conducted by (Wahyuda & Hutama, 2022) show the results of material validation with a percentage of 88.96% with a very valid category. Based on the validation results of the material substance aspect, it states that the material content aspect includes the suitability of indicators with basic competencies, the suitability of indicators with learning objectives, which get an average score of 4, indicators of mastery of concepts (C1-C5), the accuracy of videos with scientific principles, the accuracy of virtual labs with material content where the average obtained from the assessment of the three material experts was 94.8%, stating that the Android-based interactive multimedia developed was valid and suitable for testing at the one to one, small group and filed test stages.

The learning media aspects were assessed by 3 media expert validators, The following are the results of media validation by the three media validators, which can be seen in Table 6. Table 6 states that the average validation score from media experts for interactive multimedia reached 95.8%, which indicates a very high level of validity. Similar research by (Yudha et al., 2022), which focuses on developing Android-based interactive multimedia for various topics in Chemistry, received approval from media experts with an average validation score of 88%, placing it in a very valid category. Details of the media expert's evaluation can be explored further in Table 6.

Table 6. Media expert validation results

No.	Assessment Components	Validation Score	
		Validasi 1	Validasi II
1.	Instructions for using multimedia	66,7	100
2.	Combination of text color with background	66,7	100
3.	Color Picture	91,7	91,7
4.	Picture Size	75	91,7
5.	Animation Properties of Virtual Lab	91,7	100
6.	Color Composition of Background	75	83,3
7.	The level of interactivity of Android-based interactive multimedia	100	100
8.	Buttons used between scenes	66,7	100
	Average percentage	81,2	95,8

After going through an assessment process by content validators and media specialists, who tested the adequacy of content and effectiveness of interactive multimedia supported by android and integrating PBL, an average validation score of 94.8% was obtained from material experts and 95.8% from experts. Media both place the multimedia in the "very valid" classification. This confirms that interactive multimedia meets the requirements for being applied as an interactive learning aid.

4. Implementation Phase (Implementation)

The implementation phase was carried out with one-on-one trials, small group trials and field trials.

a. One to One Stage (One-on-one Test)

Three students, each from Senior High School 10 Pekanbaru, Senior High School number 6 Pekanbaru, and Senior High School of Fadhillah Islamic School Pekanbaru, underwent a series of individual evaluations using their Android cellphone devices. In this session, they took part in an interactive learning module that operates on the Android system, guided by researchers. After the learning session, they were asked to fill out a questionnaire aimed at evaluating the ease of use of the interactive multimedia. The result of the response questionnaires of students reveals that students' responses to interactive multimedia applications combined with Problem-Based Learning and running on the Android operating system achieved a high level of practicality with an average score of 86.3%, which was classified in the "very practical" category. ". Next, in the individual evaluation phase, opinions are given by students who show a positive response. Based on input and responses from students, the researcher made revisions to the interactive multimedia during the one-to-one phase, where the ease of accessibility of the on and off buttons was improved, and an explanation of the PBL buttons was added in the instructions for use. Following these adjustments in the one-to-one phase, the researcher then moved on to the small group phase.

b. Small Group Stage

The small group stage was carried out to assess the practicality of interactive multimedia. In the small group stage, the product was tested on eight students by distributing the apk file for them to download and install on their respective Android devices. During this phase, students receive instructions and support from researchers to utilize interactive multimedia applications that are integrated with Problem-Based Learning. They explore and re-understand the material through the application until it is complete. After that, to evaluate the effectiveness and usefulness of the application that had been developed, the researchers asked the students to fill out a questionnaire and provide their input and suggestions regarding the application.

From data collected through a survey carried out on small groups, it was found that the level of feasibility of using interactive multimedia that runs on the Android operating system and that adopts Problem-Based Learning reached an impressive figure of 86.5%, which is classified as very practical. The consistency of these findings was also observed in a study initiated by (Muflihatin et al., 2022), which shows similar figures in terms of interactive multimedia usability related to salt hydrolysis content, namely around 86.3%, placing it in an equally high classification. In the small group stage, students also provide comments and suggestions for interactive multimedia. The researcher revised the Android-based interactive multimedia integrated with PBL according to students' suggestions or comments at the small group stage and produced prototype 3, namely by adding short music on the loading page. Then, the researcher reduced the size of the letters used in the PBL 2 conclusion box and changed the answer key to the answer script for questions 1,3 and 4 on PBL 8.

c. Field Tests

This field test stage was carried out to determine the effectiveness of interactive multimedia on students' mastery of concepts. This stage was carried out by testing interactive multimedia products in the experimental class and comparing the results with those of the control class, which was treated using conventional methods. The test instrument for concept mastery questions in the form of a pretest and posttest was used to determine the increase in students' mastery of concepts regarding redox and electrochemistry, consisting of 30 multiple choice questions and 4 description questions. Indicators for mastery of concepts are created by referring to Bloom's taxonomy (C2-C5). The following are the results of the pretest and posttest for mastery of the concepts of the experimental class and control class, which can be seen in Figure 3 and Figure 4.

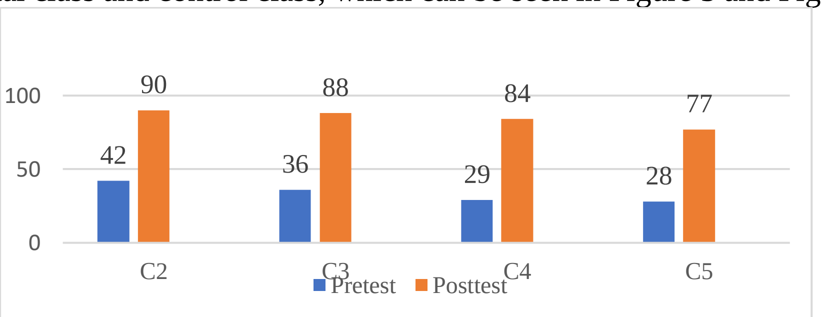

Figure 3. Average Score of Experimental Class Students' Mastery of Concepts

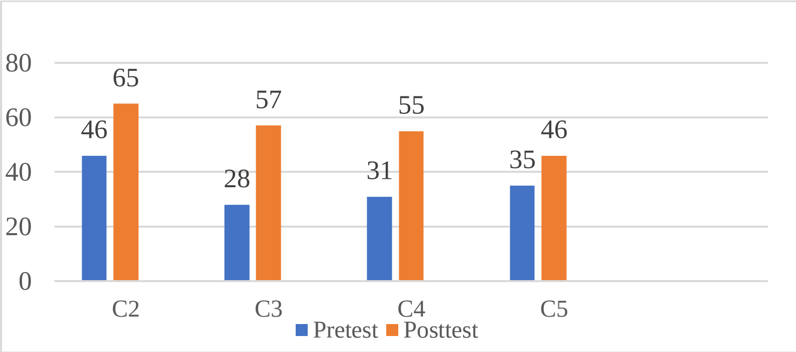

Figure 4. Pretest and Posttest Scores for Control Class Concept Mastery

After ensuring that the pretest and posttest data are normal and uniform by carrying out normality and homogeneity tests, the next step taken is to apply the Independent Sample T Test statistical analysis method. The aim of applying this method is to identify whether there is a significant difference in the means between two unrelated sample groups. The sample group in question consists of posttest data from the control class and posttest data from the experimental class. With the help of SPSS 22 software, the Independent Sample T Test was carried out to assess the existence of differences in concept mastery between students in the control class and the experimental class.

Table 7. Data on the Significance of Differences between Experimental and Control Classes

		F	Sig.	t	df	Sig. ((2-tailed)	Mean Difference
Posttest_ Concept Mastery	Equal variances assumed	1,066	0,305	20,36	68	0,000	27,143

Table 7 shows, through the results of the t-test on the posttest data, that there is statistical significance (α) of less than 0.05 (seen at sig = 0.000), which indicates rejection of Ho. This implies a significant difference in the posttest mean score of concept mastery between the control and experimental groups. Furthermore, the average posttest score in the experimental group, which used learning resources in the form of Android-based interactive multimedia integrated with Problem-Based Learning, was recorded to be higher than the control group. This confirms the effectiveness of Android-based interactive multimedia integrated with PBL in improving mastery of redox and electrochemical concepts. Variability in concept mastery between the two groups can be attributed to the use of Android-based interactive multimedia integrated with PBL in the experimental group, in contrast to the use of chemistry textbooks and traditional learning methods in the control group.

This finding is consistent with research conducted by (Husein, 2020), who found that interactive multimedia contributed to increasing students' mastery of thermodynamic concepts. Likewise, research conducted by (Diomara et al., 2022) revealed that interactive multimedia enriches students' understanding of colloid system material. The integration of teaching materials that rely on Android-based interactive multimedia and Problem-based learning in an educational context can increase students' interest in the material being studied. This is because the use of multimedia elements such as videos, animated virtual laboratories, and images, especially virtual laboratory animations that can depict the movement of electrons from the anode to the cathode, is very effective in supporting students' mastery of concepts. The N Gain value for concept mastery for the control class and experimental class can be seen in Table 8.

Table 8. Increased Ability to Concepts Mastery in Experimental and Control Classes

Class	**Concept Masterr Average**		**N-Gain Score**	**Criteria**
	Pretest	**Posttest**		
Experiment	30	78	0,7	Middle
Control	28	51	0,3	Low

From the data presented in Table 8, it is revealed that the average n-gain score for the ability to master concepts in the control class is 0.3, which indicates a low level. In contrast, for the experimental class, the average reaches 0.7, indicating the level is in the medium category. The conclusion that can be drawn from this information is that there is a disparity in the ability to master concepts between the control class and the experimental class, with the experimental class showing an increase of 70% in the medium category.

From the data presented in Table 8, it can be seen that there was an increase in the ability to master concepts in both classes, both experimental and control. However, progress in the experimental class showed a more significant figure than the control class, with a difference in the n gain value reaching 0.38 between the two classes. This indicates that the level of increase in concept mastery in the experimental class exceeds the average achievement of the control class. This conclusion is supported by a study conducted by (Dalam & Pembelajaran, 2020), who found that the use of Android-based interactive learning multimedia contributed positively to improving student learning outcomes. The following increases in students' mastery of concepts are presented in Table 9

Table 9. N-Gain Score for Students' Concept Mastery

Concept Mastery	N - Gain Score	Criteria
C2	0,7	Middle
C3	0,8	High
C4	0,7	Middle
C5	0,6	Middle
Average	0,7	Middle

Table 9 reveals that the interactive multimedia application with the Android platform, which is integrated with Problem-Based Learning, has succeeded in increasing competence in all dimensions of concept mastery. The greatest increase in mastery of concepts was recorded in aspect C3, namely the practical application of concepts, which was caused by the ability of this interactive multimedia to visually depict abstract concepts, such as the movement of electrons between cathode and anode in a virtual laboratory. This allows students to more easily apply the concepts they have learned by simulating virtual laboratory experiments on Volta Cells and electrolysis many times until they truly master the material. The suitability of these results is also supported by research (Wati, 2021), which found that the use of virtual laboratories can significantly increase students' mastery of subject matter. This virtual laboratory is also an alternative solution for educational institutions that lack practicum facilities and materials, as well as supporting the development of student independence in carrying out practicums.

The level of mastery of concepts C2, C4, and C5 achieved by students is placed in the intermediate classification. This indicates students' ability to understand these concepts, thanks to the use of Android-based interactive multimedia, which is synchronized with the Problem-based Learning model. This system exposes students to challenges that stimulate their knowledge construction and promotes teamwork to complete those challenges. According to (Muslim et al., 2015), Problem-Based Learning is a didactic strategy that prioritizes problems as the starting point for the acquisition of new knowledge. This approach, as proven by (Djamas et al., 2018), emphasized that the use of specially designed interactive multimedia can strengthen understanding of concepts and improve critical thinking skills among students.

5. Evaluation Phase (Evaluation)

In this research, the evaluation methods chosen include formative and summative assessments. The main reason for carrying out formative assessments is to identify areas that require improvement in interactive multimedia that operates on the Android system and integrates PBL. This study adopted a formative evaluation approach through a review process by experts, where the multimedia was refined based on recommendations and responses from content and media technology specialists. The subsequent process involves gradual product testing, including individual sessions, small groups, and field trials.

Suggestions for improvement originating from the results of the formative evaluation are the main focus of the summative evaluation. Material and media experts contributed constructive recommendations, which became the basis for implementing the summative evaluation. Researchers have carried out revisions to interactive multimedia following input from these experts. This revision also includes input from students obtained through one-to-one and small group sessions, which aims to test the practicality of interactive multimedia operating on the Android system and integrating Problem-Based Learning. At the end of the session, a formative evaluation is carried out to measure students' mastery of concepts.

The results of research initiated by the researchers show that interactive multimedia operating on the Android system, combined with the Problem-Based Learning method and built using Adobe Animate CC, has valid and practical qualities and contributes significantly to increasing concept mastery in students. This effectiveness can be traced through validity evaluations by content and media specialists, positive responses to practicality from teachers and students through questionnaires, and measurable improvements in concept mastery based on Independent T Test and N Gain test analysis.

CONCLUSION AND RECOMMENDATIONS

This research produces a product in the form of Android-based interactive multimedia integrated with PBL in the form of an Android application (APK) that students can install on their Android phones. Successful interactive multimedia was developed through a validation process by material experts and media experts and revised according to suggestions from material experts and media experts. After being revised, the product was tested on a small scale and a limited scale, and field trials were carried out at SMA Negeri 10 Pekanbaru. During small-scale trials (one-to-one), the product undergoes revisions based on suggestions from students. During limited-scale trials, the product also underwent improvements based on suggestions from students. Next, to see the effectiveness of the product, a field trial was carried out on 70 students at SMA Negeri 10 Pekanbaru.

Android-based interactive multimedia integrated with PBL uses Adobe Animate CC software to increase student mastery of concepts in redox and electrochemical material, which is declared very valid based on aspects of material validation and media validation. Android-based interactive multimedia integrated with PBL to increase concept mastery ability to obtain very practical categories of users. Android-based interactive multimedia integrated with PBL influences students' mastery of concepts regarding redox and electrochemistry, which can be seen from the data on students' concept mastery, which increased after using PBL-integrated Android-based interactive multimedia and based on the N-Gain test, it was stated that there was an increase in students' concept mastery in the medium category. This research produces a product in the form of Android-based interactive multimedia integrated with PBL that is valid, practical and effective.

The suggestion put forward by researchers is that teachers and students can use interactive multimedia based on android integrated with PBL as a learning medium during the learning process. Apart from that, there is a need to develop interactive multimedia based on android integrated with PBL for other different chemical topics as a 21st-century chemistry learning innovation in order to improve the quality of education in the future, especially for chemical materials that are abstract and require animation to visualize them either through Virtual Lab. or animated videos and publishing apk files in ios form so that they can be operated on iPhone devices and are not only limited to Android devices.

REFERENCES

Aisyah, S., Sari, R., Wijayanti, I. E., Kimia, P., Keguruan, F., Pendidikan, I., Sultan, U., & Tirtayasa, A. (2019). Learning the Selvo E-Module To Stimulate Critical Thinking Skills Students. *Journal of Chemistry Education Research*, *3*(1), 29–34.

Arikuonto, S. (2018). *Prosedur Penelitian*.

Ariska, N. N., Sholeh, M. I., & Laksono, P. J. (2023). Pengembangan E-Book Kimia Berbasis Augmented Reality (AR) pada Materi Bentuk Molekul. *Orbital: Jurnal Pendidikan Kimia*, *7*(2), 197–207. https://doi.org/10.19109/ojpk.v7i2.20159

Bukhari. (2017). Pendekatan Ilmu Fisika Dan Matematika Dalam Memahami Konsep Reaksi Oksidasi-Reduksi (Redoks). *Jurnal Dedikasi*, *1*(2), 252. www.jurnal.abulyatama.ac.id/dedikasiJurnalDEDIKASI

Dalam, R., & Pembelajaran, T. (2020). Pengembangan multimedia pembelajaran interaktif berbasis android pada mata pelajaran ilmu pengetahuan alam materi cahaya. *7*(1), 26–32. https://doi.org/10.17977/um031v7i12020p026

Diomara, N., Handayani, D., & Elvia, R. (2022). *Pengembangan bahan ajar berbasis android pada materi sistem koloid melalui pendekatan problem based learning*. *6*(2), 131–141.

Djamas, D., Tinedi, V., & Yohandri. (2018). Development of interactive multimedia learning materials for improving critical thinking skills. *International Journal of Information and Communication Technology Education*, *14*(4), 66–84. https://doi.org/10.4018/IJICTE.2018100105

Fahmi, an, & Hernani, dan. (2023). Pengembangan Asesmen Formatif Berbasis Problem Based Learning untuk Meningkatkan Keterampilan Berpikir Kritis: Need Assessment Study. *Orbital: Jurnal Pendidikan Kimia*, *7*(2).

Harianto, A., & Khery, Y. (2017). Pengembangan media pembelajaran kimia berbasis android untuk penumbuhan literasi sains siswa pada Program Studi Pendidikan Kimia FPMIPA IKIP Mataram. *Jurnal Kependidikan Kimia Hydrogen*, *5*(2).

Husein, S. (2020). Problem Base Learning With Interactuve Multimedia to Improve Studebt's Understanding of Thermodynamic Concept. *Problem Base Learning With Interactive Multimedia to Improve Student's Understanding of Thermodynamic Concept*.

Muflihatin, L., Sciences, N., & Surabaya, U. N. (2022). *No Title*. *11*(2).

Muslim, I., Halim, A., & Safitri, R. (2015). Penerapan Model Pembelajaran Pbl Untuk Hooke Di Sma Negeri Unggul. *Jurnal Pendidikan Sains Indonesia*, *03*(02), 35–50.

Pradana, B. I. (2020). *Pengembangan Multimedia Pembelajaran Interaktif Berbasis Android Pada Mata Pelajaran Ilmu Pengetahuan Alam Materi Cahaya*. *7*(1), 26–32. https://doi.org/10.17977/um031v7i12020p026

Ratulani, J. (2017). *Kimia Dasar*. STKIP PGRI Sumatera Barat.

Riduwan. (2019). *Belajar Mudah Penelitian Untuk Guru Karyawan dan Peneliti Pemula,*.

Rohmah, M., Ibnu, S., & Budiasih, E. (2019). Pengaruh Real Laboratory Dan Virtual Laboratory Terhadap Kualitas Proses Pada Materi Kesetimbangan Kimia. *Orbital: Jurnal Pendidikan Kimia*, *3*(1), 1–14. https://doi.org/10.19109/ojpk.v3i1.3356

Suryati, S., Surningsih, S., & Mashami, R. A. (2022). Pengembangan E-Modul Interaktif Reaksi Redoks Dan Elektrokimia Berbasis Nature Of Science Untuk Penumbuhan Literasi Sains Siswa. *Reflection Journal*, *2*(1), 26–33. https://doi.org/10.36312/rj.v2i1.847

Wahyuda, M., & Hutama, P. (2022). Pengembangan multimedia interaktif berbasis flash pada materi titrasi asam basa development of flash-based interactive multimedia on acid-base

titration materials. *11*(03), 168–176.
Wati, A. (2021). Penggunaan Media Virtual Laboratory untuk Meningkatkan Penguasaan Konsep Materi dan Kemandirian Siswa Melakukan Praktikum. *Jurnal Guru Dikmen Dan Diksus*, *4*(2), 256–270. jgdd.kemdikbud.go.id/index.php/jgdd
Wira, G., Yuhelman, N., & Rahayuningsih, J. (2019). Perbandingan Hasil Belajar Kimia Siswa Dengan Model Problem Based Learning Dan Think Pair Share Pada Materi Kelarutan Dan Hasil Kali Kelarutan Orbital : Jurnal Pendidikan Kimia. *Jurnal Pendidikan Kimia*, *3*(2), 167–176.
Yudha, S., Silaban, R., Education, C., Program, S., & Medan, U. N. (2022). *Development of Android-Based Interactive Multimedia on Odd Semester Chemistry Materials for Class X SMA / MA*. 1–8. https://doi.org/10.4108/eai.20-9-2022.2324666
Yunita, N., Linda, R., & Noer, A. M. (2023). *Development of comic-based electronic modules using canva design in elements periodic system material in class X SMA / MA*. *15*(1), 60–67. https://doi.org/10.24114/jpkim.v15i1.41668