Vol 13(1), 2024, 113-122 DOI: 10.23960/jppk.v13.i1.2024.11
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595| p-ISSN 2302-1772
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Application of Problem Based Learning Model Assisted by Android Learning Media to Increase High School Students' HOTS on Redox Reaction Material

Teddy Hardiansyah[1*], Lisa Ariyanti Pohan[2], and Uswatun Hasanah[2]

[1] Students of Chemistry Education Study Program, Faculty of Teacher Training and Education, Universitas Islam Sumatera Utara
[2] Lecturer in Chemistry Education Study Program, Faculty of Teacher Training and Education, Universitas Islam Sumatera Utara
Jl. Sisingamangaraja XII Teladan Barat, Medan, Indonesia

*Corresponding e-mail: teddyhardiansyah306@gmail.com

Received: November 17th, 2023 Accepted: April 1st, 2024 Online Published: April 26th, 2024

Abstract: Application of Problem Based Learning Model Assisted by Android Learning Media to Increase Increase High School Students' HOTS on Redox Reaction Material. This study aims to describe the application of the PBL model assisted by Android learning media to increase students' HOTS on redox reaction material. In research using the quasi-experimental design method. The sample in this study used 2 classes consisting of X MIA 2 as the control class and X MIA 3 as the experimental class. The research was conducted at SMA Negeri 2 Tanjung Morawa. Data was collected using HOTS-loaded learning outcome test instruments, observation sheets and student response questionnaires. The results of the study were obtained where there was a significant influence in the application of the problem-based learning model assisted by android learning media in increasing students' HOTS on redox reaction material with an Independent test of t-test samples at α= 0.05 obtained sig. 2-tailed by 0.000 from the posttest value of the control and experimental classes, N-gain value of 0.55 in the medium category. In addition, in the implementation of learning get an average percentage of 88.19%, and the average percentage of student response to the use of problem-based learning media is 90.83%. so it can be concluded that the problem-based learning (PBL) model assisted by interactive learning media can help train students' HOTS.

Keywords: Problem Based Learning (PBL), Android Learning Media, Higher Order Thinking Skill (HOTS), Redox Reactions

Abstrak: Application of Problem Based Learning Model Assisted by Android Learning Media to Increase High School Students' HOTS on Redox Reaction Material. *Penelitian ini bertujuan untuk mendeskripsikan penerapan model PBL berbantukan media pembelajaran android terhadap peningkatan HOTS siswa pada materi reaksi redoks. Dalam penelitian ini digunakan metode quasi-experimental design. Sampel dalam penelitian ini menggunakan 2 kelas yang terdiri dari X MIA 2 sebagai kelas kontrol dan X MIA 3 sebagai kelas eksperimen. Penelitian dilaksanakan di SMA Negeri 2 Tanjung Morawa. Data dikumpukan menggunakan instrument tes hasil belajar bermuatan HOTS, lembar observasi dan angket respon siswa. Hasil penelitian diperoleh dimana terdapat pengaruh yang signifikan dalam penerapan model problem based learning berbantukan media pembelajaran android dalam meningkatkan HOTS siswa pada materi reaksi redoks dengan uji Independent sampel t-tes pada pada α= 0,05 diperoleh sig. 2-tailed sebesar 0,000 dari nilai posttest kelas kontrol dan eksperimen, nilai N-gain sebesar 0,55 pada kategori sedang. Selain itu dalam keterlaksanaan pembelajaran mendapatkan persentase*

rata-rata sebesar 88,19 % , dan persentase rata-rata respon siswa terhadap penggunaan media pembelajaran berbasis masalah sebesar 90,83%. Sehingga dapat disimpulkan bahwa model problem based learning (PBL) berbantukan media pembelajaran interaktif dapat membantu melatih HOTS siswa.

***Kata Kunci**: Problem Based Learning (PBL), Media Pembelajaran Android, Higher Order Thinking Skill (HOTS), Reaksi Redoks*

▪ INTRODUCTION

Higher-order thinking skills (HOTS) are an important component of 21st century skills, which include the ability to think critically, and think creatively, communicatively, and collaboratively (Puspitasari &; Nugroho, 2020). HOTS can occur when a person can retrieve new information and connect it with information stored in memory so that they can organize and expand the information to get a purpose and answer. HOTS is currently the center of considerable attention in the world of education. Individuals who have HOTS that can distinguish true and false information. Likewise, students who have high HOTS will be able to understand and criticize various problems that exist in their environment. In addition, the important role of HOTS in learning lies in the learning process. Unfortunately, students' higher-order thinking skills have not been fully fulfilled, this is because not all students can follow the HOTS learning pattern (Muspawi et al., 2013).

One of the class X materials discussed in the even semester of the 2013 curriculum is redox reactions. Redox reactions are one of the materials that contain abstract and tiered chemical concepts, such as the concept of redox reactions based on electron transfer, the process of releasing and receiving electrons that cannot be seen with the eye, but only imagined and decreased oxidation number (Astutik, 2017). In addition, this material, there are applications in everyday life such as the process of rust on iron which requires an analysis to solve the problem of why rust occurs in iron.

The problem that often arises in the field is the way teachers teach using the lecture method (conventional) and present the material according to what is contained in the textbook. In addition, some teachers have not used learning models that support the material. This situation results in students not being trained to develop their analytical skills and apply the concepts they have learned in real life that students see and experience so students' HOTS skills have not been able to be trained properly (Antara, 2022)

HOTS skills are an important element of the learning process that can later affect the ability, speed, and effectiveness of students (HOTS is a future provision for students including strategic competence and adaptive thinking in answering problems in everyday life, therefore HOTS is an important feature for the implementation of the 2013 Curriculum. HOTS are often defined as cognitive processes that try to come up with solutions in difficult and confusing situations. Bloom's taxonomy categorizes higher-order thinking skills into three levels: analyzing (C4), evaluating (C5), and creating (C6). The cognitive process classified as critical thinking is analyzing and evaluating, while creating is classified as creative thinking (Mari'a &; Ismono, 2021)

HOTS are abilities that students must have to be able to think at a higher level. Students who can think at a higher level (HOTS) will be able to analyze, evaluate, and create innovations in solving problems in a chemistry lesson. The need for HOTS in chemistry learning at this time is needed especially redox reaction material. This is

because in redox reaction material many problems in applying redox reactions in everyday life can be solved using the ability of HOTS. For example, corrosion cases in metals, so students are required to have good HOTS skills in the analytical field (C4) to provide an evaluation (C5) of solving the problem. After they can provide an evaluation, the next step is to create a solution to the problem. Where the level of creating (C6) is the highest ability that students must have in the 21st century (Chalkiadaki, 2018; Saputri et al., 2019; Talmi et al., 2018). The ability of HOTS can be improved with various learning media and HOTS-based teaching materials. Therefore, an interactive learning media is needed that can increase and stimulate HOTS in students.

Based on the results of initial observations and interviews with chemistry teachers at SMA Negeri 2 Tanjung Morawa, where the teacher has taught with the discovery learning model, this learning model has not been able to support student activities in improving students' higher-order thinking skills, this is due to the lack of use of learning media during the learning process. To overcome these problems, a learning model with the help of learning media is needed that can stimulate students' higher-order thinking skills, one of the learning models that can stimulate students' higher-order thinking skills is problem-based learning with the help of android learning media. Fauziah &; Fitria (2022) explained that the Problem-Based Learning (PBL) learning model is an effective model for teaching higher-order thinking processes, this learning helps students to process ready-made information in their minds and compile their knowledge about the social world and its surroundings.

This is also reinforced by research conducted by Hia, Lisa, and Julia that the *problem-based* learning model is one of the learning models that makes students more active in learning and teaching activities. This increases student learning participation, because through this learning students learn how to use concepts and interaction processes to assess what they know, identify what they want to know, collect information, and collaboratively evaluate their hypotheses based on the data that has been collected. (Hia et al., 2018).

Based on the background and problems that have been explained, there are 2 objectives of this study: (1) Knowing whether the management of learning PBL models assisted by android-based media increases student and teacher interaction; (2) Knowing how much influence the application of *problem-based* learning (PBL) models assisted by android learning media on redox reaction material to increasing *higher order thinking skills* (HOTS) of high school students

▪ METHOD

The method used in this study is the *Quasi-Experimental* method with the type of research design used is *Nonequivalent Control Group Design*. The selection of this design is intended to see the initial state, namely whether there are differences before treatment is given between the experimental group and the control group (Sugiyono, 2013) The research design is stated as follows:

Table 1. Nonequivalent Control Group Design.

Group	Class	Pretest	Treatment	Posttest
Experiment	X MIA 3	O_1	X_1	O2
Control	X MIA 2	O_3	X_2	O_4

Information:
O_1: Experimental class pretest results
O_3: Control class pretest results
O_2: Posttest results of experimental class
O_4: Control class posttest results
X_1: Treatment given to students in experimental classes
X_2: Treatment given to students in the control class

The population in this study is all grade X science students of SMA Negeri 2 Tanjung Morawa for the 2022/2023 school year. The samples used in this study were 2 classes X MIA SMA Negeri 2 Tanjung Morawa, namely 30 students X MIA 2 as a control class and 30 students X MIA 3 as an experimental class using purposive sampling techniques. The type of data used is primary data, namely test result data (pretest and posttest scores), besides that, there is also secondary data in the form of observation sheets for learning implementation.

Research instruments include pretest and posttest test sheets in the form of essays based on HOTS indicators, student response questionnaires, and implementation observation sheets. For student response questionnaire data using a Likert scale measurement scale of 5, and learning implementation data using a Likert scale measurement scale of 4

Test the feasibility of test instruments (pretest and posttest questions) using validity, reliability, difficulty, and differentiating power tests. The test is carried out by giving pretest and posttest questions to students who have studied the redox reaction material before. To find out that the question is valid or feasible to use at the time of research. The validity of the question is determined by comparing the r-table and r-count values. The criterion is that if r-table > r-count then the question is said to be valid. While reliability is determined using Cronbach's Alpha. The criteria for the reliability of question items according to Arikunto, (2015) can be seen in Table 2.

Table 2. Reliability Index Interpretation Criteria

Correlation Interval	Reliability Criteria
$0.81 < r_{11} \leq 1.00$	Very High
$0.61 < r_{11} \leq 0.80$	Tall
$0.41 <_{r\,11} \leq 0.60$	Enough
$0.21 < r_{11} \leq 0.40$	Low
$0.00 < r_{11} \leq 0.20$	Very Low

Learning Implementation Analysis

Analysis of learning implementation in this study was obtained by calculating the number of scores obtained in the learning implementation observation format, learning implementation was carried out to see whether the PBL model assisted by android learning media could stimulate student HOTS, especially in chemistry learning on redox reaction material. To get the results of learning implementation can be done by calculating the percentage of learning implementation using the formula:

$$\% \text{ Manageability} = \frac{\text{Number of scores obtained}}{\text{The maximum number of scores on each activity}} \text{ x } 100\%$$

Student HOTS Analysis

HOTS analysis based on pretest and posttest values, testing the results of pretest and posttest through a hypothesis test of similarity of two variables if the research data is normally distributed, then testing can be done with an independent sample t-test to obtain the presence or absence of the effect of applying the PBL model assisted by android learning media on student HOTS, to determine the consistency of the increase in HOTS in both experimental classes which is statistically significant at 5% alpha. Meanwhile, to see the increase in HOTS, students can use testing with N-gain scores the criteria for the level of increase in HOTS used can be seen in Table 4. The independent sample t-test and N-gain score in the study were obtained using the help of IBM SPSS software.

Table 1. Interpretation Criteria *N-gain score*

Effect size	Criteria
(<g>) > 0.70	Tall
0.70 > (<g>) > 0.30	Medium
(<g>) < 0.30	Low

▪ RESULT AND DISCUSSION

Implementation of Test Instrument Stage

Before the test instruments (pretest and posttest questions) are given to students, validity, reliability, difficulty, and differentiating power tests are carried out. This test is used to find out whether the questions on the question are feasible or not to be used during research. In testing, the test instrument in this study was tested on students who had studied redox reaction material. After obtaining data from the pretest and posttest results analyzed using Microsoft Excel. After being calculated, the results are obtained in the form of numbers that will be analyzed according to the criteria. The test results of validity, reliability, difficulty, and differentiating power of HOTS-loaded test questions, can be seen in table 5 below.

Table 5. Test Results Validity, Reliability, Level of Difficulty, and Differentiating Power of HOTS-Loaded Test Questions

Question Number	Validity	Reliability	Difficulty Level	Differentiating Power
1	0,6218	0,7715	0,84	0,28
2	0,7343		0,80	0,32
3	0,7720		0,81	0,28
4	0,3288		0,40	0,08
5	0,6972		0,82	0,24
6	0,7848		0,83	0,28
7	0,3410		0,73	0,20
8	0,4602		0,83	0,16
9	0,7006		0,73	0,28
10	0,8217		0,62	0,48

Based on Table 5 the data for validity were analyzed using the product-moment correlation equation with Ms. Excel. The result of the product-moment correlation calculation (r count) is compared with the rtable (0.444) with a significance level of 5%.

Based on the results of the test validity analysis, there are 7 valid questions and 2 invalid questions. The reliability test result is 0.77 with a significance level of 5%. These results show that the test instrument has reliability in the high category. For the results of the difficulty level of the 10 questions tested, there were 8 questions with easy categories and 2 questions with medium categories. In the discriminating power test, the results of the analysis were obtained with 3 questions with bad categories, 6 questions categorized as medium, and 1 question with good categories.

Learning Implementation

Learning implementation is a process of interaction between teachers and students in learning activities based on the Learning Implementation Plan (RPP). The following are the results of the learning implementation in Figure 1

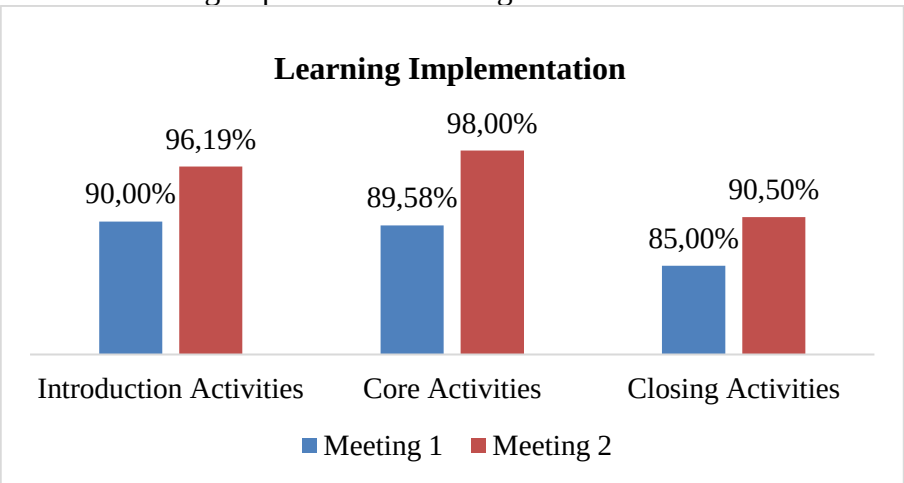

Figure 1. Observations of Learning Implementation

Based on Figure 1, it was found that the implementation of learning on redox reaction material with the PBL model was assisted by Android learning media at each meeting with good categories. Overall the activities of teachers and students are carried out very well. Learning activities using the PBL model assisted by Android learning media are effective and have a good influence on improving student and teacher interaction (Lestari et al., 2019) This is reinforced by research conducted by Rahmawati et al., (2014) that the use of problem-based learning models can increase student and teacher activities in learning where the implementation of learning steps is 100% implementation level gets an average score of 2.8 for teacher activities and 2.65 for student activities. Thus, the implementation of the PBL model assisted by Android learning media with the level of implementation is classified as very good.

Student Response

The calculation results on the questionnaire of student responses to the application of the PBL learning model assisted by interactive learning media can be seen in Table 6

Table 6. Results of the Assessment of Student Response Questionnaires to the Application of PBL Learning Models Assisted by Interactive Learning Media

Indicators	Average	Criterion
Content and design of Android-based interactive learning media	91,24%	Excellent
Ease of use of Android-based interactive learning media	92,00%	Excellent
Student interest in chemistry learning using interactive media rocky PBL	89,25%	Excellent

In Table 6, it can be seen that students gave a positive response with very good criteria to the application of the PBL learning model assisted by interactive learning media, on 3 indicators assessed. Based on the percentages in Table 6 by the observations of researchers during research using this learning media-assisted PBL learning model, students are more active in the learning process. Where almost 98% of students are active in every activity carried out during learning including discussion activities where each student plays an active role in the discussion process. This is reinforced by Febrianti et al. (2023) who explained that students' responses to the application of the *Problem-Based Learning* (PBL) learning model with the help of learning media obtained very good criteria. So that the learning process using the PBL model assisted by android learning media can attract students to study chemistry, especially redox reactions so that it can stimulate students in increasing their higher-order thinking skills.

Improvement of Higher Order Thinking Skills of Students

To see the increase in student HOTS and the effect of using the PBL model assisted by the android learning model, you can use data obtained from student pretest and posttest results in both sample classes which can be seen in Table 7.

Table 7. Centralization and Dissemination of Posttest and Pretest Results Data Experimental and Control Class

Centralization and Dissemination Data	Pretest		Posttest	
	Experiment	Control	Experiment	Control
Lowest Value	52	49	76	57
Top Rated	78	78	97	89
Average (*Mean*)	65,1	62,2	83.97	73.57
Standard Deviation	6,671	7,681	5.169	9.119
Number of Students	30	30	30	30

Table 7 shows that the results of the average posttest and pretest scores in the control and experimental classes show a considerable difference. Where the average pretest score in the control class was 62.2 and the experimental class was 65.1, while the posttest score of students in the control class was 83.97 and the experimental class was 73.57. The average scores obtained by the experimental class and the control class are different, but not too far apart.

In the learning process in the experimental class, at the beginning of learning, the researcher gave a pretest question which the author then continued with the provision of brief material about redox and activities in the PBL model learning model which will be carried out at the next meeting. At the second meeting, researchers shared links to learning media that will be used during the learning process. Furthermore, researchers

applied learning with PBL model syntax with the help of media used in the learning process and then continued with post-test administration.

Evidence carried out in data analysis also requires N-gain analysis to strengthen the increase in student HOTS in the use of PBL models assisted by Android learning media. The results in the N-gain analysis in the control class obtained a value of 0.29 with low criteria while in the experimental class 0.55 with the medium category. This shows a difference in the control class and experiments which show that the application of the PBL model assisted by android learning media is considered effective in the learning process, especially in learning redox reaction material chemistry. The use of ICT-based renewable media by utilizing technology that is close to students at this time provides interest for students to access the material contained in the application so that student learning intensity increases. Higher learning intensity will have an impact on student learning outcomes and has a high probability of improving student learning outcomes (Prasetyo et al., 2015)

The data obtained from the pretest and post-test results were then tested hypotheses by testing normality, homogeneity, and similarity tests of two variables using IBM SPSS software. It was found that in the normality test and homogeneity of pretest and posttest data are data that are normally dispersed and have the same variance, so to test the similarity of two variances an independent sample t-test is used which can be seen in Table 8.

Table 8. Data on Independent Hypothesis Test Results *Sample T-Test* Posttest Experimental and Control Class

Test the hypothesis HOTS-Based Learning Outcomes	*t-test for Equality of Means*		
	t	Df	*Sig. (2-tailed)*
Equal variances assumed	5.434	58	0.000

The decision is taken based on the provisions of the hypothesis test where if significant (2-tailed) < 0.05 then H_0 is rejected and H_a is accepted. The results in Table 8 show that the posttest results of both groups obtained significant values of 0.000 < 0.05, so it can be concluded that H_0 is rejected meaning that there is a significant difference between the posttest results of the experimental class and the control class.

During the learning process in the control class, students are faced with problems with the corrosion process on various metals with different immersion media contained in learning videos contained in Android media. The corrosion process is one example of the application of redox reactions in everyday life. In this study using the problem is expected to stimulate students' HOTS, and this is evidenced by the results of the discussion, where students play an active role in the discussion process and find the information needed to solve the problem. This is also evidenced by the students' posttest results which have increased compared to the students' pretest results on the questions that have been given before.

The results of this study are reinforced by research conducted by Nisa et al., (2022) that the use of PBL models assisted by Android learning media can improve and stimulate students' higher-order thinking skills. The use of Android application-based learning media provides new passion, a sense of pleasure, and interest for students during the learning process to arouse student interest in the process of classroom learning, especially chemistry learning (Hirsh-pasek et al., 2015) Thus, it can be said that the existence of android-based learning media in chemistry learning can increase student interest in

studying chemistry and is more effective than using package books in increasing student HOTS.(Dasilva & Suparno, 2019; Pohan et al., 2016)

▪ CONCLUSION

Based on the research that has been done, it can be concluded that the problem-based learning model assisted by android learning media can increase students' HOTS on redox reaction material, this is evidenced by an increase in scores in the experimental class with an average pretest of 65.10 and an average postest of 83.97. Based on the N-gain value, the PBL model rocked by Android learning media is effective with a gain of 0.55. Based on the Independent Sample T-test, the results of the Sig 2-tailed < α value (0.000 < 0.05) were obtained so that it can be concluded that there is a significant influence in the application of the problem-based learning model assisted by Android learning media in increasing students' HOTS on redox reaction material.

▪ REFERENCES

Antara, I. P. P. A. (2022). Model Problem Based Learning untuk Meningkatkan Hasil Belajar Kimia Pada Pokok Bahasan Termokimia. *Journal of Education Action Research*, *6*(1), 15–21. https://doi.org/10.23887/jear.v6i1.44292

Arikunto, S. (2015). *Prosedur Penelitian, Suatu Pendekatan Praktik*. Bandung: Rineka Cipta.

Astutik, T. P. (2017). Identifikasi Konsep Sukar dan Kesalahan Konsep Reaksi Redoks. *Jurnal Zarah*, *5*(1), 22–28. https://doi.org/10.31629/zarah.v5i1.155

Chalkiadaki, A. (2018). A Systematic Literature Review of 21 st Century Skills and Competencies in Primary Education. *International Journal of Instruction*, *11*(3), 1–16.

Dasilva, B. E., & Suparno. (2019). Development of The Android-Based Interactive Physics Mobile Learning Media (IPMLM) to Improve Higher Order Thinking Skills (HOTS) of Senior High School Students. *Journal of Physics: Conference Series*, *1397*(012010), 1–15. https://doi.org/10.1088/1742-6596/1397/1/012010

Fauziah, U., & Fitria, Y. (2022). Pengaruh Model Pembelajaran Berbasis Masalah dan Kemampuan Awal terhadap Kemampuan Berpikir Kritis Siswa pada Pembelajaran Tematik Terpadu. *Jurnal Basicedu*, *6*(2), 2836–2845. https://doi.org/10.31004/basicedu.v6i2.2502

Febrianti, I. R., Subiki, S., & Supriadi, B. (2023). Pengaruh Model Pembelajaran Problem Based Learning Berbantuan E-Lkpd Terhadap Aktivitas Dan Hasil Belajar Siswa Sma Pokok Bahasan Besaran Dan Satuan. *Jurnal Pembelajaran Fisika*, *12*(2), 41. https://doi.org/10.19184/jpf.v12i2.36079

Hia, E. D. S. P., Maulina, J., & Pohan, L. A. (2018). Penerapan Model Pembelajaran Problem Based Learning Menggunakan Handout dan Modul pada Materi Stoikiometri Larutan di SMA Nurul Amaliyah Deli Serdang. *Journal of Chemistry, Education, and Science*, *2*(1), 1–13.

Hirsh-pasek, K., Zosh, J. M., Michnick, R., Gray, J. H., & Robb, M. B. (2015). Putting Education in " Educational " Apps : Lessons From the Science of Learning. *Psychological Science in the Public Interest*, *16*(1), 3–34. https://doi.org/10.1177/1529100615569721

Lestari, D. I., Rusdi, M., & Dewi, F. (2019). Analisis Keterlaksanaan Problem Based Learning Berbantuan Multimedia Pembelajaran Larutan Asam Basa Terhadap

Keterampilan Memecahkan Masalah. *Konfigurasi : Jurnal Pendidikan Kimia dan Terapan*, *3*(1), 1–7. https://doi.org/10.24014/konfigurasi.v3i1.6803

Mari'a, H., & Ismono. (2021). Pengaruh Implementasi Model Pembelajaran Problem Solving Dipadukan Dengan Keterampilan Hots Terhadap Hasil Belajar Peserta Didik Berdasarkan Studi Literatur. *Unesa Journal of Chemical Education*, *10*(1), 10–19. https://doi.org/doi.org/10.26740/ujced.v10n1.p10-19

Muspawi, M., Suratno, & Ridwan. (2013). Upaya Peningkatan Higher Order Thinking Skills (HOTS) Siswa Melalui Penerapan Model Inquiri di SMA Negeri 9 Tanjung Jabung Timur. *Jurnal Ilmiah Universitas Batanghari Jambi*, *19*(2), 208–214. https://doi.org/10.33087/jiubj.v19i2.653

Nisa, H., Junus, M., & Komariyah, L. (2022). Penerapan Model Problem Based Learning Berbantuan Simulasi PhET Berbasis Instrumen HOTS Terhadap Hasil Belajar Siswa. *Jurnal Ilmiah Pendidikan Fisika*, *6*(3), 560. https://doi.org/10.20527/jipf.v6i3.5514

Pohan, L. A., Situmorang, M., & Jahro, S. (2016). *Pengembangan Bahan Ajar Inovatif Berbasis Multimedia Untuk Meningkatkan Hasil Belajar Mahasiswa Pada Pembelajaran pH Larutan*. *8*(2), 112–119.

Prasetyo, Y. D., Yektyastuti, R., Solihah, M., Ikhsan, J., & Sugiyarto, K. H. (2015). Pengaruh Penggunaan Media Pembelajaran Kimia Berbasis Android Terhadap Peningkatan Motivasi Belajar Siswa SMA. *SEMINAR NASIONAL PENDIDIKAN SAINS V "Pengembangan Model dan Perangkat Pembelajaran untuk Meningkatkan Kemampuan Berpikir Tingkat Tinggi," 19 November 2015*, 252–258.

Puspitasari, Y. D., & Nugroho, P. A. (2020). Peningkatan Higher Order Thinking Skill Dan Kemampuan Kognitif Pada Mahasiswa Melalui Pendekatan Science , Environment , Technology And Society Berbantuan Modul Pembelajaran. *JIPI (Jurnal IPA dan Pembelajaran IPA)*, *4*(1), 11–28.

Rahmawati, R., Halim, A., & Yusrizal, Y. (2014). Model Pembelajaran Problem Based Learning Untuk Meningkatkan Penguasaan Konsep Kalor Siswa SMA. *Jurnal Pendidikan Sains Indonesia*, *2*(1), 27–32.

Saputri, A. C., Sajidan, Rinanto, Y., Afandi, & Prasetyanti, N. M. (2019). Improving Students ' Critical Thinking Skills in Cell -Metabolism Learning Using Stimulating Higher Order Thinking Skills Model. *International Journal of Instruction*, *12*(1), 327–342.

Sugiyono. (2013). *Cara Mudah Menyusun Skripsi, Tesis dan Disertasi*. Jakarta: Alfabeta.

Talmi, I., Hazzan, O., & Katz, R. (2018). Intrinsic Motivation and 21st-Century Skills in an Undergraduate Engineering Project : The Formula Student Project. *Higher Education Studies*, *8*(4), 46–58. https://doi.org/10.5539/hes.v8n4p46

.