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Development of HOTS Integrated Problem Based Learning (PBL) Chemistry Learning Module on Buffer Solution Material at SMA Negeri 1 Purba

Freddy Tua Musa Panggabean
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Grestina Winda Sari Munthe
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Pasar Maulim Silitonga
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Anna Juniar
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Rini Selly
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Abstract: This research was conducted to design a Problem Based Learning (PBL) based learning module with the ADDIE model. The problems studied are 1) How is the feasibility (validity) and learning effectiveness of the Problem Based Learning (PBL)-based module developed on the buffer solution material to measure students' Higher Order Thinking Skills (HOTS) and 2) What are the students' chemistry learning outcomes using the module-based Problem Based Learning (PBL) is higher than the KKM score. The subjects of this study were 3 expert validators (expert lecturers), and 1 high school chemistry teacher to evaluate the learning to be developed and class XI MIA students of SMA Negeri 1 Purba who were determined by random sampling using an experimental class totaling 30 students. The results of the study showed that 1) the problem-based learning module for chemistry-based learning buffer solution material that was developed was feasible to be used for learning materials to improve students' critical thinking skills. The module is declared effective as seen from the increase in student learning outcomes, namely the average pretest value of 33.5 and posttest 80.13 in the experimental class, 2) The learning outcomes of chemistry using Problem Based Learning (PBL)-based modules developed on buffer solution material are higher than the value KKM (75) with an average score of 80.13.

Keywords: Problem Based Learning, HOTS, module, learning outcomes, BSNP

1. INTRODUCTION

Education is a process of interaction that occurs between teachers and students to assist students in developing their potential. Education is also interpreted as conscious guidance by educators on the spiritual and physical development of students towards the formation of the main personality and skill development through practice so that they are able to reach maturity little by little [1]. Education is always related to the curriculum. According to the KBBI, the curriculum is a set of subjects given to lesson participants. This curriculum has a function as a guide in the implementation of the teaching and learning process in schools for related parties such as teachers, principals, supervisors, parents, the community and the students themselves [2]. The 2013 curriculum that is applied now is a curriculum that prioritizes skills, understanding and character, where students are required to master the material, be active during the teaching and learning process [3] The 2013 curriculum emphasizes educators to have skills in compiling Higher Order Thinking Skill (HOTS) assessment instruments, namely evaluation tools that can train students' critical and creative thinking processes [4]. HOTS is a learning designed to prepare the 21st century generation to have competencies and skills which include: critical thinking and problem solving, creative competence, communication skills and the ability to work together [5].

Currently, the problem with education in Indonesia is related to the quality of education, such as limited facilities in schools, an unequal number of teachers, and the quality of the teachers themselves, which are considered to be lacking in the level of learning materials and approaches used in the learning process used in the learning process. which is less precise and effective [6]. In the teaching and learning process, it is expected that educators can convey the material being taught and provide facilities for learning, while students can understand the material being taught. So that the learning process can run as expected. Maximum learning activities are very important for everyone to understand or gain useful knowledge [7].

The selection and use of good teaching materials is an important factor in the quality of education. Teaching materials that can be used by students as independent learning resources have an important role in improving and developing higher-order thinking skills [8]. Learning modules are books that are written and then printed with the aim that they can be studied independently by students without any guidance from educators (teachers) [9]. It has been equipped with instructions for self-study so that it is referred to as a medium for independent learning. The difference between modules and textbooks is that the module focuses on one material, while the

book consists of several materials, so that the use of the module is more effective and efficient [10].

Problem Based Learning (PBL) is one of the innovative learning models that can provide active learning conditions for students. The PBL model prepares lessons for critical and analytical thinking, as well as for finding and using learning resources [11]. The Problem Based Learning (PBL) learning model has been studied by several previous researchers and has been proven to improve student learning outcomes [12], including: concluded that 1) there is an increase in students' creative thinking skills using the PBL model, 2) there is an increase in students' creative thinking skills. student learning outcomes using the PBL model, 3) students' creative thinking skills using the PBL model are better than using the conventional model [13].

Learning by using modules is not only for conveying information but also provides opportunities for students to learn on their own according to their abilities. students can learn on their own to solve problems and understand lessons without being too dependent on the teacher. In addition, learning using modules is expected to change students' study habits for independent study and can help students understand theory in depth through learning experiences [14].

One of the learning activities taught in high school is chemistry learning. Chemistry is a material that is considered difficult by students. The difficulties experienced by students are usually caused by the existence of concepts that must be understood, the relationship between one concept and another, besides that there are also many mathematical calculations [15]. Buffer solution is the main material in chemistry lessons in class XI IPA High School 2nd semester (even). This material is closely related to everyday life, thus making it easier for students to understand the material by connecting it with daily activities and not focusing on theory alone. In studying the buffer solution material, students are required to have good mastery of concepts and mathematical abilities. Because a buffer solution is included in the concept of a solution, it requires an initial understanding of equilibrium, stoichiometry and the concept of acid base [16].

2. METHOD

The type of research used in this research is Research and Development (R&D) with the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation) which aims to produce and develop certain products, and test the effectiveness of these products. The results of this study used Problem Based Learning (PBL) and instruments to measure the HOTS of students in the buffer solution material [17].

The development model used is the ADDIE model. The ADDIE model is a learning model design that is systematically arranged and consists of 5 steps, namely analysis, design, development, implementation, evaluation which includes the design of the entire learning process in a systematic way [18]**.** 1) Analysis, the first stage that must be done is research and information gathering. The research and data collection phase consisted of literature studies and field studies. 2) Design, carried out to identify goals and create a design for learning media that will be developed. 3) Development. The development of the module must be based on several aspects such as the criteria for a good module and the adjustment of the module to the learning material. Furthermore, the module will be validated by an expert validator. 4) Implementation, the application of HOTS-based integrated problem-based learning chemistry learning. 5) Evaluation Phase, Conducted on development products such as content/materials, developed learning media and evaluation of the effectiveness and success of the developed media.

The research also aims to determine the effectiveness of the module in improving student learning outcomes and also the responses of teachers and students regarding the practicality of the module. Student learning outcomes are assessed using pretest and posttest questions [19].

The study began by analyzing the high school chemistry textbook material for buffer solutions. Then it was designed and developed into a problem based learning chemistry module and standardized using a National Education Standards Agency questionnaire conducted by chemistry lecturers and high school chemistry teachers who have experience in teaching chemistry. The final stage is testing the module on students to determine students' chemistry learning outcomes using the HOTS integrated problem based learning model to measure students' higher order thinking skills.

In this study, one group pretest-posttest design was used in implementing the module. This design was chosen because the researcher only used one class as an experimental class, there was no control class as a comparison class. Determination of this design is also adjusted to the actions taken during the study, namely giving an initial test (pretest) then followed by giving treatment for a certain period of time and ending with giving a final test (posttest).

3. RESEARCH RESULT

Research on the development of HOTS integrated problem based learning chemistry learning modules on buffer solution material has been carried out at SMA Negeri 1 Purba through several stages starting from analyzing chemistry books, developing modules with problem based learning syntax which begins with 1) Problem orientation to students 2) Organizing students to learn, 3) Helping investigations and groups, 4) Developing and presenting work and 5) Analyzing and evaluating problem solving processes, module validation by chemistry teachers and chemistry lecturers and implementation to students [20].

3.1 HOTS Integrated Problem Based Learning-Based Chemistry Learning Module Validation

The analysis of the module that uses standardized testing based on the modified BSNP includes 4 aspects: 1) Content feasibility: 2) Language feasibility; 3) Presentation feasibility and; 4) Graphical Feasibility. Validation was given to 2 chemistry lecturers at the State University of Medan and 1 teacher at SMA Negeri 1 Purba. The assessments of the expert validators are presented in Table 3.1 as follows.

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Table 3.1 Results of Validation of High School Chemistry Learning Module Based on Problem Based Learning Based on BSNP by Lecturers and Teachers

No	Assesment	Average Score	Validation Criteria
1.	Content eligibility	3,75	Very valid and does not need revision
2.	Language Eligibility	3,79	Very valid and does not need revision
3.	Serving Eligibility	3,75	Very valid and does not need revision
4.	Graphic Eligibility	3,80	Very valid and does not need revision
BSNP Eligibility Average Score		3,77	Very valid and does not need revision
5.	With *Problem Based Learning*	3,66	Very valid and does not need revision

with ;

3,50 < M ≤ 4,00 : Very valid and does not need revision

2.,50 < M ≤ 3,50 : Sufficiently valid and does not need revision

1,50 < M ≤ 2,50 : Invalid and doesn't need revision

M < 1,50 : Invalid and does not need revision

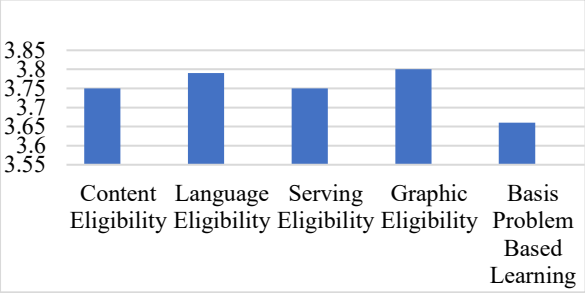

Figure 1. Graph of module feasibility analysis results

Based on the results of the validation of the module development carried out by 2 UNIMED chemistry lecturers. Obtained an average language eligibility score of 3.75; presentation eligibility 3.79; content eligibility 3.75 and graphic eligibility 3.80 which states that the High School chemistry module has met the BSNP criteria. The average score for problem-based learning is 3.66, which means that the module is already based on problem-based learning. Student responses to the developed module also have good criteria with a score on the interest indicator 3.56; 3.42 material indicators and 3.76 language indicators. With an average score of 3.58 which is classified as good criteria.

3.2 The Results of The Trial of The Integrated Problem Based Learning-Based Module HOTS Material for the Buffer Solution

After the media was declared eligible, the stage of validating the test instrument questions was carried out to UNIMED lecturers. Where the results of the test instrument validation there are as many as 10 questions. After being valid, it was then tested on students in class XI MIA 2 and the results were that there were 2 invalid questions and 8 questions declared valid.

Furthermore, at the implementation stage, the problem-based learning chemistry module on the valid buffer solution material was revised according to the suggestions from the lecturer, then tested on students to see if there was an increase in learning outcomes. In this case, the experimental class was first given a pretest to see the students' initial abilities. Where the questions used are test instruments that are validated as many as 8 questions. The average student learning outcomes obtained is 33.5. After obtaining the initial abilities, then learning is carried out using the developed chemistry module. And at the end of the material, a posttest with the same questions was given to find out whether there was an increase during the learning process. And based on the average calculation, the posttest score was 80.13.

Judging from the calculation of statistical data obtained Sig_{count} for pretest data of 0.200 and posttest data of 0.042. From these data it can be concluded that the data is normally distributed as seen from $Sig_{count} > \alpha$, with $\alpha = 0.05$. This shows that the pretest and posttest data are normally distributed, so that the experimental class has students' cognitive abilities that are normally distributed.

Table 3.2 Average Student Learning Outcomes

Class	Pretest	Posttest
Experiment	32,4	80,23

Based on the research that has been done at SMA Negeri 1 Purba, it can be concluded that the chemical module based on problem based learning on the buffer solution material developed is effective and feasible to use for the learning process. With the results of testing the hypothesis that the average student learning outcomes are 80.23. It can be seen that the average learning outcomes obtained are higher than the Minimum Completeness Criteria (KKM) of 75. Where H_a is accepted and H_0 is rejected.

4. CONCLUSIONS

Based on the results of material validation, it shows that the 1) problem-based learning chemistry module of the developed buffer solution material is suitable for use as learning material to improve students' critical thinking skills. The module was declared effective as seen from the increase in student learning outcomes, namely the average pretest score of 33.5 and posttest 80.13 in the experimental class. 2) The results of learning chemistry using a Problem Based Learning (PBL)-based module developed on the buffer solution material is higher than the KKM value (75) with an average value of 80.13.

5. REFERENCES

[1] H. Y. P. Sibuea, “Pembaruan Sistem Pendidikan Di Indonesia : Perkembangan Dan Tantangan,” *J. Kaji.*, vol. 22, no. 2, pp. 151–162, 2017, doi: 10.22212/kajian.v22i2.1520.

[2] N. Rizkia, S. Sabarni, A. Azhar, E. Elita, and R. D. Fitri, “Analisis Evaluasi Kurikulum 2013 Revisi 2018 Terhadap Pembelajaran Kimia Sma,” *Lantanida J.*, vol. 8, no. 2, p. 168, 2021, doi: 10.22373/lj.v8i2.8119.

[3] S. Yudha, O. A. Saputra, R. Purwanto, and A. W.

Nugraha, "Analysis of Chemical Teaching Materials for Class X SMA / MA on The Discussion of The Role of Chemistry in Daily Life," *J. Pendidik. dan Pembelajaran Kim.*, vol. 10, no. 3, pp. 109–117, 2021, doi: 10.23960/jppk.v10.i3.2021.11.

[4] Z. Rifka, I. Khaldun, and A. Ismayani, "Analisis Pelaksanaan Penilaian Autentik Kurikulum 2013 Oleh Guru Kimia Di SMA Negeri Banda Aceh Tahun Pelajaran 2016 / 2017 Pendahuluan," *J. Ilm. Mhs. Pendidik. Kim. Vol.2.*, vol. 2, no. 3, pp. 248–255, 2017, [Online]. Available: http://jim.unsyiah.ac.id/pendidikan-kimia/article/view/4929

[5] J. Purba, A. Sutiani, F. T. M. Panggabean, M. Isnaini, and H. D. Hutahaean, "Implementasi Bahan Ajar Kimia Umum Online Terintegrasi Media Dalam Meningkatkan HOTS Ditinjau Dari Kemampuan Awal Mahasiswa," *J. TIK dan Pendidik.*, vol. 9, no. 1, pp. 52–59, 2022, doi: 10.24114/jtikp.v9i1.35481.

[6] D. Rahman, A. Adlim, and M. Mustanir, "Analisis Kendala Dan Alternatif Solusi Terhadap Pelaksanaan Praktikum Kimia pada SLTA Negeri Kabupaten Aceh Besar," *J. Pendidik. Sains Indones.*, vol. 3, no. 2, pp. 1–13, 2015, [Online]. Available: http://jurnal.unsyiah.ac.id/jpsi

[7] N. S. Herawati and A. Muhtadi, "Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran Kimia kelas XI SMA," *J. Inov. Teknol. Pendidik.*, vol. 5, no. 2, pp. 180–191, 2018, doi: 10.21831/jitp.v5i2.15424.

[8] F. T. M. Panggabean, J. Purba, A. Sutiani, and M. A. Panggabean, "Analisis Hubungan Antara Kemampuan Matematika dan Analisis Kimia Terhadap Hasil Belajar Kimia Materi Kesetimbangan Kimia," *J. Inov. Pembelajaran Kim.*, vol. 4, no. 1, p. 18, 2022, doi: 10.24114/jipk.v4i1.32904.

[9] K. Dwiningsih, Nf. Sukarmin, Nf. Muchlis, and P. T. Rahma, "Pengembangan Media Pembelajaran Kimia Menggunakan Media Laboratorium Virtual Berdasarkan Paradigma Pembelajaran Di Era Global," *Kwangsan J. Teknol. Pendidik.*, vol. 6, no. 2, pp. 156–176, 2018, doi: 10.31800/jtp.kw.v6n2.p156--176.

[10] R. Imanda, I. Khaldun, and A. Azhar, "Pengembangan Modul Pembelajaran Kimia Sma Kelas Xi Pada Materi Konsep Dan Reaksi-Reaksi Dalam Larutan Asam Basa," *J. Pendidik. Sains Indones.*, vol. 5, no. 2, pp. 42–49, 2018, doi: 10.24815/jpsi.v5i2.9816.

[11] F. T. M. Panggabean, P. M. Silitonga, and M. Sinaga, "Development of CBT Integrated E-Module to Improve Student Literacy HOTS," *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 05, pp. 160–164, 2022, doi: 10.7753/ijcatr1105.1002.

[12] I. P. P. A. Antara, "Model Problem Based Learning untuk Meningkatkan Hasil Belajar Kimia Pada Pokok Bahasan Termokimia," *J. Educ. Action Res.*, vol. 6, no. 1, pp. 15–21, 2022, doi: 10.23887/jear.v6i1.44292.

[13] R. Silaban, F. T. M. Panggabean, F. M. Hutapea, E. Hutahaean, and I. J. Alexander, "Implementasi Problem Based-Learning (PBL) dan Pendekatan Ilmiah Menggunakan Media Kartu Untuk Meningkatkan Hasil Belajar Peserta Didik Tentang Mengajar Ikatan Kimia," *J. Ilmu Pendidik. Indones.*, vol. 8, no. 2, pp. 69–76, 2020, doi: 10.31957/jipi.v8i2.1234.

[14] M. Y. Soleh, S. Santosa, and M. Indrowati, "Studi Komparasi Penerapan Model Pembelajaran Problem Based Learning dan Inkuiri Terbimbing terhadap Keterampilan Proses Sains Siswa Kelas X SMA Negeri 3 Boyolali Tahun Pelajaran 2013/2014," *Bio-Pedagogi*, vol. 3, no. 2, p. 1, 2014, doi: 10.20961/bio-pedagogi.v3i2.5328.

[15] E. N. U. Cholifah, S. Yamtinah, and E. Susanti VH, "Hubungan Kemampuan Analisis dan Matematika dengan Prestasi Belajar Siswa pada Materi Larutan Penyangga Kelas XI SMA Negeri 4 Surakarta," *J. Pendidik. Kim.*, vol. 8, no. 2, p. 179, 2019, doi: 10.20961/jpkim.v8i2.25340.

[16] M. Gultom, D. Fitriyani, M. Paristiowati, Moersilah, Yusmaniar, and Y. Rahmawati, "Analisis Miskonsepsi pada Materi Larutan Penyangga Menggunakan Two-Tier Diagnostic Test," *JRPK J. Ris. Pendidik. Kim.*, vol. 9, no. 2, pp. 58–66, 2019, doi: 10.21009/jrpk.092.01.

[17] N. Rohmiyati, A. Ashadi, and S. B. Utomo, "Pengembangan modul kimia berbasis inkuiri terbimbing pada materi reaksi oksidasi – reduksi," *J. Inov. Pendidik. IPA*, vol. 2, no. 2, p. 223, 2016, doi: 10.21831/jipi.v2i2.4869.

[18] J. Purba, F. T. M. Panggabean, A. Widarma, and A. Sutiani, "Development of Online General Chemistry Teaching Materials Integrated with HOTS-Based Media Using the ADDIE Model," *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 05, pp. 155–159, 2022, doi: 10.7753/IJCATR1105.1001.

[19] H. Sulistiani, W. Sumarni, and T. A. Pribadi, "Pengembangan Modul Ipa Terpadu Pada Model Pembelajaran Berbasis Masalah–Pertanyaan Socratik (Mpbm-Ps) Tema Carbon Cycle Untuk Siswa Smp Kelas Vii," *Unnes Sci. Educ. J.*, vol. 4, no. 2, pp. 905–911, 2015, doi: 10.15294/USEJ.V4I2.7941.

[20] S. Nur, I. P. Pujiastuti, and S. R. Rahman, "Efektivitas Model Problem Based Learning (PBL) terhadap Hasil Belajar Mahasiswa Prodi Pendidikan Biologi Universitas Sulawesi Barat," *Saintifik*, vol. 2, no. 2, pp. 133–141, 2016, doi: 10.31605/saintifik.v2i2.105.