



Development of Problem Based Learning (PBL) Learning Module on Chemical Bonding Material

Nasio Ruth Lusianna Simbolon, Endang Ristauli Br. Simbolon, Indah Tripena
Panggabean, Partogi Mahatma Sihotang, Romian Afrina Simanullang,
Marudut Sinaga

Department of Chemistry Education, Faculty of Mathematics and Natural Sciences,
University of Medan.

Jl. William Iskandar Pasar V, Medan, Indonesia.

*Corresponding-email: lucyan1945@gmail.com

Received: December 15th, 2024 Accepted: December 19th, 2024 Online Published: December 31th, 2024

Abstract: Development of Problem Based Learning (PBL) Learning Module on Chemical Bonding Material. Limited teaching materials are often a problem in learning in schools. A module is a specific form of teaching material that aims to guide students in understanding a particular material independently. This study aims to determine the feasibility, student responses and effectiveness of the Problem Based Learning (PBL) learning module on chemical bonding material that has been developed. The research method is Research and Development (R&D) using a 4D model that is limited to 3D with stages namely define, design, development due to limited time. Data collection in this study was through interviews, questionnaires and through pre-tests and post-tests. The results showed that the learning module developed had a very good level of validity with percentage scores: 91.66% and 93.75% for the presentation aspect, 95% for the language aspect, 93.75% for the content aspect, 91.66% for the e-module design aspect, and 95% for the material aspect. This electronic-based learning module is declared very valid and suitable for use as teaching material in chemistry learning on chemical bonding material.

Keywords: Learning Module, Problem Based Learning, Development, Chemical Bonding, and R&D Method.

Abstrak: Pengembangan Modul Pembelajaran Berbasis Problem Based Learning (Pbl) Pada Materi Ikatan Kimia. Terbatasnya bahan ajar sering menjadi masalah dalam pembelajaran di sekolah. Modul adalah bentuk spesifik dari bahan ajar bertujuan dalam memandu siswa dalam memahami suatu materi tertentu secara mandiri. Penelitian ini bertujuan untuk mengetahui kelayakan, respon siswa serta keefektifan modul pembelajaran berbasis Problem Based Learning (PBL) pada materi ikatan kimia yang telah dikembangkan. Metode penelitian ini ialah Research and Development (R&D) dengan menggunakan model 4D yang dibatasi menjadi 3D yang tahapan-tahapannya yaitu define (pendefinisian), design (perancangan), development (pengembangan) dengan alasan karena terbatasnya waktu. Pengumpulan data pada penelitian ini yaitu dengan wawancara, angket dan melalui pre-test dan potst-test. Hasil penelitian menunjukkan bahwa modul pembelajaran yang dikembangkan memiliki tingkat validitas sangat baik dengan skor persentase: 91,66% dan 93,75%

untuk aspek penyajian, 95% untuk aspek bahasa, 93,75% untuk aspek isi, 91,66% untuk aspek desain e-modul, dan 95% untuk aspek materi. Modul pembelajaran berbasis elektronik ini dinyatakan sangat valid dan layak digunakan sebagai bahan ajar dalam pembelajaran kimia pada materi ikatan kimia.

Kata kunci: Modul Pembelajaran, Problem Based Learning, Pengembangan, Ikatan Kimia, dan Metode R&D.

▪ INTRODUCTION

The quality of education is highly dependent on the teacher's ability to design learning that is in accordance with the characteristics and potential of students. This ability shows the mastery of the material to be taught by the teacher, as well as a deep understanding of the needs and uniqueness of each student in the class. In science learning, especially chemistry, the Problem Based Learning (PBL) model is one of the effective approaches to increasing student activity. This problem-based learning model actively involves students in solving problems that are relevant to everyday life. Through the PBL approach, students can develop a deeper understanding of the material by collaborating, investigating, and solving problems. In addition, this model also makes it easier for students to understand abstract concepts because the problems presented are based on real situations that they face every day..

According to (Asmandhani, 2023), the Problem Based Learning (PBL) learning model begins with the presentation of real problems to be solved through a problem-solving approach, integrating understanding and application of concepts. (Samosir and Nainggolan, 2022) state that a module is a teaching material that is systematically designed with easy-to-understand language, according to the level of knowledge and age of students, so that students can learn independently with little guidance from the teacher. (Alwi et al., 2022) added that in compiling a module, several steps that must be taken include developing a module based on basic skills, compiling a module according to the RPP, designing a framework that supports the achievement of learning objectives, providing tools to evaluate student learning outcomes, and validating the module that has been compiled.

The module consists of three main components, namely the introduction, learning activities, and bibliography. The introduction contains an overview of the module, learning objectives, and special facilities that support the learning process. Meanwhile, the activities section includes an explanation of the learning material, summary, practice questions, evaluation, and feedback.

Chemical bonds are one of the materials in the chemistry subject taught to grade XI high school students in the Independent Learning Curriculum. In this material, students will learn about the various types of chemical bonds such as ionic bonds, covalent bonds and metal bonds. All concepts in chemistry are interrelated, that is why if students' understanding of one material in chemistry learning is not complete, this will affect further learning. In the study (Samosir and Nainggolan, 2022) it was revealed that students still have difficulty distinguishing between ionic bonds and covalent bonds. If the learning resources used are inadequate in the chemistry learning process on the chemical bond material, of course this will be a problem.

The results of initial observations at SMA Negeri 21 Medan showed that students' learning achievement in chemistry subjects was still unsatisfactory. Most

students have low interest in chemistry, because it is considered a difficult and abstract subject. In addition, observations also revealed that students more often rely on information provided by teachers, without the initiative to learn independently. This low motivation makes students reluctant to dig deeper into information related to learning materials, especially in chemistry subjects.

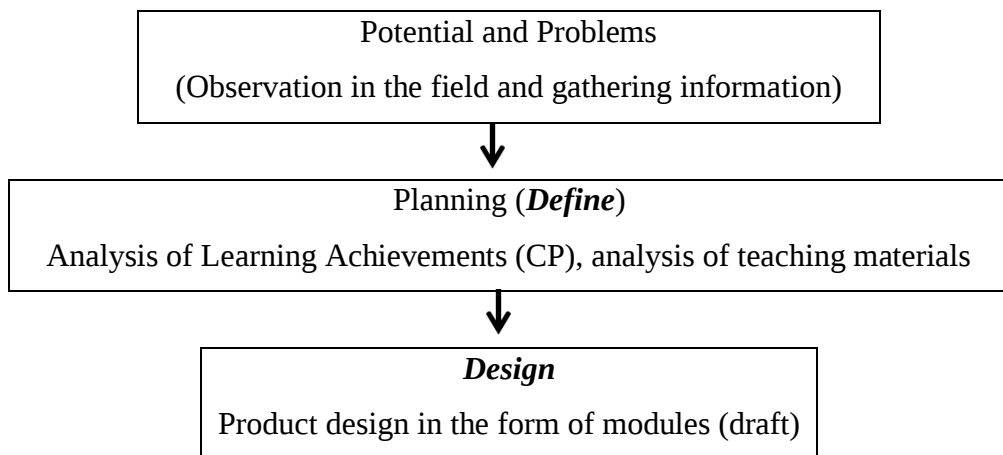
As a solution to the problems mentioned earlier, one step that can be taken is to utilize modules as teaching materials. Modules provide more flexibility for students, allowing them to learn independently with the available guidance. The use of modules in learning is expected to encourage increased student independence during the learning process.

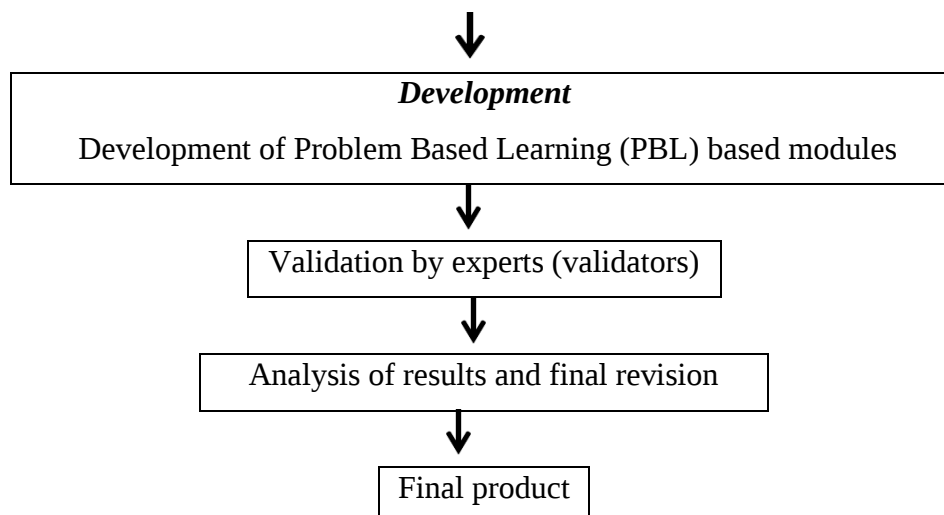
▪ METHOD

This research is a development research using the 4D model (Define, Design, Development and Disseminate), but in this study it only reached the development stage. Research and Development (R&D) research methods are used to produce a product and test the effectiveness of the resulting product (Okpatrioka, 2023). The Disseminate stage was not carried out due to limited time in this study. The object of this study is a Problem Based Learning (PBL) learning module on the Chemical Bonding material that has been developed. The data collection technique used in this study is a non-test technique using an instrument in the form of a validation sheet filled in by the validator. After the results are obtained from the validator, the score is calculated to see the validity of the module that has been developed. The aspects assessed are the presentation, discussion, content, material and design of the module. The initial stage carried out before developing this learning module is to conduct observations and interviews with subject teachers.

Observations and interviews are carried out to determine the conditions and situations regarding the problems in the school. Observations and interviews are included in the Define stage, where this stage is carried out to determine student needs in the learning process. All information is collected from various sources to support the desired product development process. At the Design stage, the draft module is prepared according to the analysis results obtained from the initial definition stage. At the Development stage, the module is prepared and created, then the finished module is validated by expert validators, then the module is revised according to the suggestions obtained from the validator.

The procedures in this research are:





▪ RESULT AND DISCUSSION

This research consists of several stages, starting from the definition that includes the analysis of learning outcomes and teaching materials. Furthermore, at the design stage, an e-module based on Problem Based Learning (PBL) was developed for chemical bonding material. The development stage includes trials and validation by lecturers at Medan State University and chemistry teachers at Medan State Senior High School 21, with assessment aspects including presentation, language, content, and design. Teacher responses are also evaluated based on material and presentation aspects.

This e-module is designed based on the Independent Learning Curriculum and various sources of chemistry books, with a focus on electronic formats that comply with PBL syntax. The material is arranged concisely and clearly to improve student independence, critical thinking skills, and understanding of chemical concepts in everyday life.

This module has the advantage of presenting problem-based learning in each topic. Validation shows that this module meets the standards in terms of presentation, language, content, design, and materials, so that it can be an effective independent learning resource. This module is expected to increase student interest, motivation, and learning outcomes, as well as support teachers in providing innovative learning products. Here is the link and QR code (quick response code) of the developed module:



link: <https://heyzine.com/flip-book/ce007fabab.html>

The data collection techniques used in this study are:

1. Conducting interviews to collect initial data related to the problems that occur
2. Testing the feasibility of the developed module using expert assessments that prove that the resulting module is valid and suitable for use

3. Providing questionnaires to teachers to find out responses as to whether the developed module is appropriate and suitable for use

The data obtained in this study are quantitative data in the form of answer scores from the assessment questionnaire by the validator on the developed module.

Qualitative data in the form of responses and suggestions obtained from the validator on the developed module.

After the validity sheet is filled in by the validator, a score is obtained which can be analyzed using a Likert scale.

Answer Criteria	Score
S = Setuju	4
CS = Cukup Setuju	3
KS = Kurang Setuju	2
TS = Tidak Setuju	1

Then to obtain the score, the formula used is:

$$\text{Nilai} = \frac{\text{Jumlah skor yang diperoleh}}{\text{Jumlah total skor}} \times 100\%$$

Then the value obtained through the calculation is adjusted according to the percentage score criteria.

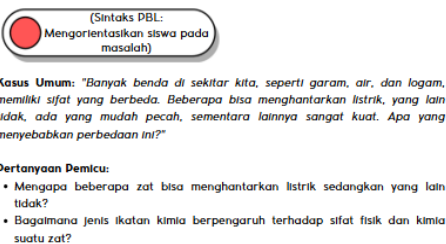
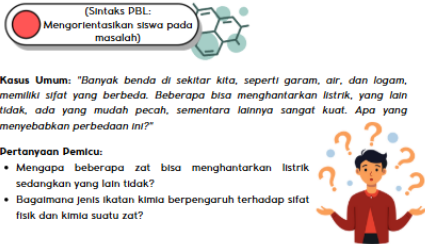
Percentage (%)	Information
81% – 100%	Very Valid
61% – 80%	Valid
41% – 60%	Quite Valid
21% – 40%	Less Valid
0% – 20%	Invalid

Validation of the Problem Based Learning (PBL)-based e-module on the Chemical Bonding material was carried out by expert validators and teachers. The instruments used were, for lecturers, a validation sheet was given which included an assessment of the presentation, language, content and design aspects, while the assessment criteria for teacher responses were the material and presentation aspects.

The results of the e-module validation included an evaluation of the e-module that had been developed and suggestions or opinions given by expert validators. Some of the inputs obtained from this validation included:

1. Adding several elements such as images related to the material so that the page sheets were not too empty;
2. Replacing the electron configuration that was pasted with an image to be typed manually;
3. Deleting inappropriate images and replacing them;
4. Slight revisions related to the material.

The researcher then used these suggestions and inputs to make improvements and improve the quality of the Problem Based Learning (PBL)-based e-module on the chemical bonding material that was being developed.

No	Improvement Suggestions
1.	Add some elements such as images related to the material so that the page is not too empty.  Before revision  After revision  Before revision  After revision
2.	Replacing the electron configuration pasted with an image with a manually typed one Contoh: $_{11}\text{Na} : [\text{Ne}] 3s^1 \rightarrow \text{elektron valensi} = 1, \text{berarti melepas } 1 \text{ elektron} \Rightarrow \text{Na}^+$ $_{13}\text{Al} : [\text{Ne}] 3s^2 3p^1 \rightarrow \text{elektron valensi} = 3, \text{berarti melepas } 3 \text{ elektron} \Rightarrow \text{Al}^{3+}$ 3. Dengan menerima elektron (ion $-$) jika elektron valensi berkisar antara 5-7 Contoh: $_{8}\text{O} : [\text{He}] 2s^2 2p^4 \rightarrow \text{elektron valensi} = 6, \text{berarti menerima } 2 \text{ elektron} \Rightarrow \text{O}^{2-}$ $_{9}\text{F} : [\text{He}] 2s^2 2p^5 \rightarrow \text{elektron valensi} = 7, \text{berarti menerima } 1 \text{ elektron} \Rightarrow \text{F}^-$ 4. Dengan memakai elektron bersama dengan unsur lain yang berikatan dengannya Contoh: NaCl $_{11}\text{Na} : [\text{Ne}] 3s^1 \rightarrow \text{elektron valensi} = 1, \text{berarti melepas } 1 \text{ elektron} \Rightarrow \text{Na}^+$ $_{17}\text{Cl} : [\text{Ne}] 2s^2 2p^6 3s^2 3p^5 \rightarrow \text{elektron valensi} = 7, \text{berarti menerima } 1 \text{ elektron} \Rightarrow \text{Cl}^-$ Before revision

	Contoh: $_{11}\text{Na} : [\text{Ne}] 3s^1 \rightarrow \text{elektron valensi} = 1, \text{berarti melepas 1 elektron} \rightarrow \text{Na}^+$ $_{13}\text{Al} : [\text{Ne}] 3s^2 3p^1 \rightarrow \text{elektron valensi} = 3, \text{berarti melepas 3 elektron} \rightarrow \text{Al}^{3+}$ 2. Dengan menerima elektron (ion -) jika elektron valensi berkisar antara 5-7 Contoh: $_{8}\text{O} : [\text{He}] 2s^2 2p^4 \rightarrow \text{elektron valensi} = 6, \text{berarti menerima 2 elektron} \rightarrow \text{O}^{2-}$ $_{9}\text{F} : [\text{He}] 2s^2 2p^5 \rightarrow \text{elektron valensi} = 7, \text{berarti menerima 1 elektron} \rightarrow \text{F}^-$ 3. Dengan memakai elektron bersama dengan unsur lain yang berikatan dengannya Contoh: NaCl $_{17}\text{Cl} : [\text{Ne}] 3s^2 3p^5 \rightarrow \text{elektron valensi} = 7, \text{berarti menerima 1 elektron} \rightarrow \text{Cl}^-$ After revision
3.	Remove inappropriate images and replace them digambarkan dengan garis. (Perhatikan Gambar 3.3) $\text{H}^\circ + {}^x\text{H} \rightarrow \text{H}_x^\circ\text{H} \rightarrow \text{H} - \text{H}$ Before revision After revision
4.	Revisions related to material Molekul Nonpolar $\delta^- \delta^+$ Pada molekul nonpolar elektron-elektron tersebar secara merata sehingga tidak terjadi pergeseran kerapatan elektron. Contohnya adalah Cl_2 Gambar 3.13 Cl₂, Contoh dari Molekul Nonpolar Before revision After Revision

The validation results from lecturers and teachers as expert validators show the evaluation of the e-module based on Problem Based Learning (PBL) on chemical bonding material. Each aspect of the evaluation is analyzed and the average is calculated to produce a final value as an indicator of module suitability.

The following table shows the results of the lecturer validation assessment.

No.	Assessment Components	Assessment Score	Percentage Criteria	Eligibility Criteria
1.	Presentation	11	91,66%	Very Valid
2.	Language	19	95%	Very Valid
3.	Contents	15	93.75%	Very Valid
4.	e-Module Design	22	91,66%	Very Valid

The following table shows the results of the validation assessment by the teacher.

No.	Assessment Components	Assessment Score	Percentage Criteria	Eligibility Criteria
1.	Material	19	95%	Very Valid
2.	Presentation	15	93.75%	Very Valid

Based on the data from both tables, it can be concluded that expert validators, both lecturers and teachers, gave a positive assessment of the developed e-module. The e-module based on Problem Based Learning (PBL) on the chemical bonding material is categorized as "Very Valid" and is suitable for use as teaching materials in schools. The positive evaluation results from lecturers and teachers indicate that the e-module meets the expected criteria.

▪ CONCLUSION

Based on the research results obtained: (1) The development of the learning module begins with an initial analysis stage that includes learning achievements, student needs, and teaching materials. The next stage is the design, namely the preparation of the module draft, followed by the development stage involving validation by chemistry lecturers at Medan State University and chemistry teachers at Medan State High School 21. (2) From the results of the data analysis related to the developed learning module, it has a very good level of validity with percentage scores: 91.66% and 93.75% for the presentation aspect, 95% for the language aspect, 93.75% for the content aspect, 91.66% for the e-module design aspect, and 95% for the material aspect. (3) This electronic-based learning module is declared very valid and suitable for use as teaching materials in chemistry learning on the material of chemical bonds.

▪ REFERENCES

- Alwi, E., Harahap, M., Fernandez, D., & Milana. (2022). Pengembangan Modul Pembelajaran Mata Pelajaran Pemeliharaan Mesin Kendaraan Ringan Kelas XI TKR SMK Negeri Padang Sidempuan. *Jurnal Ensiklopedia Education Review*, 4(3),231-236.
- Anggraini, F. (2018). Pengembangan Modul Kewirausahaan untuk Meningkatkan Pemahaman Konsep dan Hasil Belajar Siswa SMK. *Journal Of Education and Couseling*, 1(1),33-38.
- Asmandhani, S. (2023). Penerapan Model Pembelajaran PBL Untuk Meningkatkan Hasil Belajar Pada Materi Ikatan Kimia. *Jurnal Pendidikan dan Profesi Keguruan*, 3(1),1- 8.

- Auliza, O., K. R. A., & Kurniati, T. (2019). Pengaruh Penggunaan Modul Terhadap Kemampuan Multipel Representasi Siswa Pada Materi Kelarutan Dan Hasil Kali Kelarutan (Ksp) Kelas XI IPA SMA Adisucipto Sungai Raya. *Ar-Razi Jurnal Ilmiah*, 7(1),73-81.
- Hikmah, N., Kuswidyanarko, A., & Lubis, P. H. (2022). Pengembangan Media Pop-Up Book Pada Materi Siklus Air di Kelas V SD Negeri 04 Puding Besar. *Jurnal Pendidikan Guru Sekolah Dasar*, 15(2),137-148.
- Hulu, S, J, R., & Simorangkir, M. (2022). Pengaruh Penggunaan Modul Dalam Pembelajaran Kimia Berbasis Proyek Terhadap Hasil Belajar Siswa Kelas XI Semester 1 Pada Materi Termokimia. *Educenter: Jurnal Ilmiah Pendidikan*, 1(3), 143-151.
- Imanda, R., Khaldun, I., & Azhar. (2017). Pengembangan Modul Pembelajaran Kimia SMA Kelas XI Pada Materi Konsep Dan Reaksi-Reaksi Dalam Larutan Asam Basa . *Jurnal Pendidikan Sains Indonesia*, 5(2),41-48.
- Mufida, L., Subandowo, M., & Gunawan, W. (2022). Pengembangan E-Modul Kimia Pada Materi Struktur Atom Untuk Meningkatkan Hasil Belajar. *JUPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika)*, 7(1), 138 – 146.
- Norhalidah, Wardhani, R. R., & Yuridka, F. (2019). Pengaruh Media Flipbook Kimia Terhadap Hasil Belajar Siswa Pada Materi Koloid. *Dalton : Jurnal Pendidikan Kimia dan Ilmu Kimia*, 2(2),22-25.
- Okpatrioka. (2023). Research And Development (R&D) Penelitian Yang Inovatif Dalam Pendidikan. *DHARMA ACARIYA NUSANTARA : Jurnal Pendidikan, Bahasa dan Budaya*, 1(1),86-100.
- Purnomo, A., Kanusta, M., Fitriyah, Guntur, M., Siregar, R. A., Ritonga, S., et al. (2022). Pengantar Model Pembelajaran. Lombok Tengah: Yayasan Hamjah Diha.
- Putra, A. D., Yulianti, D., & Fitriawan, H. (2023). Pengembangan Bahan Ajar Berbasis Flipbook Digital untuk Meningkatkan Efektivitas Pembelajaran pada Siswa Sekolah Dasar. *JIIP (Jurnal Ilmiah Ilmu Pendidikan)*, 6(4),2173-2177.
- Rachmatia, E., Aunurrahman, & Usman, A. (2016). Pengembangan Modul Pembelajaran Kimia Untuk Kecakapan Membangun Dan Menggunakan Konsep Redoks Dan Hidrokarbon Kelas X SMAN 3 Sungai Kakap . *Jurnal Pembelajaran Prospektif*, 1(2),20-31.
- Rahantoknam, M., Saraha, A. R., & Umar, S. (2021). Pengaruh Model Pembelajaran Berbasis Masalah (Problem Based Learning) Terhadap Hasil Belajar Siswa Kelas X SMA Negeri 2 Pulau Morotai Pada Materi Ikatan Kimia. *Jurnal Pendidikan Kimia Unkhair (JPKU)*, 1(1),46-55.
- Samosir, Y. M., & Nainggolan, B. (2022). Pengaruh Penerapan E-Modul Kimia Berbasis Cooperative Learning Type NHT Pada Pembelajaran Ikatan Kimia Kelas X SMA. *Jurnal Ilmiah Pendidikan*, 1(3),165-173.
- Sari, I. R., Tewa, Y., & Marhadi, M. A. (2023). Meningkatkan Hasil Belajar Siswa Pada Materi Ikatan Kimia Dengan Model Pembelajaran Berbasis Masalah. *Jurnal Pendidikan Kimia*, 8(1),14-23.

- Septora, R. (2017). Pengembangan Modul Dengan Menggunakan Pendekatan Saintifik Pada Kelas X Sekolah Menengah Atas. *Jurnal Lentera Pendidikan Pusat Penelitian LPPM UM Metro*, 2(1),86-98.
- Syarifah, S. K., Windiyani, T., & Suchyadi, Y. (2023). Pengembangan E-Modul Menggunakan Flipbook Pada Kelas V Subtema 3 Usaha Pelestarian Lingkungan. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang*, 9(2), 2611–2619.
- Widyasari, I., Zetriuslita, Istikomah, E., & Herlina, S. (2021). Pengembangan Media Pembelajaran Berbasis Flipbook Pada Materi Sistem Persamaan Linear Dua Variabel Dikelas VIII SMP. *Jurnal Derivat*, 8(1),61-71.
- Winaryati, E., Munsarif, M., Mardiana, & Suwahono. (2021). *Cercular Model of RD & D (Model RD & D Pendidikan dan Sosial)*. Semarang: Penerbit KBM Indonesia.
- Yusuf, Y. (2018). *Kimia Dasar Panduan Untuk Belajar*. Jakarta: EduCenter Indonesia.