JPPIPA 10(9) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of Project Based Learning E-Module on Salt Hydrolysis Material to Improve Student Learning Outcomes

Nopita[1], Raudhatul Fadhilah[1*],Tuti Kurniati[1], Hamdil Mukhlishin[1]

[1] Chemistry Education, Faculty of Teacher Training of Education, Universitas Muhammadiyah Ponianak, Pontianak, Indonesia.

Received: June 01, 2024
Revised: July 25, 2024
Accepted: September 25, 2024
Published: September 30, 2024

Corresponding Author:
Raudhatul Fadhilah
raudhatul.fadhilah@unmuhpnk.ac.id

DOI: 10.29303/jppipa.v10i9.8399

Abstract: The conventional printed modules used in schools have not been able to make students active and understand chemical concepts. Therefore, it is necessary to develop an interactive multimedia-based e-module grounded in Project Based Learning (PjBL), equipped with videos, images, and interactions to engage students and facilitate easier comprehension of chemical materials. The iam of this study is to improve the learning outcomes of class XI Science Muhammadiyah 1 High School Pontianak. The method used in this research is development (research and development) employing the ADDIE model, which includes the stages of (analysis, design, development, implementation, and evaluation). The research findings indicate very high criteria with an average validity coefficient of 0.93 for each aspect of media, materials, and language. The practicality analysis, based on the response questionnaires from the small group trial and the main field trial, showed practicality values of 71% and 74%, respectively, both with practical criteria. It can be concluded that the project based learning e-module developed is feasible to be used as an effective and practical learning tool for XI Science students and chemistry teachers in high schools.

Keywords: Development; E-module learning; Project based learning

Introduction

Education is one of the most important factors in supporting human life. It is also one of the basic needs that determines a person's life goals to become a good and noble individual. Good education quality is determined by the learning process that occurs effectively between teachers and students in the classroom as a means of knowledge transformation (Abdullah et al., 2021). In response to the demands of the 21st century, teachers are expected to meet the challenges of globalization and technological advancement. One initiative that can be undertaken is to study and acquire various 21st-century skills: life skills, vocational skills, innovation skills, and media information and technology skills.

Chemistry is a subject studied in high school, and one of the topics in chemistry is Salt Hydrolysis. Salt Hydrolysis is a topic covered in the even semester. The study of salt hydrolysis requires the ability to simultaneously represent and interpret chemical problems in macroscopic, submicroscopic, and symbolic representations. The research results from Astuti, (2023) show that students' difficulties in the salt hydrolysis material are very low, specifically in determining the salt hydrolysis reaction equation, with a percentage of 32.89%. The learning difficulties categorized as very low include determining the characteristics of salts hydrolyzed in water, with a percentage of 17.76%.

This research is in line with the study by Ristiyani et al. (2019) which found that salt hydrolysis material is difficult and less popular among students. This is because students face difficulties in learning abstract or complex content. Salt Hydrolysis is a topic studied in the Chemistry subject for Grade XI SMA/MA. This material is considered difficult due to its abstract nature and the complexity of its scope. Salt hydrolysis is a continuation of the acid-base material and describes the reaction

How to Cite:
Nopita, Fadhilah, R., Kurniati, T., & Mukhlishin, H. (2024). Development of Project Based Learning E-Module on Salt Hydrolysis Material to Improve Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 613–620. https://doi.org/10.29303/jppipa.v10i9.8399

between acids and bases that results in the product of water.

The factors causing students' learning difficulties in salt hydrolysis material, based on the research by Pepteti et al. (2022), are internal factors such as a lack of interest in the salt hydrolysis material, a lack of talent, and a lack of motivation to learn the salt hydrolysis material, as well as poor study habits. External factors include the teaching style of the teacher, which is too fast and unclear, only using lecture methods, making the learning process monotonous and boring, and the teacher not using engaging learning media. These factors contribute to the low learning outcomes of students.

The high rate of students not achieving mastery in the salt hydrolysis material is partly due to the use of printed modules. According to Zahro et al. (2024) Education that is still based on traditional models such as printed modules often complicates students in understanding their contents. An analysis of students' misconceptions about salt hydrolysis reveals that misconceptions often stem from incomplete or inaccurate understanding, associative thinking, and inaccurate intuition. The use of printed modules without the support of appropriate teaching methods can worsen the situation, as students do not receive adequate explanations of basic concepts. Therefore, to address this problem, the use of e-modules or interactive multimedia-based modules can be a solution. E-modules equipped with animations and interactions allow students to understand the material more deeply and engagingly, thereby improving learning outcomes. According to Yanindah et al. (2021). Electronic modules are one example of the many learning media that provide educational materials for educators (Paul Telussa & Tamaela, 2023).

E-Module is an independent instructional material designed in a structured manner to achieve specific goals in electronic form that delivers animations, audio, video, navigation, to facilitate user access (Lestari & Ilhami, 2022). Suggest that modules have various benefits and unique characteristics (Eresti et al., 2021). The benefit of e-modules is to create a creative, interactive, and innovative learning atmosphere so that they can be used in places with sufficient distance (Kartikasari et al., 2023; Amril & Thahar, 2022). According to Asmi et al. (2018), an module is an example of technological advancement that can enhance the quality of the learning process. Research Sari et al. (2024) shows that the electronic modules they developed effectively improve learning outcomes and strengthen student character. According to Manzil et al. (2022), Interactivity is one of the keys to improving multimedia learning effectiveness. Less interactive e-modules tend to reduce student engagement and optimal learning outcomes (Indriana & Kamaludin, 2023). Overcoming these difficulties requires a more structured and interactive learning approach, including the use of student-centered learning models.

Project based learning (PjBL) is one approach that emphasizes the production of final products resulting from the learning activities taught (Pratama et al., 2023). The importance of PjBL in education lies in several aspects: Applying theory into practice, where the development of Project-based Learning (PjBL) allows students to apply learned theories into concrete projects (Yustina et al., 2020). Enhancing practical skills so that students can develop practical skills required in the field, such as problem-solving, teamwork collaboration, communication, and project management skills (Halim et al., 2023). Fostering creativity through projects, giving students the freedom to find creative solutions to specific problems, thereby enhancing their creativity (Setyani et al., 2024). Projects presented in the form of learning aids students in achieving various learning outcomes, including researching, evaluating, interpreting, synthesizing, and drawing conclusions (Sari et al., 2024), By participating in project implementation activities, students develop high-level thinking skills to reflect on and generate creative ideas when planning, executing, analyzing, and evaluating projects (Ilafi et al., 2024).

Project Based Learning (PjBL), as described by Sari et al. (2023), is highly effective in enhancing children's developmental skills. This is evident from the significantly different standard performance levels between the experimental and control classes (p-value $0.01 < 0.05$). Other findings from this research indicate that the project-based learning (PjBL) model plays a significant role in stimulating children and promoting their development. The average score was 83 points for the experimental class and 75 points for the control class. According to Lestari et al. (2022), the use of PjBL models has a significant impact on students' collaboration abilities and creative (Haryati et al., 2024), Regarding creative thinking abilities, PjBL provides opportunities for students to think critically and innovatively to solve problems and develop new products. The project-based development model is expected to enhance student engagement in creative thinking and improve student learning outcomes compared to conventional models (Baran et al., 2019; Sari et al., 2024).

The development of e-modules based on Project-Based Learning (PjBL) is crucial because it promotes relevant and conceptual learning (Masaguni et al., 2023). PjBL enables students to become independent and active learners, requiring them to manage their time and complete projects independently or in groups (Haatainen & Aksela, 2021). This research can enhance learning outcomes as students engaged in PjBL tend to have a deeper understanding and better skills (Razak & Hamsa, 2022; Prasetya, 2021). The PjBL-based e-modules are designed to meet students' needs, allowing for more effective learning (Guo et al., 2020). Therefore, this

research not only contributes to improving the quality of education but also introduces innovation by integrating technology and pedagogy to enhance effective and engaging learning. As part of this research, PjBL-based e-modules have been developed to improve student learning outcomes.

Method

Place, Time and Type of Research

The methodology used in this study is research and development (R&D) methodology utilizing the ADDIE (analysis, design, development, implementation and evaluation) development model. This study was conducted in the 11th grade Science class at Muhammadiyah 1 High School Pontianak in the 2024/2025 academic year. The school is located on Jalan Parit Haji Husein 2, Pontianak Tenggara District, Pontianak City, West Kalimantan. The ADDIE development model was adopted for the development of this research. This model consists of five steps: analysis, design, development, implementation, and evaluation. The ADDIE model was developed by Dick and Carey for instructional system design. The small group trial experiment was conducted with 8 students from class 11 Science 2 at Muhammadiyah 1 High School Pontianak. The main field experiment was carried out with 30 students from class 11 Science 1 by having them fill out a questionnaire regarding their responses to the PjBL-based Chemistry E-module. This research was conducted in April-May 2024 in class 11 Science at SMA Muhammadiyah 1 Pontianak. The data collection method is the most crucial step in research because the main goal of the research is to obtain valid data. The data used include: Interviews with chemistry teachers and students, Validation aimed at collecting data and assessments from validators, Validation instruments, and Questionnaires.

Data Analysis Technique

Table 1. Validity Score Table

Relevancy description	Category	score
Very irrelevant		1
Irrelevant	Relevance weak	2
Relevant		3
Very relevant	Relevance strong	4

Table 2. Validity Criteria

Score	Criteria
0.80-1.00	Very high
0.60-0.79	High
0.40-0.59	Medium
0.20-0.39	Low
0.00-0.19	Very low

Validation Analysis of the learning e-module obtained from the validator analysis results. E-module is considered valid if it obtains a score of 0.80-1.00 with very high criteria. The validity score can be seen in Table 1, while the validity criteria are shown in Table 2.

The practicality analysis of e-modules was obtained from the analysis of student questionnaire responses. An e-learning module is considered practical if the response score meets the criterion of achieving more than 60%. The questionnaire scores can be seen in Table 3, while the practicality criteria percentage from the questionnaire are shown in Table 4.

Table 3. Table of Questionnaire Scores

Answer choices	Positive statement	Negative statement
Strongly agree	4	1
Agree	3	2
Disagree	2	3
Strongly disagree	1	4

Table 4. Criteria Percentage Questionnaire

Percentage	Criteria
0% - 20%	Not practical
21% - 40%	Less practical
41% - 60%	Quite practical
61% - 80%	Practical
81% - 100%	Very practical

Based on these criteria, a learning e-module is considered practical if it achieves a response rate percentage greater than 61% to 80%.

Result and Discussion

Development of E-Module Learning Media

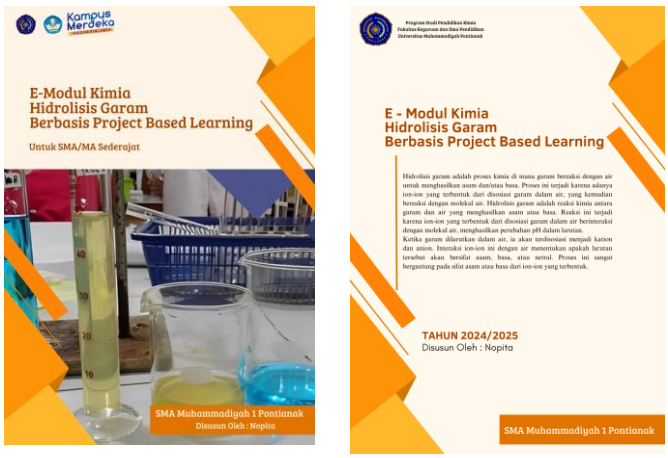
Analysis

The analysis stage is a process of defining what students will learn as a result of the obtained analysis. (a) Problem analysis is the initial stage to identify existing issues and seek solutions. Problem analysis was conducted through interviews with chemistry teachers at Muhammadiyah 1 High School Pontianak. Teachers stated that the difficulties experienced in the topic of salt hydrolysis include determining strong acids and bases, and calculating the pH of salt solutions. These difficulties impact the learning outcomes of students. High student incompleteness is caused by previous salt hydrolysis material learning using print and electronic modules, which are not yet fully understood by students, as evidenced by daily and semester exam scores. Therefore, to overcome the shortcomings of teaching materials used by teachers, developing electronic-based learning media in the form of modules is necessary. (b) Student characteristics analysis at Muhammadiyah 1 High School Pontianak is based on cognitive abilities towards learning. Many students still have low grades in learning salt hydrolysis. (c) The

product developed in this research is an e-module based on PjBL for salt hydrolysis material. To understand salt hydrolysis material, students need to study the material, one of which is through the use of teaching materials.

Design

The research design phase involves creating a PjBL-based E-module product design using Canva and Flip PDF Corporate. The designed e-module is A4-sized with 34 pages in thickness. The font type used in typing the PjBL-based chemistry e-module consists of Times New Roman size 12.



(a) (b)

Figure 1. Front cover (a) and back cover (b) of the chemistry pocket book

The software programs used to create electronic modules are Canva and Flip PDF Corporate. These applications were chosen for their user-friendly interfaces, particularly suited for beginners, along with their strong compatibility and diverse features (Mishra & Alzoubi, 2023). Canva allows for the creation of various attractive designs that can be saved in JPG and PDF formats, making it highly popular among beginners (Hasibuan et al., 2023). On the other hand, Flip PDF Corporate manipulates PDF files, transforming them into electronic modules styled as flipbooks resembling page-turning images in books (Kumar et al., 2023). Its features include page modules, images, videos, interactive tests, and links, enabling the integration of various module formats for distribution purposes (Susanti & Sholihah, 2021).

Development

Development stages are stages that involve activities to realize the product design that has been prepared in the design stage (Pereira et al., 2024). The instruments needed in this stage, such as student response questionnaires. At this stage, the product is created based on the subsequent design, namely validation, and developed according to input and suggestions from 3 validators (media experts, content experts, and language experts) before implementation in schools.

Implementation

Small Group Trial

The small group trial is a phase conducted to determine whether the PjBL based chemistry e-module developed is suitable for classroom use. The small group trial involved 8 students from class XI Science Muhammadiyah 1 High School Pontianak.

Primary field trial

The main field trial is conducted to measure how well a product achieves its objectives and targets. This field trial was conducted to obtain the final results of the PjBL based Chemistry e-module. The main field trial involved 30 students from class XI Science 1 who were asked to fill out a questionnaire regarding their reactions to the media in the PjBL based Chemistry e-module.

Evaluation

At the evaluation stage, student survey responses are assessed to evaluate the practical suitability of the E-module. The outcomes of this stage are used to analyze whether the newly developed teaching materials are suitable for use as additional teaching materials in the teacher and student learning process.

Feasibility Analysis

Feasibility analysis is conducted on the chemistry e-module and its development outcomes. This is stated by (Awuy et al., 2023). The learning tool tested must undergo a validation stage conducted by various experts, including media experts, subject matter experts, and language experts. This is to determine the effectiveness of the developed tool before it is finally implemented.

Validation Test Results

Validation results of the e-module by nine validators, including three media experts, three content experts, and three language experts, averaged 0.93, which is considered very high. According to research by Gusman et al. (2022), Validation data analysis of the e-module shows a very high validity category with an average V Aikens of 0.92, indicating that the chemical-based salt hydrolysis e-module is valid and complies with the composition specified by the Ministry of Education. The validation results of the project-based learning e-module on salt hydrolysis material are presented in Table 5.

Based on the validation results shown in Table 5, the material coverage aspect with a High category obtained a score of 0.94 with V Aikens. The accuracy of the material with a High category with V Aikens obtained a score of 0.93. Presentation technique with a High category with V Aikens obtained a score of 1.00.

Completeness of presentation with a High category with V Aikens obtained a score of 0.94, and supporting presentation with a High category with V Aikens obtained a score of 0.94, indicating that the e-module material is appropriate. The e-module outlines core competencies, indicators, competency achievements, learning objectives achieved. The materials and questions taught help students discover and understand concepts.

Table 5. Results of E-Module Validity Analysis

Aspect Assessed	V Aikens	Category of Validity
Scope of material	0.94	Very high
Material accuracy	0.93	Very high
Presentation technique	1.00	Very high
Completeness of presentation	0.94	Very high
Supportive presentation	1.00	Very high
Conciseness	0.88	Very high
Communicative	0.93	Very high
Adherence to language norms	0.88	Very high
Characteristics of e-module	0.94	Very high
Quality of e-module design	0.94	Very high
Average	0.93	Very high

The language validation results in the project-based learning chemistry e-module as shown in Table 5 demonstrate clarity with a high category score of V Aikens 0.88, high communicativeness with V Aikens 0.93, and high language rule conformity with V Aikens obtaining a score of 0.88, indicating that the language in the project-based learning chemistry e-module is appropriate and suitable for use.

The validation results of the characteristic aspects and design quality of the Chemistry E-module project on salt hydrolysis material yielded a score of 0.94, categorizing it as 'highly valid'. This aligns well with the e-module's characteristics and is deemed suitable for use.

Practicability Analysis

Students' Response Questionnaire Results

The students' responses to the Chemistry E-module based on PjBL were obtained before and after verification by media experts. According to Raisa et al. (2018), the questionnaire containing student responses can be used as a reference to improve e-learning modules for optimal and effective use (Muliasari & Efendi, 2024). In this study, teachers used PjBL to enhance students' creativity by developing customized assessments to evaluate and improve students' ability to master the learning materials provided through projects using digital technology and enhanced learning (Ghimire & Charters, 2022; Eliaumra et al., 2024).

The results of the study by Esaputri et al. (2023), on the initial field trial obtained after distributing student response questionnaires showed a percentage of 89.40%, categorized as highly practical. This shows that students responded well to the use of the hydrolysis salt E-module based on the 8E learning cycle, and the developed E-module was deemed suitable for the learning process. Validity testing by media experts and subject matter experts based on the research by Esaputri et al. (2023) yielded a result of 88.8% (highly valid). Practicality testing by students obtained a result of 89.40% (highly practical).

Based on the research findings of (Artika & Bayharti, 2021), the content validity test resulted in an average Aiken's V value of 0.93. Construct validity and media expert validity tests showed Aiken's V values of 0.86 and 0.98, respectively. Individual evaluations found the e-module to be engaging, with clear text and easily understandable language. Data analysis from small group testing yielded an average percentage of 89.94%, and field testing resulted in 91.52%. Based on the data obtained, the Discoberry Salt Hydrolysis Learning Module for Grade 11 is valid, practical, and worthy of testing its effectiveness.

The research findings from Diana et al. (2021) indicate that a simple electronic module for learning Indonesian language serves as a crucial learning resource for students to facilitate self-learning or with teachers. 77.94% of students prefer using electronic modules as a learning resource because they are considered easier to grasp. E-modules provide simple and comprehensive content with lessons and instructions, aimed at summarizing and evaluating the material. The development of modules in this study aims to provide a solution for students experiencing difficulties with certain learning models and approaches. Therefore, an E-module designed in this research focuses on higher-level skills

The research results indicate that the validity aspects of media, content, and language show validity coefficient values averaging 0.93, indicating very high criteria. The practicality aspect obtained a 71% questionnaire response rate from small-group trials, meeting practical criteria, and a 74% rate from major field trials, also meeting practical criteria. The PjBL-based e-module on salt hydrolysis demonstrates very high validity and good practicality, consistent with previous findings that also show high effectiveness and practicality of various e-module approaches. This indicates that PjBL-based e-modules are effective and practical learning tools for salt hydrolysis material.

Conclusion

The Chemistry E-module based on PjBL developed in this research meets the criteria of relevance and practicality, making it suitable for use as a learning medium. The research findings indicate very high criteria with an average validity coefficient of 0.93 for

each aspect of media, materials, and language. The practicality analysis, based on the response questionnaires from the small group trial and the main field trial, showed practicality values of 71% and 74%, respectively, both with practical criteria. It can be concluded that the project based learning e-module developed is feasible to be used as an effective and practical learning tool for XI Science students and chemistry teachers in high schools.

Acknowledgments
We extend our thanks to the Principal of Muhammadiyah 1 High School Pontianak, the chemistry teachers of Muhammadiyah 1 High School Pontianak, and the students of class XI Science Muhammadiyah 1 High School Pontianak. May this research be beneficial.

Author Contributions
Conceptualization, N, RF, TK; Methodology, N, TK, RF; Software, N, RF, TK, HM; Validation, N, TK, RF, HM; Research, N; Data Analysis, N, RF, HM.

Funding
This research did not receive external funding.

Conflicts of Interest
The author declares no conflict of interest.

References

Abdullah, A., Danial, M., & Anwar, M. (2021). Pengembangan E-Modul Asam Basa Berbasis Problem Based Learning melalui Google Classroom pada Sekolah Menengah Kejuruan (SMK). *Chemistry Education Review (CER)*, *5*(1), 87. https://doi.org/10.26858/cer.v5i1.13315

Amril, K. J., & Thahar, H. E. (2022). Pengembangan Modul Elektronik Menulis Teks Cerpen Berbasis Project Based Learning bagi Siswa Kelas XI SMA. *Diglosia: Jurnal Kajian Bahasa, Sastra, Dan Pengajarannya*, *5*(3), 715–730. https://doi.org/10.30872/diglosia.v5i3.489

Asmi, A. R., Dhita Surbakti, A. N., & C., H. (2018). E-Module Development Based Flip Book Maker for Character Building in Pancasila Coursework Sriwijaya University. *Jurnal Pendidikan Ilmu Sosial*, *27*(1), 1. https://doi.org/10.17509/jpis.v27i1.9395

Astuti, R. T. (2023). Profil Kesulitan Belajar Peserta Didik dalam Memahami Materi Hidrolisis Garam. *Orbital: Jurnal Pendidikan Kimia*, *7*(2), 250–261. https://doi.org/10.19109/ojpk.v7i2.20245

Awuy, V. F., Sulangi, V. R., & Tumalun, N. K. (2023). Pengembangan Perangkat Pembelajaran Materi Relasi dan Fungsi Menggunakan Model Kooperatif Tipe Think Pair Share. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(3), 2222–2233. https://doi.org/10.31004/cendekia.v7i3.2431

Baran, M., Maskan, A., & Yasar, S. (2019). Learning physics through project-based learning game techniques. *International Journal of Instruction*, *11*(2), 221–234. https://doi.org/10.12973/iji.2018.11215a

Diana, N., Yohannes, & Sukma, Y. (2021). The effectiveness of implementing project-based learning (PjBL) model in STEM education: A literature review. *Journal of Physics: Conference Series*, *1882*(1). https://doi.org/10.1088/1742-6596/1882/1/012146

Eliaumra, E., Samaela, D. P., Gala, I. N., & Rurua, S. F. (2024). Development of Digital Literacy-Based Project Based Learning Assessment Models to Improve High School Students' Creative Thinking Abilities. *Jurnal Penelitian Pendidikan IPA*, *10*(2), 572–582. https://doi.org/10.29303/jppipa.v10i2.6211

Eresti, A., Kasmantoni, K., & Latipah, N. (2021). Pengembangan E-Modul Ipa Terpadu Berbasis Project Based Learning Materistruktur Dan Fungsi Jaringan Tumbuhan Kelas Vlll Smp. *Jurnal Pengabdian Masyarakat Ilmu Terapan (JPMIT)*, *3*(1), 111. http://dx.doi.org/10.33772/jpmit.v3i1.18974

Esaputri, A., & Okmarisa, H. (2023). Desain dan uji coba e-modul berbasis learning cycle 8e pada materi hidrolisis garam. *Jurnal Pendidikan Kimia*, *8*(1), 25–32. http://dx.doi.org/10.33578/jpk-unri.v8i1.7831

Ghimire, D., & Charters, S. (2022). The Impact of Agile Development Practices on Project Outcomes. *MDPI*, *1*(3), 265–275. https://doi.org/10.3390/software1030012

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, *102*(May), 101586. https://doi.org/10.1016/j.ijer.2020.101586

Gusman, F., Dewata, I., Andromeda, A., & Zainul, R. (2022). Development of Problem Based Learning Based E-Modules on Salt Hydrolysis Materials to Improve Students Science Literature. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2410–2416. https://doi.org/10.29303/jppipa.v8i5.1831

Haatainen, O., & Aksela, M. (2021). Project-based learning in integrated science education: Active teachers' perceptions and practices. *LUMAT: International Journal on Math, Science and Technology Education*, *9*(1), 149–173. https://doi.org/10.31129/LUMAT.9.1.1392

Halim, N., Boys, M., Fahmi, F., & Nitin, M. (2023). The Implementation of Project-Based Learning in Indonesian EFL Class Between 2017 to 2022: A Systematic Review. *Lingeduca: Journal of Language and Education Studies*, *2*(2), 95–111. https://doi.org/10.55849/lingeduca.v2i2.96

Haryati, T., Rusdi, M., Asyhar, R., Hasibuan, M. H. E., & Zainul, R. (2024). Effect of Scaffolding Provision an Acid and Base Learning Project on Students'

Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(2), 905–914. https://doi.org/10.29303/jppipa.v10i2.4673

Hasibuan, M. P., Sari, R. P., & Nasution, H. (2023). Development of Students' Worksheet Based on Inquiry Integrated STEM on Acid-Base Materials. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 99–103. https://doi.org/10.29303/jppipa.v9i1.2118

Ilafi, M. M., Suyanta, S., Wilujeng, I., & Nurohman, S. (2024). The Effect of Using e-Books with the STEM-PjBL Approach on Students' Learning Motivation and Creative Thinking Ability. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1396–1401. https://doi.org/10.29303/jppipa.v10i3.6546

Indriana, R. A., & Kamaludin, A. (2023). Development of Interactive Electronic Module for Charged Reaction Rate Science Technology Engineering and Mathematics (STEM). *Jurnal Penelitian Pendidikan IPA*, *9*(3), 977–986. https://doi.org/10.29303/jppipa.v9i3.1788

Kartikasari, M., Ismet, I., & Sriyanti, I. (2023). Development of an E-Module Based on the 5E Learning Cycle to Improve the Creative Thinking Abilities of Junior High School Students. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 121–129. https://doi.org/10.29303/jppipa.v9ispecialissue.6528

Kumar, A. P., Omprakash, A., Mani, P. K. C., Kuppusamy, M., Wael, D., Sathiyasekaran, B. W. C., Vijayaraghavan, P. V., & Ramasamy, P. (2023). E-learning and E-modules in medical education—A SOAR analysis using perception of undergraduate students. *PLoS ONE*, *18*(5 May), 1–14. https://doi.org/10.1371/journal.pone.0284882

Lestari, I., & Ilhami, A. (2022). Penerapan Model Project Based Learning Untuk Meningkatkan Keterampilan Berpikir Kreatif Siswa Smp: Systematic Review. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *12*(2), 135–144. https://doi.org/10.24929/lensa.v12i2.238

Manzil, E. F., Sukamti, S., & Thohir, M. A. (2022). Pengembangan E-Modul Interaktif Heyzine Flipbook Berbasis Scientific Materi Siklus Air Bagi Siswa Kelas V Sekolah Dasar. *Sekolah Dasar: Kajian Teori Dan Praktik Pendidikan*, *31*(2), 112. https://doi.org/10.17977/um009v31i22022p112

Masaguni, A. N., Lamangantjo, C. J., Katili, N., Pikoli, M., Buhungo, T. J., & Payu, C. S. (2023). Development of Science Learning Modules Based on Project Based Leraning on Additives and Addictive Substances (A Research in Class VIII SMP Negeri 7 Telaga Biru). *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10758–10767. https://doi.org/10.29303/jppipa.v9i12.5731

Mishra, A., & Alzoubi, Y. I. (2023). Structured software development versus agile software development: a comparative analysis. *International Journal of System Assurance Engineering and Management*, *14*(4), 1504–1522. https://doi.org/10.1007/s13198-023-01958-5

Muliasari, D., & Efendi, T. F. (2024). Implementation of Project-Based Learning Method to Enhance English Listening Skills of Computer Science Students at ITB AAS Indonesia. *International Journal of Computer and Information System (IJCIS)*, *05*(03), 192–195. Retrieved from https://ijcis.net/index.php/ijcis/index

Paul Telussa, R., & Tamaela, K. A. (2023). Science E-Module Based on Ethnoscience. *International Journal of Elementary Education*, *7*(4), 657–665. https://doi.org/10.23887/ijee.v7i4.70120

Pepteti, S., & Latisma DJ. (2022). Deskripsi Kesulitan Belajar Siswa Kelas XI MIPA SMAN 2 Solok Selatan Pada Materi Hidrolisis Garam. *Jurnal Pendidikan Mipa*, *12*(3), 402–409. https://doi.org/10.37630/jpm.v12i3.629

Pereira, E., Nsair, S., Pereira, L. R., & Grant, K. (2024). Constructive alignment in a graduate-level project management course: an innovative framework using large language models. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00457-2

Prasetya, A. (2021). Electronic Module Development with Project Based Learning in Web Programming Courses. *International Journal of Computer and Information System (IJCIS)*, *2*(3), 69–72. https://doi.org/10.29040/ijcis.v2i3.38

Pratama, D. H., Maryati, M., & Suyanta, S. (2023). The need analysis of PjBL Model Science e-book based indigenous knowledge on process of making ulos woven cloth. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10523–10530. https://doi.org/10.29303/jppipa.v9i12.5904

Razak, N. K., & Hamsa, A. (2022). Prototype Development of Pragmatic Teaching Materials Based on Blended Learning Students of Indonesian Language and Literature Study Program Muhammadiyah University Makassar. *International Journal of Science and Applied Science: Conference Series*, *6*(1), 127–135. https://doi.org/10.20961/ijsascs.v6i1.69948

Ristiyani, E., & Bahriah, E. S. (2019). Analisis Kesulitan Belajar Kimia Siswa Di Sman X Kota Tangerang Selatan. *Jurnal Penelitian Dan Pembelajaran IPA*, *2*(1), 18. https://doi.org/10.30870/jppi.v2i1.431

Sari, A. M., Suryana, D., Bentri, A., & Ridwan, R. (2023). Efektifitas Model Project Based Learning (PjBL) dalam Implementasi Kurikulum Merdeka di Taman Kanak-Kanak. *Jurnal Basicedu*, *7*(1), 432–440. https://doi.org/10.31004/basicedu.v7i1.4390

Sari, J. D. R., Ambiyar, A., Mukhaiyar, R., & Wulansari, R. E. (2024). Project-Based Module Development in the Electrical Circuit Course. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 1532–1538. https://doi.org/10.29303/jppipa.v10i4.7385

Setyani, U., Nugroho, I. R., Jumadi, J., Suyanta, S., & Wilujeng, I. (2024). Development of the PjBL Model Science E-Book to Improve Creative Thinking Skills of Middle School Students. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1032–1038. https://doi.org/10.29303/jppipa.v10i3.6303

Susanti, E. D., & Sholihah, U. (2021). Pengembangan E-Modul Berbasis Flip Pdf Corporate Pada Materi Luas Dan Volume Bola. *RANGE: Jurnal Pendidikan Matematika*, *3*(1), 37–46. https://doi.org/10.32938/jpm.v3i1.1275

Yanindah, A. T. C., & Ratu, N. (2021). Pengembangan E-Modul Sugar Berbasis Android. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 607–622. https://doi.org/10.31004/cendekia.v5i1.445

Yustina, Syafii, W., & Vebrianto, R. (2020). The effects of blended learning and project-based learning on pre-service biology teachers' creative thinking skills through online learning in the COVID-19 pandemic. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 408–420. https://doi.org/10.15294/jpii.v9i3.24706

Zahro, M., & Lutfianasari, U. (2024). Penerapan Model Pembelajaran Problem-Based Learning terhadap Kemampuan Berpikir Kritis dan Aktivitas Belajar Peserta Didik pada Materi Hidrolisis Garam. *Jurnal Inovasi Pendidikan Kimia*, *18*(1), 17–22. https://doi.org/10.15294/jipk.v18i1.45567