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Needs Analysis of Redox Reaction E-Module Teaching Material Based on PjBL Integrated with Local Wisdom

Edwin Pakpahan, Ramlan Silaban, Citra Sianturi
Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Medan,
Jl. William Iskandar Ps V Medan, Sumatera Utara, Indonesia
*Corresponding Author e-mail: edwinpakpahan941@gmail.com

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Abstract
This study aims to identify the need for developing a redox reaction e-module based on Project-Based Learning (PjBL) integrated with ethnopedagogy in senior high school chemistry learning. The research addresses the gap between the Merdeka Curriculum's emphasis on contextual, student-centered learning and the predominantly textbook-oriented instructional practices implemented in classrooms. A descriptive qualitative approach was employed at SMA Negeri 2 Percut Sei Tuan involving one chemistry teacher and 33 twelfth-grade students selected through purposive sampling. Data were collected through teacher interviews, student needs questionnaires, analysis of the Learning Objective Flow (ATP), and evaluation of existing textbooks using BSNP criteria. Quantitative data from questionnaires were analyzed using percentage calculations, while textbook feasibility was assessed using a five-point Likert scale. The findings indicate that 81.81% of students experience difficulties in understanding redox concepts, and learning remains largely expository and textbook-centered. Although the analyzed textbooks achieved a high feasibility score (89.36%, categorized as very suitable), they lack support for project-based, contextual, and ethnopedagogical integration. Furthermore, 96.96% of students expressed the need for interactive electronic learning media integrated with local wisdom. These results confirm the urgency of developing a structured e-module that aligns curriculum standards with active and culturally responsive learning. This study contributes theoretically by providing an empirical and systematic needs-analysis framework as a foundational basis for designing a PjBL-oriented redox e-module integrated with ethnopedagogy, addressing the limited research on culturally contextualized digital chemistry teaching materials.

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INTRODUCTION

Education is one of the most important aspects of every individual's life because through education, a person can develop their potential, acquire knowledge, skills, and values useful in life (Rahman et al., 2022). Therefore, education should not only focus on the transfer of knowledge, but also on the development of character and competencies that prepare individuals to face the challenges of life and society. Through a focused learning process, education occupies a strategic position in developing superior, characterful, and competent human resources, as stated in Law Number 20 of 2003 concerning the National Education System (Qomarudin et al., 2021).

In the context of national development, education not only plays a role in transferring knowledge but also shapes the character and personality of students. Quality education will produce human resources who are not only intellectually intelligent, but also possess skills, creativity, innovation, and high productivity. This is in line with the demands of the 21st century, which emphasize the importance of mastering critical thinking, communication, collaboration,

and creativity competencies (Syasmita, 2019). Therefore, schools have a big responsibility as formal educational institutions, where teachers play a key role in improving the quality of learning.

To achieve national educational goals, teachers are required not only to master the material but also to provide learning that is appropriate to the characteristics of the students and their environment (Senduk, 2024). One approach that can support this is ethnopedagogy, which is education based on local wisdom. Through ethnopedagogy, learning not only serves as a means of acquiring knowledge but also as a medium of culture that connects modern knowledge with the values and traditions of society (Suarningsih, 2019). The ethnopedagogical approach provides opportunities for students to engage directly with the local wisdom that surrounds them, allowing them to see the relevance of science in everyday life. Through this contextual learning experience, students not only gain theoretical understanding but are also able to connect scientific concepts with real-world practices that develop in society (Ayu et al., 2024).

Seeing the potential of local wisdom, which has scientific and cultural value, efforts are needed to integrate these local values into the formal education system. This integration not only serves to preserve regional culture but also to provide contextual, meaningful, and relevant learning for students. In line with this, education in Indonesia is now being adapted to accommodate the needs of the 21st century in various aspects, one of which is through the design of a curriculum that serves as a guideline for teaching and learning. A curriculum designed to respond to global challenges requires learning that encourages students to be active, creative, and able to relate knowledge to real life (Alhayat et al., 2023).

In the learning process, teachers need to pay attention to students' needs by providing appropriate supporting tools, especially in chemistry lessons. Chemistry is often considered difficult because of its abstract concepts and calculations, so students are required to understand concepts theoretically and through experiments, so that they can obtain the facts, concepts, and principles contained therein (Bowo, 2022). Therefore, learning chemistry requires an instructional approach that not only helps students understand abstract concepts but also actively involves them in the learning process through meaningful activities. Learning should encourage students to construct their own understanding by linking theoretical concepts with real-life phenomena and their surrounding environment. This condition highlights the need for a learning model that supports active participation, critical thinking, collaboration, and contextual learning experiences.

To support the implementation of active and contextual learning, one of the appropriate models to use is Project-Based Learning (PjBL), where students are involved in real projects that allow them to explore scientific concepts and connect them with the surrounding culture and environment. The advantage of this model is that it can represent learning theory in a real, simple, and easy-to-understand way because it can be organized independently by students (Rifai et al., 2021).

Based on the facts and results of research conducted by (Wati et al., 2022) The application of the Project-Based Learning (PjBL) model can have a significant impact on improving high school students' learning outcomes and critical thinking skills. The results of the study show that students' critical thinking skills have improved, as seen from the learning outcomes in the knowledge domain, with an increase in the percentage of students who have mastered the material. Data from the study shows that PjBL is not only effective in improving students' conceptual understanding of abstract material but also capable of developing affective and psychomotor aspects in a balanced manner.

In relation to efforts to improve chemistry learning outcomes, particularly in developing students' critical thinking skills, various studies have been conducted by applying innovative learning models. A study by (Van Harling & Martono, 2023) at SMA Negeri 3 Kota Sorong found that implementing PjBL in redox material significantly enhanced students’ critical thinking, showing a very strong correlation between PjBL syntax and improved analytical, active, and reflective learning. However, the study focused solely on critical thinking development without integrating cultural contexts or local values to enhance learning relevance to students’ daily lives.

In order for PjBL to be more meaningful and relevant to everyday life, learning should be connected to real-life contexts that are close to students' experiences, encouraging active engagement in authentic projects while developing transferable skills and interpersonal competencies (Rehman et al., 2024). In this context, integrating ethnopedagogy into PjBL connects scientific concepts with local culture and community practices, thereby enhancing cognitive, affective, and psychomotor outcomes while fostering appreciation of local wisdom. This approach allows modern science to be learned in harmony with cultural traditions, making learning more relevant and meaningful.

Based on the findings of (Rakhman et al., 2025), Integrating the ethnopedagogy approach with the Project-Based Learning (PjBL) model has been shown to enhance learning quality. The study indicates that this integration optimizes teachers' roles, improves student outcomes, fosters contextual and collaborative learning, and enriches instructional resources with local wisdom. However, the discussion remains theoretical and does not clearly specify the media or teaching materials used in implementing the approach. This reveals a gap between conceptual integration and its practical application in chemistry learning. The lack of well-defined teaching materials highlights the need for instructional resources that are structured, interactive, and capable of systematically facilitating project-based activities while embedding local wisdom (Mustafaoğlu & Yücel, 2022).

In this context, E-modules are considered a relevant form of teaching material because they offer interactive and engaging features. E-modules are equipped with various supporting media, such as videos, animations, audio, and interactive quizzes, which can create a more varied and enjoyable learning experience (Sukma & Wulandari, 2025). These features have the potential to enhance students' motivation and deepen their understanding of the material. In addition, E-modules support independent and flexible learning, as they can be accessed anytime and anywhere according to students' needs (Ashari et al., 2023).

In line with this need, research conducted by (Ramlan Silaban, 2025) the development of a Project-Based Learning (PjBL) E-module integrated with the local wisdom of Man Belo/Marsukil (the tradition of chewing betel nut) has been proven to increase student interest, strengthen conceptual understanding, and foster a love for local culture.

The study demonstrates that integrating culture into chemistry learning aligns with the characteristics of the Merdeka Curriculum, which emphasizes contextual and student-centered learning that is relevant to the socio-cultural environment of the students. However, the innovation developed still focuses on stoichiometric materials, so it does not yet cover other chemistry competencies that also require a deep conceptual understanding, such as oxidation-reduction (redox) reactions.

The integration of ethnopedagogy in chemistry learning is important because it connects abstract scientific concepts with students' local cultural contexts, making learning more meaningful and relevant (Siswanto et al., 2025). However, the effectiveness of this integration largely depends on the availability of structured teaching materials that can systematically accommodate both cultural values and curriculum demands.

Although previous studies have confirmed the effectiveness of PjBL and ethnopedagogy in improving learning outcomes, empirical studies focusing specifically on the needs analysis of chemistry e-modules that systematically integrate both approaches, particularly for abstract topics such as oxidation-reduction (redox) reactions remain limited. This gap highlights the necessity of conducting a structured needs analysis as a foundational step prior to the development of an E-module. Therefore, this study aims to identify the need for developing a redox reaction E-module suitable for classroom implementation. The findings are expected to serve as a reference for future development of electronic-based chemistry teaching materials.

METHOD

This study employed a descriptive qualitative approach to analyze the need for developing teaching materials on redox reaction topics (Rukajat ajat, 2021). The research was conducted at SMA Negeri 2 Percut Sei Tuan using purposive sampling. The subjects consisted of one chemistry teacher and 33 students of class XII D who had studied redox reaction material. Data collection

was conducted through four stages namely preliminary analysis through interviews with the chemistry teacher to identify learning conditions and challenges in teaching redox reactions, student analysis using a questionnaire with Yes/No responses to determine students' learning difficulties, characteristics, and needs for instructional media, then learning objective flow (ATP) analysis to examine the alignment of learning objectives with curriculum requirements, and teaching material analysis to evaluate the textbooks currently used in the classroom.

Student questionnaire data were analyzed using percentage calculations to determine the proportion of responses for each indicator. Meanwhile, the teaching material analysis employed a five-point Likert scale with the following categories: Very Good = 5, Good = 4, Good Enough = 3, Not Good = 2, and Not Very Good = 1 (Riduwan, 2019). The percentage results were interpreted using the following criteria: 0-25% (very low), 26-50% (low), 51-75% (moderate), and 76-100% (high). The overall findings were used to identify gaps between expected and actual learning conditions as the basis for determining the need to develop a redox reaction e-module

RESULTS AND DISCUSSION

The needs analysis was conducted to identify the requirements for teaching materials on redox reaction topics. The analysis was based on data obtained from interviews with chemistry teachers, student questionnaires, learning objective flow analysis, and an analysis of the teaching materials currently used at SMA Negeri 2 Percut Sei Tuan. The findings describe the existing learning conditions, the challenges faced by teachers and students in learning redox reactions, and the potential need for electronic-based teaching materials to support more active, contextual, and meaningful chemistry learning. The description of each analysis is presented as follows.

Preliminary Analysis

The preliminary analysis in this study aims to identify fundamental problems that arise in the chemistry learning process. At this stage, the researcher collected preliminary information through interviews with chemistry teachers at SMA Negeri 2 Percut Sei Tuan to obtain an overview of the implementation of learning, the use of teaching materials, and learning needs in the subject of redox reactions.

Based on the results of interviews with chemistry teachers, it was found that the curriculum implemented is the Merdeka Curriculum with a deep learning approach. The teacher as a resource, stated that familiar with and had applied the project-based learning (PjBL) model in the chemistry learning process. However, the PjBL model had not been applied routinely because not all chemistry materials were considered suitable for presentation through a project-based approach. Some materials required simpler learning strategies oriented towards understanding basic concepts, so the use of the PjBL model was adjusted to the characteristics of the material being taught. Nevertheless, according to (Rehani, 2023) the PjBL model has advantages in increasing student engagement, developing critical thinking skills, and linking learning to real-world contexts. However, in chemistry learning at SMA Negeri 2 Percut Sei Tuan, the implementation of the PjBL model has not been optimized to its full potential.

The implementation of the Project for Strengthening the Pancasila Student Profile (P5) in the Merdeka Curriculum requires contextual, meaningful, and relevant learning that is relevant to the real lives of students (Ramadhani et al., 2025). This opens up space for the integration of local contexts into the learning process as part of character building and conceptual understanding. However, based on interviews with chemistry teachers at SMA Negeri 2 Percut Sei Tuan, it was found that chemistry lessons had never been directly linked to the context of local wisdom, including in the material on redox reactions.

The chemistry learning process in schools still refers to the Merdeka Curriculum textbooks and is not yet supported by the use of other teaching materials. In practice, teachers tend to use question-and-answer methods to increase student activity, considering that the variety of teaching materials used in learning is still limited. During the learning process, students showed greater enthusiasm when learning was connected to real-life contexts, which is consistent with the principles of contextual learning theory that emphasize the importance of linking academic content with students' everyday experiences to

enhance motivation and understanding (Jubhari et al., 2022). That is why teachers emphasized the importance of developing teaching materials that were contextual and relevant to the students' environment, considering that the connection between chemistry and local wisdom was still rarely applied in learning. These findings form the basis for determining the characteristics of the e-module developed so that chemistry learning, especially redox reaction material, can be presented in a more meaningful and contextual manner.

Student Analysis

The student analysis was conducted to obtain an initial overview of their learning needs as a basis for developing the redox reaction e-module. This analysis was carried out to understand students' learning conditions, both in terms of the problems they faced in learning, their characteristics and the material, as well as their needs for learning media. Therefore, data collection is carried out by distributing initial needs questionnaires to students, which aim to identify the characteristics and needs of students so that the media developed is in accordance with the conditions and demands of learning (Marhamah & Zikriati, 2024). The data from the analysis of students' needs were given to 33 students in class XII D, as shown in Table .

Table 1. Analysis of Students' Needs

No	Question	Frequency		Percentage (%)	
		Yes	No	Yes	No
	A. Problems in learning				
1	Do you have difficulty learning chemistry, especially redox reactions?	27	6	81.81	18.18
2	Are the difficulties you experience in learning redox reactions due to incomplete material in the textbook?	18	15	54.54	45.45
3	Are the difficulties you experience in learning redox reactions due to uninteresting teaching methods?	20	13	60.6	39.39
4	During the chemistry learning process on redox reactions, is the lecture method the one most often used by teachers?	24	9	72.72	27.27
5	Can you understand and comprehend the explanations related to redox reactions provided by teachers?	15	18	45.45	54.54
6	Are textbooks or text books the only learning resources used by teachers?	17	16	51.51	48.48
	Average	20.17	12.83	61.11	38.89
	B. Student Characteristic and Materials				
7	When teaching redox reactions, have you ever used electronic media?	10	23	30.3	69.69
8	Do you think it is necessary to use electronic media in the learning process?	26	7	78.78	21.21
9	Are you interested in learning chemistry, specifically redox reactions, using electronic media as a learning tool?	24	9	72.72	27.27
10	Would redox reaction material be more interesting if the learning process encouraged students to actively explore knowledge independently?	23	10	69.69	30.3
11	Would redox reaction material be easier to understand if it were integrated with enopedagogy and science concept chemistry learning?	25	8	75.75	24.24
12	Are you motivated to learn about redox reaction material?	27	6	81.81	18.18
	Average	22.5	10.5	68.18	31.82
	C. Media Needs				
13	Do you need interesting learning media for redox reaction material?	32	1	96.96	3.03

No	Question	Frequency		Percentage (%)	
		Yes	No	Yes	No
14	Is redox reaction material more interesting when using electronic media?	31	2	93.93	6.06
15	Do you agree with the development of media in the form of e-modules integrated with ethnopedagogy that help you master the concepts of redox reaction material?	32	1	96.96	3.03
Average		31.67	1.33	95.95	4.04
N (Number of samples)		33			

Based on the results of the student needs analysis, 81.81% of students reported experiencing difficulties in learning redox reaction material. This high percentage indicates that redox reactions are perceived as abstract and conceptually challenging, requiring not only procedural understanding but also strong conceptual connections. Furthermore, 60.6% of students stated that the learning methods used were not interesting, and 51.51% reported that learning resources were still limited to textbooks.

These findings suggest that students' learning difficulties are not solely caused by the complexity of the material, but also by instructional approaches that may not sufficiently support active engagement and conceptual construction. The dominance of textbook-based learning potentially limits opportunities for contextual and exploratory experiences, which are essential for mastering abstract chemistry concepts, considering that learning experiences grounded in real-life contexts promote active knowledge construction and deeper conceptual understanding (Plooy et al., 2024).

Furthermore, in terms of student characteristics and media needs, 69.69% of students had never used electronic media in learning redox reactions. However, 72.72% expressed interest in learning through electronic media, and the majority indicated that redox material would be more engaging if presented digitally. This contrast between limited exposure and high interest reflects a gap between current classroom practices and students' learning preferences. It implies that students are open to more interactive and technology-supported learning environments. Therefore, the findings highlight a clear pedagogical need for the development of electronic-based teaching materials that can enhance motivation, provide interactive visualization of abstract concepts, and support more meaningful learning experiences.

Learning Objective Flow Analysis

The Learning Objective Flow (ATP) analysis was conducted to ensure that the proposed development of the redox reaction e-module is aligned with the learning objectives outlined in the Merdeka Curriculum. The ATP analyzed in this study refers to the ATP implemented by the chemistry teacher at SMA Negeri 2 Percut Sei Tuan in the corresponding academic year. This analysis focused on identifying the scope, sequence, and depth of redox reaction material as stated in the ATP document.

The results indicate that the redox topic is organized systematically, beginning with the fundamental concepts of oxidation and reduction, followed by the determination of oxidation numbers, identification of redox reactions, balancing redox equations, and their application in chemical processes. The ATP also clearly outlines the expected competencies that students must achieve at the senior high school level, as learning objectives function as a foundation for competency-based education (Alwi et al., 2025).

The findings of the ATP analysis serve as a guideline in determining the structure, content coverage, and learning progression of the e-module to be developed. By referring to the existing ATP, the proposed e-module is designed to remain consistent with curriculum standards while accommodating the identified needs for more interactive, contextual, and project-based learning materials.

Teaching Material Analysis

An analysis of teaching materials was conducted to identify the learning resources used in chemistry education in schools. The results of the analysis show that the main teaching material currently used is the Merdeka Curriculum textbook. Previously, the learning process was also supported by the 2013 curriculum and the education unit level curriculum (KTSP) textbooks.

These books serve as the main reference in delivering material, therefore the researcher analyzed three high school chemistry textbooks commonly used by teachers in the chemistry learning process. The list of books analyzed in this study is presented in Table 2.

Table 2. List of books Analyzed

No	Title of Book	Author	Publisher	Publication Year
1	Kimia untuk SMA/MA Kelas XII	Yuliani	Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi	2022
2	Kimia Untuk SMA/MA Kelas XII	Unggul Sudarmo	Erlangga	2021
3	Praktis Belajar Kimia	Rahayu	Pusat Perbukuan Departemen Pendidikan Nasional	2009

The three chemistry textbooks analyzed were evaluated using the BSNP assessment instrument with a 1-5 Likert scale covering aspects of content suitability, presentation suitability, language suitability, and graphic suitability (Yudha & Yuliani, 2023). The material analyzed in this study was redox reaction material, including content suitability, sub-material coverage, and the form of assessment presented in the book in accordance with BSNP criteria. The assessment results for each aspect were then calculated in the form of a suitability percentage, with a summary of the analysis results presented in Table 3.

Table 3. Aspects of book assessment analyzed

No	Assessment Aspect	Percentage Average (%)
1	Content suitability	86.88
2	Presentation suitability	88.27
3	Graphics	92.13
4	Language	90.16
	Average	89.36
	Category	**Very Suitable**

The analysis of the three chemistry textbooks shows that these books meet the BSNP standards for suitability, covering content, language, presentation, and graphics, as shown in Table 3. The results show that the textbooks obtained high feasibility scores in all assessed aspects, with an overall average of 89.36% categorized as "Very Suitable". This indicates that the books meet national standards in terms of content quality, structure, language clarity, and visual presentation. The visualization of the results of the chemistry book feasibility analysis is presented in Figure 1.

However, high feasibility based on BSNP criteria does not automatically guarantee pedagogical alignment with the Merdeka Curriculum. Although the textbooks demonstrate strong compliance with national standards, their instructional design remains predominantly content-oriented rather than learning-process-oriented. The materials are generally presented in an expository format with limited opportunities for project-based activities, contextual exploration, or integration of local wisdom. Textbooks that rely heavily on expository presentation often position students as passive recipients of information rather than active participants in constructing understanding, reinforcing rote memorization and limiting opportunities for critical thinking and authentic communication (Twentieth et al., 2025).

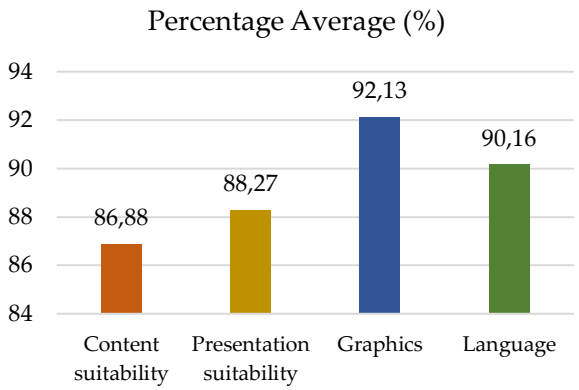

Figure 1. Chemistry books analysis result

As a result, while the textbooks are nationally feasible, they have not yet fully facilitated meaningful learning experiences that emphasize student-centered inquiry, real-world problem solving, and ethnopedagogical integration. Consequently, their capacity to support Project-Based Learning (PjBL) and contextual chemistry learning remains limited.

CONCLUSION

This study indicates that redox reaction instruction at SMA Negeri 2 Percut Sei Tuan has not yet fully embodied the principles of meaningful and contextual learning promoted by the Merdeka Curriculum. The needs analysis reveals that students struggle to comprehend abstract redox concepts, are primarily exposed to textbook-centered and expository approaches, and have limited access to diverse instructional resources. Although the textbooks in use satisfy BSNP feasibility standards, their content-driven orientation offers minimal support for project-based activities, contextual exploration, or the integration of ethnopedagogical elements.

At the same time, students demonstrate a strong interest in electronic learning media, signaling readiness for more innovative instructional formats. Drawing on teacher interviews, student response data, ATP examination, and textbook feasibility analysis, this research constructs a comprehensive empirical basis for developing a PjBL-oriented e-module grounded in ethnopedagogical values. By clarifying the disconnect between curriculum ideals and classroom implementation, the study provides a systematic foundation for designing chemistry teaching materials that align national standards with active, contextual, and culturally responsive learning practices at the senior high school level.

RECOMMENDATION

Based on the findings of this study, it is recommended that future research involve a wider range of samples and more repeated trials for each variable to obtain more comprehensive and reliable data. In particular, for each concentration and cross-sectional area variable, further studies should consider increasing the number of samples and repetitions for each variation. This approach is expected to improve the accuracy, consistency, and generalizability of the results

BIBLIOGRAPHY

Alhayat, A., Mukhidin, Utami, T., & Yustikarini, R. (2023). The relevance of the project-based learning (PjBL) learning model with Kurikulum Merdeka Belajar. DWIJA CENDEKIA: Jurnal Riset Pedagogik, 7(1), 106-116.

Alwi, I., Harahap, J., Pramita, S., Abdullah, R., & Halimah, S. (2025). Analysis Of Competency-Based Learning Objectives In Curriculum 13 And Independent Curriculum-Ibnu Alwi Jarkasih Harahap et.al Analysis Of Competency-Based Learning Objectives In Curriculum 13 And Independent Curriculum. *Jurnal Multidisiplin Sahombu*, *5*(02), 153–166. https://doi.org/10.58471/jms.v5i02

Annisa rehani. (2023). Implementasi Project Based Learning dalam Meningkatkan Pola Pikir Kritis Siswa di SMK Negeri 1 Surakarta. *Didaktika: Jurnal Kependidikan*, *12*(4), 487–496. https://jurnaldidaktika.org/contents/article/view/273

Ashari, V. R., Fatirul, A. N., & Walujo, D. A. (2023). Pengembangan E-Modul Kimia Materi Asam Basa Berbasis Flip PDF Professional untuk Peserta Didik Kelas XI SMA Negeri 1 Menganti. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran*, *4*(2), 1391–1398. https://doi.org/10.62775/edukasia.v4i2.449

Ayu, G., Kade, N., 1◎, S., Suastra, W., Bagus, I., & Arnyana, P. (2024). Integrasi Etnopedagogi dalam Pembelajaran IPA untuk Memperkaya Pemahaman Budaya dan Sains. *Jurnal Ilmu Pendidikan*, *6*(6), 6507–6518. https://doi.org/10.31004/edukatif.v6i6.7726

Bowo, B. (2022). Meningkatan Aktivitas Belajar Kimia Materi Reaksi Redoks Menggunakan Model PjBL di Madrasah Aliyah. *Indonesian Journal of Action Research*, *1*(2), 177–186. https://doi.org/10.14421/ijar.2022.12-06

du Plooy, E., Casteleijn, D., & Franzsen, D. (2024). Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. *Heliyon*, *10*(21), e39630. https://doi.org/10.1016/j.heliyon.2024.e39630

Jubhari, Y., Sasabone, L., & Nurliah, N. (2022). The Effectiveness of Contextual Teaching and Learning Approach in Enhancing Indonesian EFL Secondary Learners' Narrative Writing Skill. *REiLA : Journal of Research and Innovation in Language*, *4*(1), 54–66. https://doi.org/10.31849/reila.v4i1.8633

Marhamah, M., & Zikriati, Z. (2024). Mengenal Kebutuhan Peserta Didik Diera Kurikulum Merdeka. *Wathan: Jurnal Ilmu Sosial Dan Humaniora*, *1*(1), 89–106. https://doi.org/10.71153/wathan.v1i1.32

Mathematics, A. (2016). *The Relevance of the Project-Based Learning (PjBL) Learning Model with Kurikulum Merdeka Belajar Amsal*. *7*(1), 1–23.

Mustafaoğlu, F. M., & Yücel, A. S. (2022). Context-Based Teaching Experiences of Chemistry Teachers: Expectations, Gains and Applicability

Conditions. *Journal of Turkish Science Education*, *19*(3), 958–978. https://doi.org/10.36681/tused.2022.158

Qomarudin, O. A., Stai, D., Had, M. ', Al-, A., & Malang, H. (2021). Aktivitas Pembelajaran Sebagai Suatu Sistem. *PIWULANG: Jurnal Pendidikan Agama Islam*, *4*(1), 24–34. http://e-journal.staima-alhikam.ac.id/index.php/piwulang

Rahman, A., Munandar, S. A., Fitriani, A., Karlina, Y., & Yumriani. (2022). Pengertian Pendidikan, Ilmu Pendidikan dan Unsur-Unsur Pendidikan. *Al Urwatul Wutsqa: Kajian Pendidikan Islam*, *2*(1), 1–8.

Rakhman, W., Subiyanto, B., Syahruddin, S., & Mutiani, M. (2025). Integrasi Pendekatan Etnopedagogi Dalam Meningkatkan Kualitas Pembelajaran Ipas Berbasis Proyek Di Sekolah Dasar. *Jurnal Pendidikan Dasar*, *13*(1), 34–43. https://doi.org/10.46368/jpd.v13i1.3121

Ramadhani, S., & Wahyu Safutri, L. (2025). The Implementation of the Pancasila Student Profile Strengthening Project Module (P5) For Elementary School Students Creativity: An Experimental Study. *Journal of Psychology and Instruction*, *9*(1), 43–50. https://doi.org/10.23887/jpai.v9i1.49814

Ramlan Silaban. (2025). Development Innovative e-Module Based on Project Based Learning (PJBL) Integrated Betel Eating Local Wishdom (Man Belo or Marsukil) From North Sumatera on Teaching Stoichiometric Chemistry by Using Anyflip. *Journal of Information Systems Engineering and Management*, *10*(49s), 932–945. https://doi.org/10.52783/jisem.v10i49s.10009

Rehman, N., Huang, X., Mahmood, A., AlGerafi, M. A. M., & Javed, S. (2024). Project-based learning as a catalyst for 21st-Century skills and student engagement in the math classroom. *Heliyon*, *10*(23), e39988. https://doi.org/10.1016/j.heliyon.2024.e39988

Rifai, A. S., Utomo, S. B., & Indriyanti, N. Y. (2021). Penerapan Model Project Based Learning untuk Meningkatkan Kreativitas dan Prestasi Belajar Siswa pada Materi Pokok Termokimia Kelas XI IIS SMA Negeri 5 …. *Jurnal Pendidikan Kimia*, *10*(2), 123–129. https://doi.org/10.20961/jpkim.v10i2.41379

Rukajat ajat. (2021). Pendekatan Penelitian Kualitatif. Yogyakarta. *Publish*, *1*(April), 100.

Senduk, M. (2024). e-ISSN: 2809-8463 The Role of Teachers in Implementing the Independent Curriculum at Lokon St. *International Journal of Information Technology and Education (IJITE)*, *3*(3), 2809–8463. http://ijite.jredu.idhttp//ijite.jredu.id

Siswanto, S., Tarigan, A. T. S., Silaban, R., & Situmorang, M. (2025). Needs Analysis of Innovative Chemistry Teaching Materials Integrated with Ethnopedagogy Oriented to 21st Century Learning. *Jurnal Inovasi Pembelajaran Kimia*, *7*(2), 214–225. https://doi.org/10.24114/jipk.v7i2.68601

Sukma, F. M., & Wulandari, P. A. (2025). Pengembangan E-Modul Berbasis Project Based Learning Menggunakan Flip Pdf Professional Pada Materi Struktur Atom. *Jurnal Pendidikan Kimia Dan Terapan*, *10*(02), 10–20.

Syasmita, I. (2019). Pendekatan Etnopedagogi Upaya Membangun Dunia Pendidikan di Era Revolusi 4.0. *Prosiding Seminar Nasional Fakultas Ilmu Sosial Universitas Negari Medan*, *3*(2013), 748–751.

Twentieth, F., Islamy, J., Yudha Kristiawan, D., & Rahman, A. (2025). the Critical Discourse Analysis of Content Pedagogy in the Indonesian Efl Textbook: the Alignment With Kurikulum Merdeka. *ELITERATE : Journal of English Linguistics and Literature Studies*, *4*(3), 2025.

Van Harling, V. N., & Martono, S. M. (2023). Implementation of Project Based Learning (PjBL) Models to Improve Students' Critical Thinking Ability in Corrosion Materials. *Soscied*, *6*(1).

Wati, D. R., Masykuri, M., & Nurhayati, N. D. (2022). Implementasi Pembelajaran Daring Berbasis Project Based Learning pada Materi Redoks terhadap Hasil Belajar dan Kemampuan Berpikir Kritis Siswa SMAN Ngemplak Boyolali. *Jurnal Pendidikan Kimia*, *11*(2), 150–160.

Yudha, C. P., & Yuliani. (2023). The Development of E-Worksheet to Train Scientific Literacy on Membrane Transport Material for 11th-Grade High School Students. *Jurnal Bioedu*, *12*(3), 754–764. https://ejournal.unesa.ac.id/index.php/bioedu