RESEARCH TRENDS IN LOCAL WISDOM-BASED CHEMISTRY LEARNING MEDIA: A SYSTEMATIC LITERATURE REVIEW 2015-2025

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Abstract. *Chemistry education is often considered difficult because many concepts are abstract. Therefore, local wisdom-based learning media are needed to make learning more contextual and relevant to students' experiences. This study aimed to map research trends on the integration of local wisdom into chemistry learning media using a Systematic Literature Review. Articles were collected from Scopus and Google Scholar (2015-2025), limited to empirical studies. Of the 515 initially identified articles, 24 met the inclusion criteria and were analyzed. The findings show that studies were dominated by the development of modules and e-modules (25%), mainly for high school students (88%), with acid-base chemistry being the most frequently studied topic (29.17%). Research variables focused on media feasibility (70.83%), while affective aspects, chemistry literacy, immersive digital media, and broader regional representation of local wisdom remain limited. This study provides research trend mapping and directions for developing more innovative and contextual chemistry learning media.*

Keywords: *chemistry education, learning media, local wisdom, systematic literature review*

INTRODUCTION

Chemistry education is closely related to everyday life because it explains various phenomena encountered in students' daily experiences, such as the fermentation process in traditional foods and color changes in natural indicators. These phenomena demonstrate that chemistry not only examines the principles, structures, properties, and reactions of substances, but also explains various phenomena in the surrounding environment [1]. Chemistry is also known as the central science due to its role in bridging various fields of knowledge [2].

Despite its significant contribution to the advancement of science, chemistry learning is still considered difficult by the majority of students [4], [5], [6]. These difficulties arise due to the abundance of abstract concepts and the demands for complex computational skills [7, 8]. Therefore, effective learning strategies are needed to present abstract concepts in a more concrete and comprehensible manner [5]. One approach to addressing these learning barriers is the use of innovative learning media [9], [10], [11].

Media can simplify complex instructional materials, represent concepts that are difficult to visualize with words alone, and make molecular representations and microscopic phenomena that are difficult to observe directly more concrete [12], [13], [14]. Contextual media help students connect chemical concepts to everyday life, making learning more meaningful [14].

Given these challenges, integrating local wisdom into chemistry education offers an opportunity to connect abstract concepts with students' cultural and environmental contexts. Local wisdom acts as a cognitive bridge that enables students to associate abstract chemical concepts with real-world practices familiar to

their daily lives. In line with the Indonesian National Education System Law No. 20 of 2003, Article 36 paragraph (3), curriculum development should consider regional potential and the students' surrounding environment. Therefore, incorporating local wisdom into the learning process may serve not only as an instructional innovation but also as an effort to implement educational policies that support learning aligned with students' backgrounds and needs. Local wisdom reflects a community's social and cultural identity through values and traditions inherited across generations [16], [17]. These values not only enrich the curriculum but also help students understand and appreciate their own cultural identities [17].

Integrating local wisdom into learning can create a more meaningful and relevant learning process. In addition, local wisdom-based learning media may assist students in understanding chemical concepts through real-life experiences in their surroundings [18]. Furthermore, local wisdom also plays an important role in maintaining environmental balance and the sustainability of natural resources through cultural values inherited across generations [19]. Therefore, the integration of local wisdom into chemistry learning media enhances conceptual understanding while encouraging environmental awareness and appreciation of local culture.

Currently, various studies have developed media that support the chemistry learning process, such as E-LKPDs incorporating ethnoscience [21], [22], [23], chemistry learning media based on socio-scientific issues [24], [25], [26], and contextual-based media [25], [27]. Along with the development of these innovations, research has also begun to examine the incorporation of local wisdom into chemistry learning media. Kelana & Irawan [27] developed an e-module on colloids based on Papuan local wisdom, while Normayanti & Zamhari [28] designed a "Chemical Paper Puppet" teaching aid for chemical bonding using an approach that integrates character education and local wisdom. Additionally, Tangio et al. [29] explored the use of local plants from Meranti Village as learning content and media integrated with local wisdom.

These findings indicate a positive trend toward local wisdom-based chemistry learning. However, existing studies are still centered on the design and assessment of learning media. In addition, previous reviews have not specifically mapped local wisdom-based chemistry learning media. Therefore, this study was conducted to identify research trends, gaps, and future directions for the development of local wisdom-based chemistry learning media. Research Questions:

1. How is the integration of local wisdom in chemistry learning media examined in terms of research objectives, research variables, chemistry concepts, and the local wisdom addressed?
2. What are the reported results and conclusions from the research, and what insights can be identified from these findings?

METHOD

This study used a systematic literature review (SLR) to identify and analyze articles related to the integration of local wisdom into chemistry learning media.

Data Collection

The data were obtained through a systematic search of the Scopus and Google Scholar databases, covering publications from 2015 to 2025. The 2015-2025 publication period was selected because, over the past decade, there has been a significant transformation in chemistry education, particularly the transition toward the digitization of teaching materials and the strengthening of local wisdom-based character education in response to the 21st-century curriculum. The keywords used included: "Media"; "Chemistry Learning"; "Local Wisdom"; "Media"; "Chemistry Learning"; and "Local Culture." The articles selected for this study met the inclusion criteria established by the researcher, as follows:

1. Explicitly discuss the integration of local wisdom into chemistry learning media;
2. Articles were written in Indonesian or English;
3. Articles are the results of empirical research (not literature reviews, editorials, or short reports);
4. Available in full text; and

5. Articles published in journals indexed by Scopus or Google Scholar.

The initial search yielded 515 articles, which were then screened through a multi-stage process including duplicate removal, title and abstract screening, and eligibility assessment based on inclusion criteria. In the final stage, 24 articles were selected for analysis. The reduction occurred because many studies did not specifically focus on local wisdom integration in chemistry learning media or lacked sufficient empirical data. Figure 1 presents the article selection flowchart.

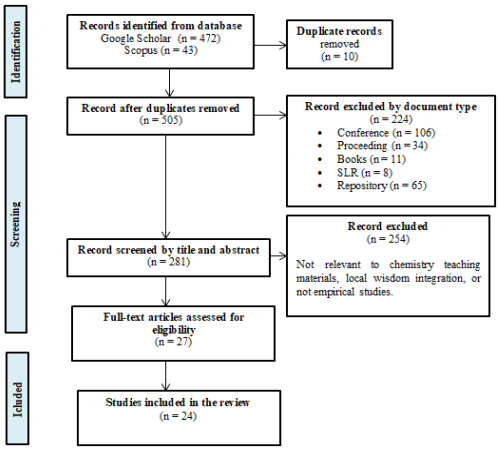

Figure 1 Flowchart of SLR

Data Analysis

Data were analyzed manually using an inductive thematic analysis approach, which involved reading articles, identifying key data, coding, and compiling main themes. Primary codes were extracted from key information, including research objectives, media types, chemistry concepts, local wisdom, sample characteristics, and research variables. Similar codes were then grouped into secondary codes to establish the overarching themes. To ensure validity and consistency, the coding and thematic groupings underwent a peer-review process. The final results are presented using frequency tables, percentages, and descriptive narratives.

RESULT AND DISCUSSION

This study identified six main themes: research objectives, research variables, sample, chemical concepts, local wisdom addressed, and research conclusions.

The "Objectives" theme. The frequency of themes identified through the coding process is presented in Table 1. The analysis results indicate that there are four main categories of research objectives in studies on local wisdom-based chemistry learning. The first code, namely the development and feasibility assessment of local wisdom-based learning media, had the highest percentage at 70.83%. This shows that most studies still focus on the development and validation of learning media. The second code, concerning the effect of local wisdom-based media on students' cognitive abilities, accounted for 16.67%. These findings suggests that improving students' cognitive learning outcomes remains a key focus in chemistry education [31], [32], [33], [34].

The third code, regarding the improvement of chemistry literacy, accounted for 8.33%. This indicates that chemistry instruction based on local wisdom is beginning to emphasize students' ability to comprehend and apply chemical concepts in real-life contexts [35, 36]. Meanwhile, the fourth code, the influence of local wisdom-based media on students' affective aspects, accounted for 4.17%. This focus is aimed at increasing students' interest, motivation, and positive attitudes [36].

Table 1 Frequency and Percentage of the Theme "Research Objectives"

Code	Research ID	f	%
Developing and evaluating the feasibility of learning media based on local wisdom	A1, A2, A3, A5, A6, A7, A8, A9, A10, A13, A15, A16, A17, A19, A21, A23, A24	17	70.83
The effect of learning media based on local wisdom on students' cognitive abilities	A4, A14, A18, A22	4	16.67
The effect of learning media based on local wisdom on scientific and chemistry literacy	A12, A20	2	8.33
The effect of learning media based on local wisdom on	A11	1	4.17

Code	Research ID	f	%
students' affective abilities			
Total		24	100%

In general, research trends on chemistry learning media that integrate local wisdom are still dominated by product feasibility tests. This finding aligns with the results of a systematic literature review conducted by Rahmi et al. [37], which showed that research on chemistry learning media is still dominated by studies on the development of such media. This dominance is likely influenced by the growing need for contextual, interactive learning media that are relevant to students' daily lives to help them understand abstract chemical concepts. On the other hand, studies examining the actual impact of learning media integrated with local wisdom on students' cognitive, affective, and chemical literacy domains remain relatively limited. This situation indicates an imbalance in research focus within the field of learning. Therefore, there is an opportunity for future research to develop more integrated studies, not only product-oriented but also focused on their impact on the cognitive, affective, and chemical literacy domains within real-life contexts.

The "Variables" theme. The variables in this study were classified into two main categories: independent variables and dependent variables. The frequency distribution of the independent variables is shown in Figure 2.

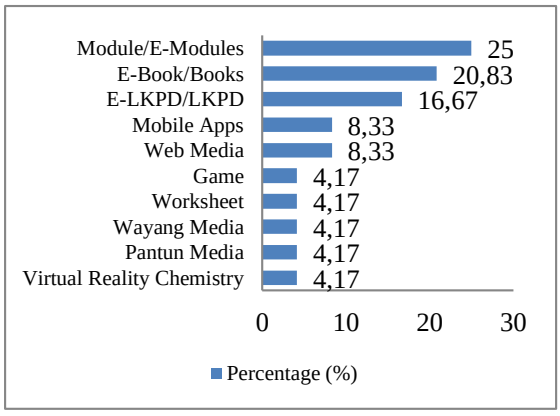

Figure 2 Percentage of 'Research Independent Variable' Codes

Based on Figure 2, modules and e-modules are the most widely used forms of media used to integrate local wisdom into chemistry learning, with the highest percentage at 25%. This finding aligns with the research by Islamiati and Redhana [38], which indicates that e-modules are widely developed in chemistry education because they can be flexibly accessed both online and offline, support self-directed learning, and enable multimedia integration to visualize abstract chemical concepts. Meanwhile, the adoption of innovative learning media, including Virtual Reality, mobile applications, and educational games, remains relatively limited. This finding opens opportunities for future research to explore interactive media that can contribute to creating more authentic and meaningful learning experiences. Meanwhile, the distribution of dependent variables is presented in Figure 3.

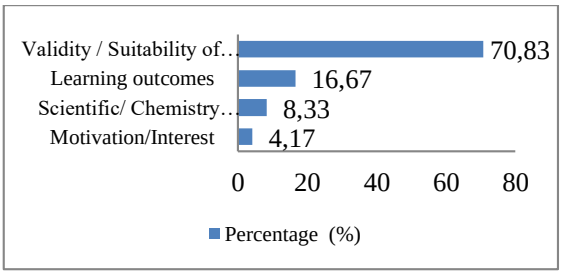

Figure 3 Percentage of the 'Research Dependent Variable' Code

Based on Figure 3, the feasibility test was the most frequently measured variable, with a percentage of 70.83%. This indicates that most studies still focus on the validity and suitability of media as the initial stage of learning product development. Other variables, such as learning outcomes, learning motivation, and students' interest in learning, as well as science and chemistry literacy, remain relatively limited. These findings suggest that future research should develop innovative learning media while comprehensively testing their impact across various domains of student competencies.

The **'Sample' theme.** As shown in Figure 4, most studies were conducted at the high school level, accounting for 88%, while only 12% involved university students.

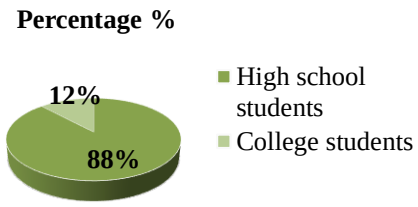

Figure 4 Percentage of "Research Sample" Themes

Based on Figure 4, most research samples consisted of high school students from various grade levels. According to the study by Hakim et al. [39], this predominance is attributed to the numerous challenges students face in learning chemistry at the high school level, such as a lack of understanding of abstract concepts, insufficient mathematical skills, and low motivation to learn. Therefore, chemistry education research has largely focused on addressing various learning challenges at this level. Conversely, research involving college students remains relatively limited. This situation indicates that the integration of local wisdom in higher education chemistry still needs further investigation to obtain a broader understanding of its effectiveness across educational levels.

The 'Research Concepts' theme. As shown in Figure 5, the most frequently studied chemistry topic was acid-base chemistry [31], [32], [38], [39], [40], [41], with a percentage of 29.17%, while other topics such as colloids [28], [42], [43], electrochemistry [46], inorganic chemistry [36], green chemistry [47], buffer solutions [48], and others appear in smaller numbers, as shown in Figure 5.

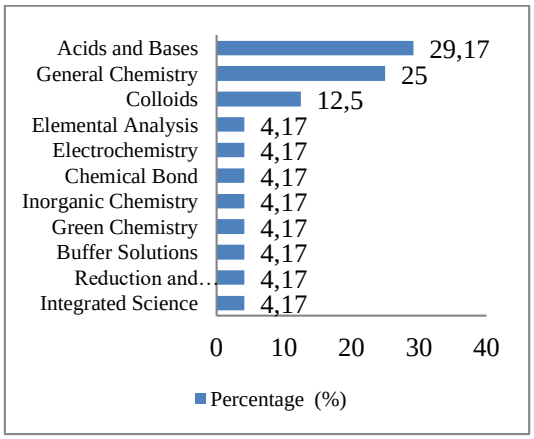

Figure 5 Percentage of 'Chemical Concepts' Codes

Acid-base concepts are frequently discussed in research articles due to their abstract nature and tendency to lead to misconceptions [49], necessitating a contextual learning approach grounded in local wisdom to assist students in linking these concepts to real-world phenomena in everyday life. Meanwhile, the limited research on concepts such as electrochemistry, green chemistry, and other topics opens opportunities for future research to broaden the use of local wisdom in more complex topics.

The 'Local Wisdom Highlighted' theme. As shown in Figure 6, local wisdom originating from Jambi appeared most frequently with a percentage of 19.5%, while Malang [46], Tanjung Pinang [36], and Papua was less frequently represented in the literature, and there were also articles that did not specifically explain the local wisdom highlighted [34], [36], [48].

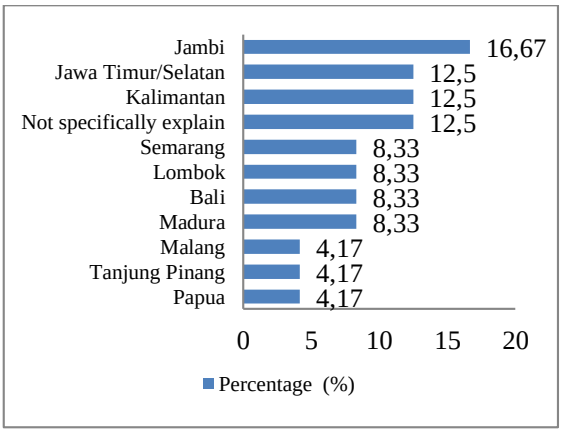

Figure 6 Percentage of the Code 'Local Wisdom Highlighted'

As shown in Figure 6, the local wisdom most frequently highlighted in the research originates from the Jambi region, while areas such as Malang, Tanjung Pinang, and Papua remain largely unexplored. This indicates that research on chemistry education based on local wisdom remains concentrated in specific regions. Equally significant yet under-exposed cultures still hold great potential for development in future research. Thus, expanding the sources of local wisdom from various regions in Indonesia has the potential to enrich contextual chemistry learning approaches, while simultaneously strengthening the preservation of cultural values in education.

The 'Conclusions' theme. Based on Table 2, the mapping results indicate that most studies conclude that learning media based on local wisdom have a high level of feasibility and have a positive impact on chemistry learning [49], [50], [51].

Table 2. Percentage of 'Research Conclusion' Codes

Code	Research ID	f	%
Learning media based on local wisdom have been proven to be feasible and valid	A1, A2, A3, A5, A6, A7, A8, A9, A10, A13, A15, A16, A17, A19, A21, A23, A24	17	70.83
Local wisdom-based learning media can improve students' cognitive abilities	A4, A14, A18, A22	4	16.67
Local wisdom-based media effectively improve students' chemistry and scientific literacy	A12, A20	2	8.33
Local wisdom-based media improve students' affective abilities	A11	1	4.17
Total		24	100

Based on Table 2, the results from the analysis of 24 articles indicate that research on chemistry learning media integrated with local wisdom effectively supports the learning process. The majority of studies (70.83%) concluded that the developed learning media were proven to be feasible, valid, and practical to use. These findings suggest that the integration of local wisdom into learning media may produce learning tools that are contextually relevant and suited to students' needs [29], [48].

Furthermore, the research indicates that chemistry learning media integrated with local wisdom can enhance students' cognitive abilities, affective aspects, and chemistry literacy. This improvement occurs because the integration of local culture serves as a conceptual bridge that helps concretize abstract chemistry concepts, bringing them closer to students' daily experiences.

Overall, the findings indicate that chemistry learning media incorporating local wisdom can promote more meaningful and contextual learning. Future studies should also give greater attention to developing innovative technology-based media, as immersive technologies have the potential to enhance culturally relevant learning experiences and support 21st-century skills [52], [53]. Additionally, research should also examine its impact more comprehensively on students' cognitive, affective, and chemistry literacy aspects.

This study has several limitations because the analyzed articles were limited to specific databases and publication periods. In addition, the selection process used specific inclusion and exclusion criteria, so some relevant studies may not have been included. Therefore, future research should use broader literature sources to provide a more comprehensive overview of local wisdom-based chemistry education research.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of a systematic literature review of 24 articles published between 2015 and 2025, this study indicates that research on chemistry learning media integrated with local wisdom is still dominated by the development of modules and e-modules at the high school level, particularly in regarding acid-base topics. The findings indicate that local wisdom has the potential to support more contextual and meaningful chemistry learning. However, research involving digital technology, science literacy, and the higher education context remains relatively limited. Therefore, future research should focus on the development of more innovative technology-based media and the expansion of the application of local wisdom integration into a broader educational context.

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REFERENCES

[1] Kurnia, M. R. A., Haryanto, H., Sanova, A., & Dewi, C. A. (2022). Studi respon siswa terhadap pengembangan multimedia interaktif berbasis chemo-entrepreneurship berbentuk aplikasi android. *Hydrogen: Jurnal Kependidikan Kimia*, *10*(1), 10–20. https://doi.org/10.33394/hjkk.v10i1.4954

[2] Brown, T. L., LeMay, H. E., Bursten, B. E., Murphy, C. J., & Woodward, P. M. (2018). *Chemistry: the central science* (14th ed.). Pearson.

[3] Erlangga, M. D., & Dwiningsih, K. (2024). Pengembangan e-modul kimia interaktif untuk meningkatkan hasil belajar peserta didik melalui representasi kimia pada materi reaksi reduksi dan oksidasi. *JIIP: Jurnal Ilmiah Ilmu Pendidikan*, *7*(3). https://doi.org/10.54371/jiip.v7i3.3762

[4] Okumuş, S., Özdilek, Z., & Doymuş, K. (2022). The effects of model-based cooperative and individual learning methods on pre-service science teachers' conceptual understanding of gases. *Acta Didactica Napocensia*, *15*(1). https://doi.org/10.24193/adn.15.1.1

[5] Safitri, R., & Sari, M. (2022). Pengembangan e-modul kimia berbasis SETS (science, environment, technology, and society) untuk siswa SMAN 1 Kecamatan Payakumbuh. *Journal of Chemistry Education and Integration*, *1*(1), 9. https://doi.org/10.24014/jcei.v1i1.16245

[6] Ristiyani, E., & Bahriah, E. S. (2016). Analisis kesulitan belajar kimia siswa di SMAN X Kota Tangerang Selatan. *Jurnal Penelitian dan Pembelajaran IPA*, *2*(1), 18–29. https://doi.org/10.30870/jppi.v2i1.431

[7] Yakina, Y., Kurniati, T., & Fadhilah, R. (2017). Analisis kesulitan belajar siswa pada mata pelajaran kimia kelas X di SMA Negeri 1 Sungai Ambawang. *Ar-Razi Jurnal Ilmiah*, *5*(2). https://doi.org/10.29406/arz.v5i2.641

[8] Bau, C. P., Olii, S., & Pakaya, N. (2022). Perbandingan motivasi belajar pada mata pelajaran kimia sebelum dan sesudah penerapan media pembelajaran augmented reality chemistry. *Inverted: Journal of Information Technology Education*, *2*(1), 44–53. https://doi.org/10.37905/inverted.v2i1.12978

[9] Sundari, C., & Silitonga, P. M. (2022). Penerapan media interaktif articulate storyline dalam pembelajaran ikatan kimia di SMA. *Jurnal Ilmiah Pendidikan*, *1*(4). https://doi.org/10.55904/educenter.v1i8.116

[10] Susanti, L. Y., Hasanah, R., & Khirizin, M. H. (2018). Penerapan media pembelajaran kimia berbasis science, technology, engineering, and mathematics (STEM) untuk meningkatkan hasil belajar siswa SMA/SMK pada materi reaksi redoks. *Jurnal Pendidikan Sains (JPS)*, *6*(2), 32–40. https://doi.org/10.26714/jps.6.2.2018.32-40

[11] Zuhri, M. S., & Rizaleni, E. A. (2016). Pengembangan media lectora inspire dengan pendekatan kontekstual pada siswa SMA kelas X. *Pythagoras: Jurnal Program Studi Pendidikan Matematika*, *5*(2). https://doi.org/10.33373/pythagoras.v5i2.463

[12] Olim, S. C., Nisi, V., & Romão, T. (2024). Augmented reality interactive experiences for multi-level chemistry understanding. *International Journal of Child-Computer Interaction*, *42*, 100681. https://doi.org/10.1016/j.ijcci.2024.100681

[13] Sadam, P. A. P., Paristiowati, M., & Syaadah, R. S. (2025). Pengembangan media pembelajaran diaroma dan 3D hidrokarbon (deret homolog) menggunakan assembler edu pada pembelajaran kimia materi hidrokarbon. *Jurnal Riset Pendidikan Kimia (JRPK)*, *15*(1), 54-59. https://doi.org/10.21009/JRPK.151.05

[14] Andriani, M., Muhali, M., & Dewi, C. A. (2019). Pengembangan modul kimia berbasis kontekstual untuk membangun pemahaman konsep siswa pada materi asam basa. *Hydrogen: Jurnal Kependidikan Kimia*, *7*(1), 25–36. https://doi.org/10.33394/hjkk.v7i1.1653

[15] Istiawati, N. F. (2016). Pendidikan karakter berbasis nilai-nilai kearifan

lokal adat Ammatoa dalam menumbuhkan karakter konservasi. *Cendekia: Journal of Education and Teaching, 10*(1), 1. https://doi.org/10.30957/cendekia.v10i1.78

[16] Khery, Y., Indah, D. R., Aini, M., & Nufida, B. A. (2020). Urgensi pengembangan pembelajaran kimia berbasis kearifan lokal dan kepariwisataan untuk menumbuhkan literasi sains siswa. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran, dan Pembelajaran, 6*(3), 460–474. https://doi.org/10.33394/jk.v6i3.2718

[17] Andini, D. R., & Sirozi, M. (2024). Integrasi kearifan lokal dalam perencanaan pengembangan kurikulum pendidikan Islam. *Jurnal Inovasi, Evaluasi dan Pengembangan Pembelajaran (JIEPP), 4*(3), 465–471. https://doi.org/10.54371/jiepp.v4i3.566

[18] Rahmatin, A., & Marzuki, I. (2022). Analisis kesulitan belajar siswa pada materi operasi hitung campuran bilangan cacah kelas 3 sekolah dasar. *Edusaintek: Jurnal Pendidikan, Sains dan Teknologi, 9*(3), 707–722. https://doi.org/10.47668/edusaintek.v9i3.572

[19] Mekonnen, Z., Kidemu, M., Abebe, H., Semere, M., Gebreyesus, M., Worku, A., Tesfaye, M., & Chernet, A. (2021). Traditional knowledge and institutions for sustainable climate change adaptation in Ethiopia. *Current Research in Environmental Sustainability, 3*, 100080. https://doi.org/10.1016/j.crsust.2021.100080

[20] Kiswanto, R. A., Wardani, S., Sudarmin, M. S., & Nurhayati, S. (2024). Pengembangan E-LKPD bermuatan STEM terintegrasi etnosains untuk meningkatkan keterampilan berpikir kritis siswa pada materi koloid. *Jurnal Kajian Penelitian Pendidikan dan Kebudayaan, 2*(1), 10–23. https://doi.org/10.59031/jkppk.v2i1.305

[21] Suparwati, N. M. A., Suja, I. W., & Tika, I. N. (2023). E-LKPD kimia berbasis STEM dengan muatan etnosains untuk meningkatkan model mental kimia pada materi laju reaksi. *Jurnal Pendidikan Kimia Undiksha, 7*(1). https://doi.org/10.23887/jjpk.v7i1.60208

[22] Wariani, T., Hayon, V. H. B., Mukin, M. U. J., & Naen, A. B. (2025). Pengembangan lembar kerja peserta didik (LKPD) berbasis etnosains materi redoks, sel Volta, dan elektrolisis. *Jurnal Locus Penelitian dan Pengabdian, 4*(5), 2207–2226. https://doi.org/10.58344/locus.v4i5.4092

[23] Miranti, I., & Refelita, F. (2023). Pengembangan media pop up book materi minyak bumi berbasis socio-scientific issue (SSI). *Journal of Chemistry Education and Integration, 2*(1), 58–66. https://doi.org/10.24014/jcei.v2i1.21625

[24] Salsabila, N., & Nurjayadi, M. (2019). Pengembangan modul elektronik (e-module) kimia berbasis kontekstual sebagai media pengayaan pada materi kimia unsur. *Jurnal Riset Pendidikan Kimia (JRPK), 9*(2), 103–111. https://doi.org/10.21009/JRPK.092.07

[25] S Sholeh, M. I. (2018). Pengembangan modul pembelajaran kimia dasar terintegrasi socio-scientific issue (ssi) dan keislaman. *Orbital: Jurnal Pendidikan Kimia, 2*(2), 37–57. https://doi.org/10.19109/ojpk.v2i2.2669

[26] Paristiowati, M., N, M., & Rahma, W. A. (2017). Video kimia online berbasis pembelajaran kontekstual sebagai alternatif media pada materi asam basa di SMA. *Jurnal Lentera Pendidikan Pusat Penelitian LPPM UM Metro, 2*(1), 63–73. https://doi.org/10.24127/jlplppm.v2i1.537

[27] Kelana, A. H., & Irawan, S. (2024). Pengembangan e-modul pembelajaran kimia pada materi koloid berbasis kearifan lokal Papua untuk meningkatkan hasil belajar peserta didik. *Journal of Innovation Research and Knowledge, 4*(7), 4365–4374. https://doi.org/10.53625/jirk.v4i7.9074

[28] Normayanti, F. P. & Muhammad Zamhari. (2022). Pengembangan watak (wayang kertas kimia) sebagai media pembelajaran ikatan kimia berbasis pendidikan karakter dan kearifan lokal untuk peserta didik SMA/MA. *Journal*

of Tropical Chemistry Research and Education, *4*(1), 10–21. https://doi.org/10.14421/jtcre.2022.41-02

[29] Tangio, J. S., Utina, R., Yusuf, F. M., Kunusa, W. R., Karim, C. R., & Arviani, A. (2023). Potensi tumbuhan lokal desa Meranti sebagai konten dan media pembelajaran berbasis kearifan lokal pada materi kimia. *Jambura Journal of Educational Chemistry*, *5*(2).

[30] Isdayanti, I., Wicaksono, A. T., & Rahmawati, H. (2022). Pengaruh penggunaan worksheet materi asam basa berbasis kearifan lokal terhadap hasil belajar siswa. *Al Kawnu: Science and Local Wisdom Journal*, *1*(2).

[31] Salamiyah, S., Astutik, T. P., & Wicaksono, A. T. (2023). Efektivitas lembar kerja peserta didik (LKPD) berbasis kearifan lokal dengan pendekatan STEAM pada materi asam basa. https://doi.org/10.19109/ojpk.v7i1.1613

[32] Redhana, I. W., Sudria, I. B. N., & Suardana, I. N. (2024). A digital instructional book: A tool for improving students' learning outcomes on the redox reaction. *Science Education International*, *35*(1), 61–70.

[33] Golu, A. A., Yuliatin, D., Inna, M., & Khery, Y. (2019). Respon mahasiswa pendidikan kimia terhadap pembelajaran kimia berbasis kearifan lokal dan kepariwisataan melalui pemanfaatan teknologi mobile. *Jurnal Ilmiah IKIP Mataram, 6*(2), 86–89..

[34] Faista, D. H., Sumarni, W., Sudarmin, S., & Harjito, H. (2023). Pengembangan modul kimia bermuatan etnosains pada budaya jamu tradisional terhadap literasi kimia siswa. *Chemistry in Education, 12*(2).

[35] Mashami, R. A., Ahmadi, & Pahriah. (2025). Green chemistry and cultural wisdom: A pathway to improving scientific literacy among high school students. *Social Sciences & Humanities Open, 11*, 101653. https://doi.org/10.1016/j.ssaho.2025.101653

[36] Willian, N., & Andriani, M. (2015). Pembelajaran kimia berbasis kultur budaya: Tinjauan pembelajaran kimia pantun pada topik konsep kimia unsur. *Jurnal Zarah, 3*(1).

[37] Rahmi, C., Fitria, A., Santika, V., & Rahmawati, S. (2022). Analisis pengembangan media dalam pembelajaran kimia. *Lantanida Journal, 10*(1), 10–24.

[38] Islamiati, E. F., & Redhana, I. W. (2025). The use of e-module in chemistry learning: A literature review. *AIP Conference Proceedings, 3206*, 070010.

[39] Hakim, E., Astafani, A., & Resmawati, R. F. (2024). Systematic review faktor-faktor kesulitan belajar materi kimia. *Jurnal Inovasi Pendidikan Kimia, 18*(2), 81–88. https://doi.org/10.15294/qm1ym619

[40] Anjasti, A. D., Alawiyah, N., & Sari, W. K. (2024). Pengembangan modul digital bermuatan cerita pendek berbasis kearifan lokal pada materi pokok asam basa. *LENSA: Lentera Sains Jurnal Pendidikan IPA, 14*(1), 37–47. https://doi.org/10.24929/lensa.v14i1.356

[41] Sihombing, N. P., Asrial, A., & Asmiyunda, A. (2025). Pengembangan media pembelajaran interaktif terintegrasi kearifan lokal pada materi asam basa di SMA. *Jurnal Penelitian, Pendidikan dan Pengajaran (JPPP), 6*(1), 28–36.

[42] Sulistiana, D., & Anggraini, D. P. (2024). Pengembangan modul elektronik kimia berbasis potensi lokal batik Blitar pada konsep materi dan asam basa. *LENSA: Lentera Sains Jurnal Pendidikan IPA, 14*(2), 84–94.

[43] Riza, M., Firmansyah, R. A., Zammi, M., & Djuniadi, D. (2020). Pengembangan modul kimia berbasis kearifan lokal Kota Semarang pada materi larutan asam dan basa. *JIPVA: Jurnal Pendidikan IPA Veteran, 4*(1), 25–38.

[44] Lia, Z. A. H., Junaidi, E., & Hadisaputra, S. (2024). Development of LKPD based on problem-based learning with ethnoscience content on colloidal system material. *Chemistry Education Practice, 7*(2), 403–409. https://doi.org/10.29303/cep.v7i2.5359

[45] Yusnidar, Y., & Epinur, E. (2021). Pengembangan e-modul kontekstual

berbasis kearifan lokal untuk siswa SMA pada materi pelajaran sistem koloid. *Journal of The Indonesian Society of Integrated Chemistry, 13*(2), 92–97.

[46] Nareswari, T. J., Alfaruq, M. S., Laili, N., Anggraini, L., Putri, V. K., & Setiawan, N. C. E. (2024). Development of ETNOCHEM application for chemistry learning with STEAM-2C approach based on local wisdom. *EXSACT-A*, *2*(1), 34–42.

[47] Togatorop, P., & Syahri, W. (2025). Pengembangan E-LKPD kimia hijau berbasis project based learning terintegrasi kearifan lokal di SMA fase E. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan, 3*(4), 5261–5271.

[48] Alexon, & Handayani, D. (2024). The development of e-LKPD with a culture-based integrated learning model (MPTBB) to improve student learning outcomes on buffer solution material. *International Journal of Information and Education Technology, 14*(1), 141–150. https://doi.org/10.18178/ijiet.2024.14.1.2034

[49] Mubarokah, F. D., Mulyani, S., & Indriyanti, N. Y. (2018). Identifying students' misconceptions of acid-base concepts using a three-tier diagnostic test: A case of Indonesia and Thailand. *Journal of Turkish Science Education, 15*. https://doi.org/10.36681/

[50] Rahayu, I. P. N. (2025). Pengembangan media pembelajaran kimia ramah budaya: Dakonic berbasis permainan dakon. *Journal of Research and Education Chemistry, 7*(2).

[51] Iswanto, I. H., Wulandari, A. Y. R., Wahyuni, E. A., Sutarja, M. C., & Putera, D. B. R. A. (2024). Pengembangan media pembelajaran IPA terpadu tipe webbed berbasis Wix tema garam Madura. *INKUIRI: Jurnal Pendidikan IPA, 13*(2), 182–194. https://doi.org/10.20961/inkuiri.v13i2.85388

[52] Hendrawani, H., Hatimah, H., Safitri,B. R. A., & Pahriah, P. (2025). Development of an inquiry-based ethnochemistry textbook to improve students' scientific literacy and understanding. *Hydrogen: Jurnal Kependidikan Kimia, 13*(2), 347–357. https://doi.org/10.33394/hjkk.v13i2.15467

[53] Yuendita, D., & Dina, D. (2024). Development of chemical literacy book on local wisdom of Madura culture based on augmented reality (AR). *Jurnal Penelitian Pendidikan IPA, 10*(1), 346–359. https://doi.org/10.29303/jppipa.v10i1.5689

[54] Serrano-Ausejo, E., & Mårell-Olsson, E. (2024). Opportunities and challenges of using immersive technologies to support students' spatial ability and 21st-century skills in K-12 education. *Education and Information Technologies, 29*, 5571–5597. https://doi.org/10.1007/s10639-023-11981-5

[55] Nurroniah, N. S., & Farizi, T. A. (2024). The use of virtual laboratories and immersive technology in science education in the digital era. *Jurnal Pendidikan dan Ilmu Fisika, 4*(2), 215–225. https://doi.org/10.52434/jpif.v4i2.42863