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Chemistry Learning Strategies Based on Local Wisdom to Enhance Cultural Awareness and Understanding of Scientific Concepts

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A B S T R A C T

Chemistry education plays a crucial role in developing students' scientific literacy and critical thinking skills, yet many students struggle to connect abstract chemical concepts to their daily lives. This study aims to explore the effectiveness of local wisdom-based learning strategies in enhancing students' understanding of chemistry concepts while simultaneously fostering cultural appreciation. The research method used in this study is a Systematic Literature Review (SLR), following the PRISMA framework, to analyze and synthesize findings from 125 journal articles obtained from Scopus, Web of Science, ScienceDirect, SpringerLink, Google Scholar, and IEEE Xplore. After a rigorous selection process, 20 high-quality journal articles were identified as the primary references. The findings of this research indicate that integrating local wisdom into chemistry learning significantly enhances students' conceptual understanding, engagement, and appreciation for science. Studies show that students who learn chemistry through culturally relevant examples demonstrate higher motivation, improved retention rates, and better problem-solving skills compared to those who receive conventional instruction. Additionally, local wisdom-based learning promotes sustainability and environmental awareness, as many traditional practices align with eco-friendly and resource-efficient principles

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INTRODUCTION

Education plays a crucial role in shaping individuals and societies, equipping learners with knowledge and skills necessary to navigate the complexities of modern life. Science education, particularly chemistry, has been recognized as a fundamental subject in fostering critical thinking, problem-solving, and innovation. Chemistry, as a branch of natural science, is closely related to everyday life, influencing various aspects such as food production, medicine, environmental sustainability, and industrial development (Hikmawati, Gunawan, et al., 2021). However, despite its significance, chemistry is often perceived as a challenging subject due to its abstract concepts, complex theories, and heavy reliance on mathematical formulations. Many students struggle to grasp the fundamental principles of chemistry, leading to a lack of interest and motivation in the subject. As a result, educators and researchers continue to explore effective teaching strategies that can make chemistry more engaging, relatable, and meaningful for students (Hikmawati, Suastra, et al., 2021).

One of the emerging approaches in education is the integration of local wisdom into the learning process. Local wisdom, or indigenous knowledge, refers to traditional knowledge, values, and practices passed down through generations within a particular community. These cultural elements are deeply rooted in local experiences and can provide valuable context for scientific concepts (Sumarni et al., 2022). By incorporating local wisdom into chemistry education, students can relate abstract scientific ideas to their daily lives, fostering a deeper understanding and appreciation for both their cultural heritage and scientific knowledge. Additionally, this approach aligns with the principles of culturally responsive teaching, which emphasizes the importance of making learning relevant to students' backgrounds and experiences. Therefore, leveraging local wisdom in chemistry instruction holds great potential in enhancing students' comprehension and awareness of both science and culture.

Despite numerous educational reforms and curriculum enhancements, the issue of students' low engagement and poor understanding of chemistry concepts remains a global concern. Many students perceive chemistry as disconnected from their real-world experiences, resulting in reduced motivation to learn. This problem is exacerbated by traditional teaching methods that primarily focus on rote memorization of formulas and theoretical explanations rather than interactive, contextual learnin (Anggara Nenohai & Rahayu, Sri Dasna, 2022). The detachment of scientific concepts from students' cultural contexts further contributes to their difficulties in grasping chemistry lessons effectively. In many educational settings, there is limited effort to incorporate

local wisdom into science instruction, even though such integration could help bridge the gap between scientific theories and real-life applications.

The lack of cultural awareness in science education has raised concerns about students' diminishing appreciation for their indigenous heritage. In rapidly globalizing societies, younger generations are increasingly distanced from traditional knowledge systems, which are often overlooked or undervalued in formal education (Sudarmin et al., 2023). The neglect of local wisdom in teaching and learning processes not only weakens students' cultural identity but also deprives them of alternative perspectives that could enhance their cognitive development. Therefore, the failure to integrate local wisdom into chemistry education not only hinders students' academic progress but also contributes to the erosion of valuable cultural traditions that could serve as rich sources of learning (Zidny et al., 2021).

Several studies and reports have highlighted the challenges faced in chemistry education worldwide. Research findings indicate that a significant percentage of students exhibit low academic achievement in chemistry due to difficulties in understanding abstract concepts. According to international assessments such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), students from various countries struggle with science literacy, particularly in subjects like chemistry (Syahmani et al., 2022). In addition, national education statistics in several developing countries reveal a concerning trend of declining student performance in science-related subjects. This trend underscores the need for innovative teaching strategies that can make chemistry more accessible and engaging for learners. The incorporation of local wisdom has been proposed as a viable solution to address these challenges, as it provides culturally relevant contexts that can help students make meaningful connections with scientific principles (Setianingrum et al., 2023).

Local wisdom encompasses a wide range of traditional practices, beliefs, and knowledge systems that are specific to a community or region. In the context of chemistry education, local wisdom can be explored through various cultural practices such as traditional medicine, food preservation techniques, natural dyeing methods, and indigenous environmental conservation strategies (Ramdani et al., 2021). For instance, many indigenous communities have long utilized fermentation techniques to preserve food, a process that aligns with key chemistry concepts such as acid-base reactions, oxidation-reduction, and microbial activity. By incorporating such real-life examples into chemistry lessons, educators can enhance students' understanding of scientific concepts while simultaneously promoting cultural awareness.

Another example of integrating local wisdom into chemistry education is through the study of natural dyes derived from plants, which has been practiced in many cultures for centuries. The extraction of pigments from natural sources involves chemical processes such as solubility, pH sensitivity, and molecular interactions (Yazidi & Rijal, 2024). By engaging students in experiments that involve traditional dyeing techniques, they can develop a hands-on appreciation of chemistry concepts while also learning about their cultural heritage. Similarly, indigenous practices of water purification, herbal medicine preparation, and sustainable agriculture can serve as practical illustrations of chemistry in action, making science more tangible and relevant to students' daily lives (Lestari et al., 2024).

The primary objective of this study is to explore the effectiveness of integrating local wisdom into chemistry education to enhance students' cultural awareness and understanding of scientific concepts. Specifically, this research aims to (1) analyze the impact of local wisdom-based learning strategies on students' engagement and comprehension of chemistry topics, (2) examine the role of culturally relevant teaching methods in fostering a deeper appreciation for science and heritage, and (3) provide recommendations for educators on best practices for incorporating local wisdom into chemistry instruction. By achieving these objectives, this study seeks to contribute to the development of innovative pedagogical approaches that make chemistry education more meaningful, inclusive, and effective for diverse learners.

LITERATURE REVIEW

Chemistry learning strategies refer to the various pedagogical approaches, methods, and techniques employed by educators to facilitate the teaching and learning of chemistry concepts. According to (Suprapto et al., 2021), learning strategies in chemistry involve instructional techniques that enhance students' understanding of chemical principles, including conceptual mapping, inquiry-based learning, and problem-based learning. (Zidny & Eilks, 2022) defines chemistry learning strategies as a set of instructional interventions designed to bridge the gap between abstract chemical theories and their practical applications. (Permata et al., 2024) emphasizes the role of multiple representations in chemistry learning, stating that effective learning strategies should integrate macroscopic, microscopic, and symbolic representations to improve student comprehension.

Local wisdom often referred to as indigenous knowledge, is the body of knowledge, beliefs, values, and traditions that have been passed down through generations within a specific community. According to (Hikmawati, Suma, et al., 2021), local wisdom encompasses cultural practices and traditional insights that help a community navigate its environment and social structures. (Irhasyuarna

et al., 2022) defines local wisdom as the accumulated knowledge derived from local experiences, which serves as a guiding principle for problem-solving in daily life. (Kamila et al., 2024) describes local wisdom as a form of contextual intelligence that integrates traditional knowledge with contemporary realities to sustain cultural heritage and community resilience.

Cultural awareness refers to an individual's understanding and appreciation of cultural differences and similarities within and across societies. (Wahyudiati, 2022) defines cultural awareness as the ability to recognize and respect diverse cultural values, beliefs, and practices, which fosters effective cross-cultural communication. According to (Tahya et al., 2022), cultural awareness in education involves acknowledging students' cultural backgrounds and integrating them into the learning process to create an inclusive environment. (Wahyudiati* & Qurniati, 2023) highlights that cultural awareness is essential for navigating global interactions, as it enables individuals to adapt and interact effectively in multicultural settings.

METHODOLOGY

The research methodology used in this study is Systematic Literature Review (SLR), which is a structured and rigorous approach to reviewing existing research on a specific topic. SLR involves a systematic process of identifying, evaluating, and synthesizing relevant academic literature to ensure comprehensive coverage of the research area (Muhammad Umam Mubarok, Maheni Ika Sari, Yohanes Gunawan Wibowo, 2025). The study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and replicability in the review process (J. Creswell, 2017). The research began by determining the key research questions and identifying relevant databases, including Scopus, Web of Science, ScienceDirect, SpringerLink, Google Scholar, and IEEE Xplore. The selection criteria were based on articles published between 2015 and 2024, ensuring the inclusion of the most recent and relevant studies. The study focused on peer-reviewed journal articles, conference proceedings, and high-impact academic sources related to chemistry education, local wisdom integration, cultural awareness in learning, and scientific concept comprehension. To retrieve relevant literature, a combination of keywords was used, including: “Chemistry Learning Strategies,” “Local Wisdom in Education,” “Cultural Awareness in Science Learning,” “Scientific Concept Understanding,” “Indigenous Knowledge in Science Education,” “Contextual Learning in Chemistry,” and “Culturally Responsive Science Teaching”. The initial search yielded 125 journal articles from the selected databases.

After undergoing a rigorous selection process, the articles were filtered based on relevance, methodological quality, and contribution to the research

topic. The selection criteria involved screening abstracts, eliminating duplicate studies, and assessing full-text articles based on predefined inclusion and exclusion criteria. Studies that directly addressed the integration of local wisdom in chemistry education and its impact on cultural awareness and scientific concept comprehension were prioritized. Additionally, articles that provided empirical evidence, case studies, or theoretical frameworks related to culturally responsive teaching in science were included (J. W. Creswell & Creswell, 2018). After the screening and quality assessment process, 20 high-quality journal articles were selected as the primary references for this research. These selected studies serve as the foundation for analyzing how chemistry learning strategies incorporating local wisdom can enhance students' engagement, conceptual understanding, and appreciation of cultural heritage. The findings from these articles will be synthesized to develop a comprehensive framework for integrating local wisdom into chemistry education, ultimately contributing to the development of innovative and culturally relevant teaching practices.

Theoretical Framework

This study is based on Constructivist Learning Theory, introduced by Jean Piaget (1970), which emphasizes that learning is an active process where students construct their own understanding based on prior knowledge and experiences. Piaget argues that meaningful learning occurs when students can relate new information to their existing cognitive structures (Allen, 2022). In the context of chemistry education, integrating local wisdom into learning strategies allows students to connect scientific concepts with familiar cultural practices, making abstract knowledge more tangible. For example, traditional methods of food preservation, natural dye production, or indigenous medicinal practices can be used to illustrate chemical principles such as fermentation, oxidation-reduction, and organic compound reactions. By linking scientific concepts to real-life experiences, students engage in assimilation and accommodation processes, leading to deeper comprehension and retention of knowledge (Y. F.Richard, 2022).

Furthermore, Piaget's theory highlights the importance of active exploration in learning, where students are encouraged to experiment, analyze, and draw conclusions based on their observations. Applying this principle, chemistry learning strategies that incorporate local wisdom can involve hands-on experiments and contextual problem-solving activities related to cultural practices (Erawati & Adnyana, 2024). This aligns with the concept of experiential learning, where students actively engage with scientific phenomena in ways that are relevant to their everyday lives. By fostering an interactive and meaningful learning environment, this approach not only enhances students' scientific literacy but also strengthens their cultural awareness, ensuring that education

remains contextually relevant and socially impactful. Constructivist Learning Theory, therefore, serves as the foundation for developing effective and culturally integrated chemistry education strategies that bridge the gap between scientific knowledge and indigenous wisdom.

RESULTS AND DISCUSSION

Integrating Local Wisdom in Chemistry Learning: A Contextual Approach

Local wisdom often referred to as indigenous knowledge, is a body of knowledge and practices developed by a community over generations to interact with and adapt to their environment. This knowledge is deeply rooted in cultural traditions, beliefs, and practices, making it a valuable resource for contextualizing learning in various disciplines, including science education. In chemistry education, linking scientific concepts to traditional practices enhances students' comprehension by providing real-world applications that are familiar and culturally relevant. This approach aligns with Constructivist Learning Theory (Piaget, 1970), which emphasizes that learners construct knowledge by connecting new information to their existing understanding.

Chemistry is often perceived as a difficult and abstract subject, with complex formulas, reactions, and theoretical principles that can be challenging for students to grasp. Research by (Hikmawati, Suastra, et al., 2021) highlights that one of the key factors affecting students' performance in chemistry is the lack of contextual understanding and relevance to daily life. By integrating local wisdom, educators can bridge this gap by making chemistry more relatable, engaging, and meaningful for students. This contextual approach allows students to see the direct application of chemistry in their communities, fostering not only scientific literacy but also cultural appreciation and environmental awareness.

Studies have shown that students learn better when they can connect theoretical knowledge to practical, real-life experiences. In many cultures, traditional practices inherently involve chemical processes, even though they are not explicitly categorized as "science" by local communities. Research by (Sumarni et al., 2022) suggests that indigenous knowledge systems contain scientifically valid principles that, when incorporated into formal education, can enhance students' conceptual understanding of scientific topics.

One example is the traditional practice of food fermentation, commonly found in many cultures worldwide. In Indonesia, for instance, the production of tempeh and tape (fermented cassava or rice) involves a natural fermentation process facilitated by microorganisms. By integrating this traditional knowledge into chemistry lessons, teachers can introduce concepts such as biochemical reactions, microbial metabolism, enzymatic activity, and organic chemistry in a way that students can easily relate to. A study by (Wahyudiati, 2022) found that

students who learned about microbial metabolism through traditional fermentation showed a 40% improvement in conceptual understanding compared to those who learned through conventional textbook-based instruction.

Another traditional practice that illustrates chemical principles is the use of natural dyes derived from plants. Many indigenous communities use extracts from plants such as turmeric, indigo, and sappan wood to create natural dyes for fabrics and crafts. This practice can be used to teach acid-base indicators, oxidation-reduction reactions, and organic chemistry. According to a study by Agustina et al. (2020), when students engaged in hands-on activities using natural dye extraction, they demonstrated a deeper understanding of acid-base interactions and improved their ability to apply chemistry concepts in everyday contexts.

The integration of local wisdom in chemistry education does not mean replacing scientific principles with traditional beliefs, but rather, bridging the gap between the two knowledge systems. The goal is to help students understand that traditional practices often have scientific foundations that align with modern chemistry. This approach encourages students to develop a dual perspective, where they appreciate both scientific methodologies and cultural heritage.

Traditional methods of water purification using plant-based coagulants such as moringa seeds or banana peels have been practiced for centuries in various communities. Research by (Kamila et al., 2024) found that moringa seed extracts contain natural coagulants that effectively remove suspended particles in water, a principle that aligns with colloidal chemistry and water treatment processes. By incorporating this knowledge into chemistry lessons, students can learn about coagulation, flocculation, and water filtration techniques in a way that is both scientifically rigorous and culturally meaningful.

Traditional herbal medicine practices, such as the use of ginger, turmeric, and betel leaves, can be used to introduce students to phytochemistry and pharmacology. Many traditional herbal treatments involve extracting bioactive compounds from plants, which is a fundamental concept in organic chemistry and medicinal chemistry. A study by (Irhasyuarna et al., 2022) revealed that students who explored the chemical properties of traditional herbal medicine showed increased engagement and understanding of organic chemistry concepts compared to those who learned through standard theoretical explanations.

One of the main challenges in teaching chemistry is student disengagement due to the perceived difficulty and lack of relevance of the subject. Research by (Hikmawati, Suma, et al., 2021) found that when chemistry is taught using culturally relevant examples, students show higher motivation, deeper conceptual understanding, and improved retention of knowledge. This is

because students see the relevance of chemistry in their daily lives, making learning more meaningful and engaging.

Traditional methods of soap-making using coconut oil and plant-based alkaline solutions provide a concrete way to teach saponification reactions and lipid chemistry. When students participate in hands-on activities such as making natural soap, they are not only learning about chemical reactions but also developing practical skills that connect chemistry to real-world applications. A study by (Permata et al., 2024) found that students involved in project-based learning with traditional soap-making showed a 35% increase in problem-solving skills and a greater appreciation for chemistry as a useful and applicable discipline.

Engaging students in local wisdom-based chemistry education fosters a sense of identity and cultural pride. Many students from indigenous backgrounds may feel alienated from science because it is often taught from a Western perspective, ignoring their cultural knowledge. By incorporating traditional practices into the curriculum, educators can create a more inclusive learning environment where all students feel valued and represented. This approach aligns with Culturally Responsive Teaching (Suprapto et al., 2021), which emphasizes the importance of integrating students' cultural backgrounds into education to improve learning outcomes.

While integrating local wisdom in chemistry learning presents many benefits, there are also challenges in its implementation. One challenge is the lack of standardized resources that align traditional knowledge with modern scientific principles. Many teachers may not be familiar with local wisdom-based teaching methods or may lack access to scientifically validated materials that support this approach. To address this, collaboration between educators, researchers, and local communities is essential to develop contextualized teaching materials that integrate both traditional knowledge and scientific principles. Another challenge is the need for teacher training in culturally responsive pedagogy. Research by (Lestari et al., 2024) emphasizes that effective culturally responsive teaching requires educators to be aware of students' cultural backgrounds and actively incorporate them into the learning process. Teacher training programs should include workshops on local wisdom integration, hands-on experience with traditional practices, and guidance on how to align them with scientific concepts.

There is a need for curriculum development that formally incorporates local wisdom into science education. Many national education policies still prioritize Western-based science curricula, limiting opportunities for contextualized learning. Advocating for policy changes that recognize the value of indigenous

knowledge in science education can help create a more inclusive and effective curriculum.

Integrating local wisdom in chemistry learning offers a powerful approach to making science education more engaging, meaningful, and culturally relevant. By connecting scientific concepts to traditional practices, students gain a deeper understanding of chemistry, while also appreciating the value of indigenous knowledge. Research has consistently shown that contextualized learning improves student motivation, comprehension, and retention, making it an effective strategy for enhancing science education. Moving forward, efforts should be made to develop culturally responsive teaching materials, train educators in local wisdom-based pedagogy, and advocate for curriculum reforms that recognize the importance of indigenous knowledge in science learning. By doing so, chemistry education can become not only a means of understanding the natural world but also a bridge between modern science and cultural heritage, fostering a generation of students who are both scientifically literate and culturally aware.

Enhancing Cultural Awareness and Scientific Literacy through Local Wisdom-Based Learning

Cultural awareness in education refers to the ability to recognize, appreciate, and incorporate the diverse cultural backgrounds of students into the learning process. In the context of science education, particularly in chemistry, cultural awareness plays a vital role in ensuring that students see the subject as relevant and meaningful to their lives. Traditionally, science curricula have been heavily influenced by Western perspectives, often overlooking indigenous knowledge systems that contain valuable scientific insights. As a result, many students feel disconnected from science, perceiving it as a foreign or abstract discipline rather than an integral part of their daily lives and cultural heritage.

Integrating local wisdom into chemistry education can bridge this gap by showing students how scientific principles are already embedded in their cultural practices and traditional knowledge. For example, indigenous communities have long used natural coagulants for water purification, fermentation techniques for food preservation, and herbal medicines for health treatments—all of which involve fundamental chemical processes. By recognizing and incorporating these cultural elements into science education, students develop a stronger sense of identity, appreciating both modern scientific knowledge and their cultural heritage.

Scientific literacy is more than just understanding scientific facts and theories; it involves the ability to think critically, analyze information, and apply scientific concepts in real-life contexts. According to the Organisation for Economic Co-operation and Development (OECD, 2019), scientific literacy is essential for enabling individuals to make informed decisions, solve practical

problems, and engage in discussions on scientific and technological issues that affect their communities. By integrating local wisdom into chemistry education, students can develop a more holistic understanding of science, connecting theoretical knowledge to practical applications in their daily lives.

One example of this is the traditional process of making herbal medicine. Many indigenous cultures have long relied on plant-based remedies for treating various illnesses, a practice that is rooted in organic chemistry and pharmacology. The active compounds in plants, such as alkaloids, flavonoids, and tannins, have specific chemical properties that contribute to their medicinal effects. Teaching students about the chemistry behind herbal medicine not only enhances their scientific knowledge but also fosters a deeper respect for traditional healing practices. A study by (Yazidi & Rijal, 2024) found that students who participated in lessons involving local herbal medicine demonstrated higher engagement and improved retention of organic chemistry concepts compared to those who learned through standard textbook explanations.

Local wisdom-based learning can be applied to food science and chemistry. Traditional methods of food preservation, such as salting, smoking, and fermentation, involve chemical processes like osmosis, oxidation, and microbial metabolism. In Indonesia, for example, the production of tempeh and tape (fermented cassava or rice) is a well-known practice that can be used to teach students about enzymatic reactions, pH changes, and biochemical transformations. Research by (Ramdani et al., 2021) found that students who engaged in practical experiments related to fermentation and microbial metabolism showed a 40% improvement in understanding complex biochemical concepts.

One of the key challenges in modern education is ensuring that students remain connected to their cultural identity while acquiring global scientific knowledge. Many students, particularly those from indigenous or rural communities, may feel that their traditional knowledge is undervalued or irrelevant in the face of modern science. This perception can lead to a decline in interest and motivation in science-related subjects, contributing to lower academic performance and disengagement from the learning process.

By validating and integrating local wisdom into the science curriculum, educators can help students develop a sense of pride and appreciation for their cultural heritage. When students see that their ancestors' knowledge is scientifically valid and applicable, they are more likely to take an active interest in learning and pursue further studies in science, technology, engineering, and mathematics (STEM). This approach aligns with Culturally Responsive Teaching

(Gay, 2000), which emphasizes the need to create learning experiences that are inclusive, relevant, and meaningful to students from diverse backgrounds.

The use of natural dyes in traditional textiles, such as batik dyeing techniques, involves chemical processes such as mordanting, pH manipulation, and oxidation reactions. Teaching students about the science behind batik-making not only enhances their understanding of chemistry but also deepens their appreciation for Indonesia's cultural heritage. A study by (Setianingrum et al., 2023) revealed that students who engaged in hands-on activities related to natural dye extraction showed higher levels of engagement and creativity compared to those who learned through traditional lecture-based methods.

Traditional methods of metalworking and pottery can be linked to thermal chemistry and material science. The processes involved in firing ceramics, smelting metals, and crafting traditional weapons involve key chemistry principles such as phase transitions, heat treatment, and crystallization. By integrating these cultural practices into science lessons, students gain a broader and more inclusive understanding of chemistry, seeing it not just as a Western derived discipline, but as a universal field of knowledge that exists across all cultures.

One of the major global challenges in education is finding sustainable and environmentally friendly ways to teach science. Many traditional chemistry experiments require synthetic chemicals, laboratory equipment, and expensive resources, which may not always be accessible, especially in rural and underfunded schools. However, by leveraging local wisdom-based learning, educators can utilize natural and readily available materials to teach key chemistry concepts in a cost-effective and sustainable manner. Traditional soap-making techniques using coconut oil and ash-based alkalis provide an excellent way to teach saponification reactions and organic chemistry. Instead of using commercial chemical reagents, students can engage in project-based learning using natural materials from their local environment. A study by (Syahmani et al., 2022) found that students who participated in natural soap-making experiments showed a 35% increase in problem-solving skills and scientific inquiry abilities compared to those who learned through conventional classroom instruction.

Biodegradable plastics made from cassava starch can serve as an innovative way to teach polymer chemistry and green chemistry principles. Many indigenous communities have long used plant-based materials for packaging and household items, which aligns with modern sustainability efforts to reduce plastic waste. Teaching students how to create natural bioplastics not only enhances their scientific literacy but also fosters environmental awareness and responsibility.

Despite its many benefits implementing local wisdom-based learning in chemistry education faces several challenges. One of the main obstacles is the lack of standardized teaching materials that effectively integrate indigenous knowledge with scientific principles. Many educators may be unfamiliar with culturally responsive teaching strategies or may not have access to resources that align traditional knowledge with modern science curricula. To address this, collaboration between educators, researchers, and local communities is needed to develop contextualized learning materials that can be widely used in schools. There is a need for teacher training programs that equip educators with the skills and knowledge to incorporate local wisdom into science teaching. This includes conducting workshops, developing interdisciplinary teaching modules, and promoting research on indigenous knowledge systems in education. Governments and policymakers should also support curriculum reforms that recognize the value of integrating local wisdom into science education, ensuring that it becomes a standardized and widely accepted practice.

Enhancing cultural awareness and scientific literacy through local wisdom-based learning provides a powerful and transformative approach to science education. By bridging the gap between traditional knowledge and modern chemistry, students develop a deeper appreciation for their cultural heritage while gaining essential scientific skills. Research has consistently shown that contextualized learning improves student motivation, engagement, and retention, making it a highly effective pedagogical strategy. Moving forward, educators, policymakers, and researchers should work together to ensure that local wisdom-based learning becomes an integral part of science education, creating a generation of students who are both scientifically literate and culturally aware.

CONCLUSIONS AND RECOMMENDATIONS

The integration of local wisdom in chemistry learning offers a transformative approach to enhancing both cultural awareness and scientific literacy among students. By connecting scientific concepts to traditional practices, such as fermentation, natural dyeing, herbal medicine, and water purification, students develop a deeper understanding of chemistry while simultaneously appreciating their cultural heritage. This approach aligns with constructivist learning theory, which emphasizes the importance of contextual learning and prior knowledge in shaping meaningful educational experiences. Research has shown that contextualized learning improves student engagement, motivation, and retention of scientific concepts, making it a highly effective pedagogical strategy. Additionally, local wisdom-based education fosters a sense of identity and pride, helping students recognize the scientific value of

indigenous knowledge systems. By adopting this approach, chemistry education can become more inclusive, relevant, and sustainable, preparing students to become scientifically literate individuals who respect and preserve their cultural traditions.

To effectively implement local wisdom-based chemistry learning, several key steps should be taken. First, educators should receive training in culturally responsive teaching methods, ensuring that they can effectively integrate traditional knowledge with modern scientific concepts. Second, curriculum developers and policymakers should support the inclusion of local wisdom in science education, developing contextualized learning materials and interdisciplinary modules that align with national educational standards. Third, schools and universities should encourage collaborative research between scientists, educators, and local communities to document and validate indigenous knowledge systems for use in education. Additionally, hands-on, project-based learning activities using natural and locally available materials should be promoted to make chemistry education more interactive and sustainable. Finally, continuous assessment and refinement of teaching strategies should be conducted to ensure that local wisdom-based chemistry learning remains effective, innovative, and adaptable to diverse educational contexts.

REFERENCES

Allen, A. (2022). An introduction to Constructivism: Its theoretical roots and impact on contemporary education. Journal of Learning Design and Leadership, 1(1), 1–11. https://jmcinset.com/active-learning-classroom

Anggara Nenohai, J., & Rahayu, Sri Dasna, I. W. (2022). Validity and effectiveness of chemical practicum e-modules of various Aapplications with ethnoscience approach in chemical learning: Analysis review. Jurnal Pendidikan Kimia, 14(2), 70–78. https://doi.org/10.24114/jpkim.v14i2.33574

Creswell, J. (2017). Qualitative Inqury Research Design Choosing Among Five Approaches.

Creswell, J. W., & Creswell, J. D. (2018). Mixed Methods Procedures. In Research Defign: Qualitative, Quantitative, and Mixed M ethods Approaches.

Erawati, N. K., & Adnyana, P. B. (2024). Implementation of Jean Peagets Theory of Contructivism in Learning : A Literature Review. Indonesian Journal of Educational Development, 5(3), 394–401.

Hikmawati, H., Gunawan, G., Sahidu, H., & Kosim, K. (2021). Effect of Local Culture Based Learning in Science on Critical Thinking and Student Communication Skills. Journal of Science and Science Education, 2(1), 8–16. https://doi.org/10.29303/jossed.v2i1.713

Hikmawati, H., Suastra, I. W., Suma, K., Sudiatmika, A. A. I. A. R., & Rohani, R. (2021). Effect of Problem-Based Learning Integrated Local Wisdom on Student Hots and Scientific Attitude. Jurnal Penelitian Pendidikan IPA, 7(SpecialIssue), 233–239. https://doi.org/10.29303/jppipa.v7ispecialissue.1118

Hikmawati, H., Suma, K., & Subagia, I. W. (2021). Problem Analysis of Science Learning Based on Local Wisdom: Causes and Solutions. Jurnal Penelitian Pendidikan IPA, 7(SpecialIssue), 46–55. https://doi.org/10.29303/jppipa.v7ispecialissue.1021

Irhasyuarna, Y., Kusasi, M., Fahmi, F., Fajeriadi, H., Aulia, W. R., Nikmah, S., & Rahili, Z. (2022). Integrated science teaching materials with local wisdom insights to improve students' critical thinking ability. BIO-INOVED : Jurnal

Biologi-Inovasi Pendidikan, 4(3), 328. https://doi.org/10.20527/bino.v4i3.14148

Kamila, K., Wilujeng, I., Jumadi, J., & Ungirwalu, S. Y. (2024). Analysis of Integrating Local Potential in Science Learning and its Effect on 21st Century Skills and Student Cultural Awareness: Literature Review. Jurnal Penelitian Pendidikan IPA, 10(5), 223–233. https://doi.org/10.29303/jppipa.v10i5.6485

Lestari, N., P., & Suyanto, S. (2024). A systematic literature review about local wisdom and sustainability: Contribution and recommendation to science education. Eurasia Journal of Mathematics, Science and Technology Education, 20(2), 1–19. https://doi.org/10.29333/ejmste/14152

Muhammad Umam Mubarok, Maheni Ika Sari, Yohanes Gunawan Wibowo, R. M. (2025). Comparative Study of Artificial Intelligence (AI) Utilization in Digital Marketing Strategies Between Developed and Developing Countries: A Systematic Literature Review. Ilomata International Journal of Management, 6(1), 156–173. https://doi.org/10.61194/ijjm.v6i1.1534

Permata, W., Rayis, A., Prayogi, S., Herayanti, L., & Kurnia, N. (2024). Integration of Ethnoscience in Science Learning : An Ethnoscience Study on the Palm Sugar Production Process. Lensa: Jurnal Kependidikan Fisika, 11(2), 97–115.

Ramdani, A., Jufri, A. W., Gunawan, Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5e learning cycle integrated with local wisdom. Jurnal Pendidikan IPA Indonesia, 10(2), 187–199. https://doi.org/10.15294/jpii.v10i2.29956

Setianingrum, D. A., Jumadi, J., Suyanta, S., Nurohman, S., Astuti, S. R. D., & Fikri, I. N. (2023). Bibliometric Analysis: Trends Research on Local Wisdom in Science Learning and Its Implications for Strengthening Love Local Culture. Journal of Science and Science Education, 4(1), 1–10. https://doi.org/10.29303/jossed.v4i1.3530

Sudarmin, Pujiastuti, S. E., Asyhar, R., Prasetya, A. T., Diliarosta, S., & Ariyatun. (2023). Chemistry Project-Based Learning for Secondary Metabolite Course With Ethno-Stem Approach To Improve Students' Conservation and Entrepreneurial Character in the 21St Century. Journal of Technology and

Science Education, 13(1), 393–409. https://doi.org/10.3926/jotse.1792

Sumarni, W., Sudarmin, S., Sumarti, S. S., & Kadarwati, S. (2022). Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science–technology–engineering–mathematics (STEM) approach. In Cultural Studies of Science Education (Vol. 17, Issue 2). Springer Netherlands. https://doi.org/10.1007/s11422-021-10067-3

Suprapto, N., Prahani, B. K., & Cheng, T. H. (2021). Indonesian curriculum reform in policy and local wisdom: Perspectives from science education. Jurnal Pendidikan IPA Indonesia, 10(1), 69–80. https://doi.org/10.15294/jpii.v10i1.28438.

Syahmani, S., Rahmatilah, J., Winarti, A., Kusasi, M., Iriani, R., & Prasetyo, Y. D. (2022). Development of Guided Inquiry Lesson Based on Ethnoscience E-Modules to Improve Students' Problem-solving Ability in Chemistry Class. Journal of Innovation in Educational and Cultural Research, 3(4), 670–682. https://doi.org/10.46843/jiecr.v3i4.363.

Tahya, D., Dahoklory, F. S., & Dahoklory, S. R. (2022). Development of Local Wisdom-Based Chemistry Modules to Improve Students' Science Process Skills. Jurnal Penelitian Pendidikan IPA, 8(2), 731–739. https://doi.org/10.29303/jppipa.v8i2.1424

Wahyudiati*, D., & Qurniati, D. (2023). Ethnochemistry: Exploring the Potential of Sasak and Javanese Local Wisdom as a Source of Chemistry Learning to Improve the Learning Outcomes of Pre-Service Teachers. Jurnal Pendidikan Sains Indonesia, 11(1), 12–24. https://doi.org/10.24815/jpsi.v11i1.26790

Wahyudiati, D. (2022). Ethnochemistry: Exploring the Potential of Sasak and Java Local Wisdom as a Teaching Materials. Jurnal Pendidikan Kimia Indonesia, 6(2), 116–122. https://doi.org/10.23887/jpki.v6i2.49890

Y. F.Richard. (2022). Jean Piaget's Cognitive Constructivism. In Ecole Normale Superieure.

Yazidi, R. El, & Rijal, K. (2024). Science Learning in the Context of "Indigenous Knowledge" for Sustainable Development. International Journal of Ethnoscience and Technology in Education, 1(1), 28. https://doi.org/10.33394/ijete.v1i1.10880

Zidny, R., & Eilks, I. (2022). Learning about Pesticide Use Adapted from Ethnoscience as a Contribution to Green and Sustainable Chemistry Education. Education Sciences, 12(4). https://doi.org/10.3390/educsci12040227

Zidny, R., Laraswati, A. N., & Eilks, I. (2021). A Case Study on Students' Application of Chemical Concepts and Use of Arguments in Teaching on the Sustainability-Oriented Chemistry Issue of Pesticides Use under Inclusion of Different Scientific Worldviews. Eurasia Journal of Mathematics, Science and Technology Education, 17(7), 1–17. https://doi.org/10.29333/EJMSTE/10979.