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FOSTERING ENGAGEMENT AND LEARNING OUTCOMES: A COMPARATIVE ANALYSIS OF ETHNOCHEMICAL AND STEM-BASED PEDAGOGIES FOR CHEMISTRY LEARNING IN VOCATIONAL HIGH SCHOOLS

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ABSTRACT

In contemporary education, the perceived difficulty of learning chemistry, attributed to its abstract nature, remains a challenge for many students. This difficulty is compounded by a notable lack of alignment between chemistry concepts and students' daily experiences, despite the inherent relevance of chemistry to their everyday phenomena. Building on previous research affirming the efficacy of ethnochemical modules in enhancing student learning and achievement, this study investigates the suitability of a STEM-based approach for chemistry education, particularly in vocational high school. The research methodology employs a literature study method, utilizing the PICO(T) framework for keyword selection. A rigorous review and analysis of 15 from 94 scientific papers were conducted to glean insights into the effectiveness of these pedagogical approaches. The literature synthesis emphasizing the importance of cultural relevance, interactive module design, and active learning strategies in shaping students' engagement and learning outcomes in chemistry education in vocational high school.

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INTRODUCTION

The discipline of chemistry constitutes an integral component of the pedagogical framework within culinary education. It holds particular significance within the domain of nutritional science at both vocational and tertiary education levels. Chemistry, as a scientific discipline, delves into the comprehensive study of matter, encompassing its constitution, attributes, alterations, and the associated energy conversions attendant to these material transformations (Robo & Taher, 2021). Presently, a noteworthy challenge persists wherein students often encounter difficulty in assimilating chemical concepts, primarily owing to the abstract nature of the subject. An additional contributing factor is the perceived lack of cohesive pedagogical linkage between chemistry principles and everyday life phenomena, despite the inherent interconnectedness of chemistry with the daily experiences of students. Consequently, establishing a meaningful correlation between chemistry education and students' cultural context or commonplace occurrences becomes imperative, thereby facilitating a more profound and purposeful learning encounter.

The current predicament is characterized by a notable absence of educational institutions, instructors, or students fostering culture-based ethnochemical competencies within the classroom milieu. A study conducted by Arif et al. (2021) at MAN 1 Tikep elucidates that the prevailing chemistry learning paradigm in schools is predominantly numerical-centric, lacking due consideration for the cultivation of a diverse skill set, notably excluding 21st-century skills. Similarly, an investigation by Robo and Taher (2021) at Madrasah Aliyah Alkhairaat Guraping underscores that the chemistry learning approach remains excessively grade-focused, neglecting the incorporation of essential skills, including those pertinent to the 21st century. Consequently, the pedagogical process manifests as stagnant and adheres to traditional methods, predominantly relying on lectures, exercises, and assignments. Such an instructional approach hampers the honing of students' communication skills and stifles the development of their innovative ideas. This deficiency

in fostering a dynamic learning environment is a causative factor contributing to the students' diminished curiosity and waning interest in the chemistry learning experience within the classroom setting.

The incorporation of cultural products into chemistry education as a learning resource yields positive effects in enhancing the comprehension of chemical concepts, consequently leading to improved student learning outcomes (Fadli & Irwanto, 2020; Ismiani et al., 2017; Sutrisno et al., 2020). The chemical triangle, encompassing macro, micro, and symbolic concepts, constitutes the fundamental characteristics of chemistry and finds widespread applicability in daily life. The practical manifestation of chemical concepts in everyday existence is observed within the societal framework and cultural artifacts, collectively referred to as ethnochemistry.

Ethnochemistry is characterized by the utilization of chemical concepts in people's lives, as evidenced by cultural traditions, symbols, value systems, social structures, and cultural products identified as pertinent to chemical concepts or practices present in diverse cultures (Abramova & Greer, 2013; Said-Ador, 2017). The amalgamation of chemistry materials with local wisdom is readily achievable through the provision of examples linking chemical concepts to cultural products. Moreover, leveraging cultural products as natural laboratories facilitates a seamless integration of chemistry education with local cultural contexts (Fadli & Irwanto, 2020; Wahyudiati, 2020; Wahyudiati & Fitriani, 2021). This pedagogical approach not only renders learning more meaningful but also nurtures a contextualized understanding of chemistry within the framework of cultural diversity.

Examining the literature pertinent to strategies aimed at augmenting students' interest in learning, the adoption of a STEM-based approach (Science, Technology, Engineering, and Mathematics) emerges as a viable solution, wherein the interconnection of chemistry with other scientific domains becomes pivotal. STEM education offers a platform for learners to delve comprehensively into academic concepts by amalgamating four key disciplines: science, technology, engineering, and mathematics. This pedagogical framework not only facilitates a nuanced understanding of subject matter but also fosters innovation, problem-solving acumen, and instills confidence in students as adept inventors. Additionally, STEM-based learning contributes to heightened technological awareness and cultivates logical thinking skills among students (Susanti et al., 2018).

Within the ambit of STEM-based education, students are guided to integrate their academic knowledge and skills across the domains of science, technology, engineering, and mathematics, employing them collaboratively to devise solutions to specific challenges. The overarching objective of the STEM approach is to equip students with critical thinking skills, enabling them to evolve into creative problem solvers, a trait highly prized in professional environments (Granovskiy, 2018). This multidisciplinary educational strategy thus serves as a catalyst in not only enriching students' academic experiences but also in nurturing the competencies essential for success in the contemporary workforce.

In STEM educational contexts, three predominant teaching approaches are commonly employed. Firstly, the Silo Method entails the discrete instruction of the four STEM elements, wherein emphasis is placed on the substantive content of each individual element (Safitri & Iryani, 2021). Secondly, the Embedded Approach concentrates more extensively on one specific STEM component, considering the other components as supplementary elements (Winarni et al., 2016). Thirdly, the Integrated Approach involves the instruction of STEM materials as an integral unit, eliminating the compartmentalization of STEM components. This integrated STEM learning methodology is regarded as more straightforward to implement, particularly at the foundational education level (Laisnima & Siregar, 2020). These distinct approaches offer educators flexibility in tailoring their instructional methods to the specific learning objectives and needs of their students within the STEM framework.

A comprehensive investigation has been undertaken to assess the efficacy of learning modules designed in the forms of Ethnochemical and STEM-based approaches, specifically tailored for utilization within the classroom setting. This research endeavors to scrutinize existing literature on the implementation of ethnochemical-based learning modules and STEM-based learning modules, with a primary objective of comparing the outcomes derived from these two distinct approaches. The focus of this inquiry is to critically review and evaluate the effectiveness of both ethnochemical and STEM-based methodologies in cultivating learning interest among vocational students enrolled in the Tata Boga department. Through a rigorous examination of the scholarly literature, this research aims to contribute valuable insights into the comparative impact of these pedagogical approaches, thereby informing educational practices and advancing the field of vocational education.

METHOD

This research adopts the literature study method, specifically employing a literature review approach, to systematically collect and describe pertinent data or sources related to the research subject, drawing on insights provided by Gazali et al. (2023) and Wulandini et al. (2022). The methodology involves a meticulous analysis of journals, where summaries are generated to address the research questions and objectives. These summarized findings are subsequently integrated into the results and discussion section, ultimately culminating in the formulation of conclusions. The analysis of the selected journals adheres to the PICO(T) framework, incorporating keywords that signify Population, Intervention, Comparison, Outcomes, and Time, as elucidated by Eriksen and Frandsen (2018). The specific PICO(T) values employed in this study are detailed in Table 1. This methodological approach ensures a systematic and structured examination of the literature, contributing to a robust foundation for drawing meaningful conclusions within the realm of the research subject.

The research process involved a meticulous review and analysis of a curated selection of 15 from 94 scientific papers, all of which deliberated on the implementation of ethnochemical-based learning modules and STEM-based learning modules. The chosen articles for review possess certification from reputable indexing bodies, including Sinta, Scopus, and ISSN journals. The selection criteria ensure the reliability and scholarly standing of the sources under examination. Access to these articles was facilitated through reputable academic databases, specifically Google Scholar and Proquest.

Table 1. PICO(T) analysis as a research method.

Keywords PICO(T)	Implementation in Research
P (Problem)	Low interest in learning nutrition science
I (Implementation/Intervention)	The impact of students' learning interest on ethnochemical and STEM-based modules
C (Comparison)	Students' learning interest when given ethnochemical and STEM modules
O (Outcomes)	Effective learning modules increase students' interest in learning
T (Time)	10 years (2013–2023)

The research methodology unfolds through distinct phases, commencing with the systematic collection of data pertaining to the subjects under investigation. Subsequently, a comprehensive analysis was conducted to distill key insights from the selected literature. The research process culminates in the formulation of conclusive findings and insights. This methodological framework ensures a rigorous and scholarly approach to examining the application and impact of ethnochemical-based and STEM-based learning modules, contributing to a nuanced understanding of their efficacy in the educational context.

RESULTS

Utilization of Ethnochemical Modules

Herawati and Muhtadi (2018) developed an interactive chemistry e-module designed for secondary schools, with the primary objective of assessing its appropriateness and effectiveness in enhancing learning outcomes. The study aligns with a broader interest in understanding how ethnochemical modules influence learning engagement, as it corresponds with the overarching research focus on the efficacy of e-modules in enhancing educational outcomes.

Subsequently, Sutrisno et al. (2020) delved into the integration of ethnochemistry into the realm of chemistry education, with a specific emphasis on leveraging Sasak local wisdom for chemistry learning modules. This research scrutinized the incorporation of ethnochemical elements into the chemistry curriculum, investigating the resultant impact on students' enthusiasm for the subject. The findings revealed that the infusion of Basic Chemistry teaching materials with Sasak local wisdom led to heightened interest, motivation, and active participation among students in comprehending Basic Chemistry 1 concepts that hold relevance to their daily lives. The integration of chemistry concepts with the community's local wisdom values not only rendered learning more meaningful but also demonstrated practical applications in the daily activities of the community.

Jofrishal and Seprianto (2020) conducted a research study implementing ethnochemical-based instructional modules within vocational schools specializing in culinary arts, with the objective of enhancing students' comprehension of food chemistry concepts. The outcomes demonstrated a significant improvement in learning results, manifesting as a 40-point increase subsequent to the implementation of the ethnochemical-based module. The research further unveiled a congruent correlation with students' cultural acumen, elucidating that learners adeptly connected chemistry concepts acquired in the classroom to their everyday experiences, thereby facilitating a more facile assimilation of the material.

In a related study, Utari et al. (2021) systematically examined the effectiveness of ethnoscience-based chemistry learning materials, placing a distinct emphasis on the cultivation of behavioral attributes and character qualities. This investigation assumes significance as it delineates the reliability and affirmative impact of ethnochemical learning materials. This discernment is pivotal in comprehending the influence of such materials on students' enthusiasm for engaging with chemistry in the educational setting. The synthesis of these research findings contributes valuable knowledge, enriching our understanding of how ethnochemical learning materials contribute to students' receptivity and engagement in chemistry education.

Utilization of STEM Modules

The utilization of STEM-based modules (Science, Technology, Engineering, and Mathematics) has also undergone scrutiny in the academic literature. Research conducted by Susanti et al. (2018) systematically explored the viability of employing STEM-based chemistry learning media to enhance the educational outcomes of high school and vocational high school students. The investigation yielded noteworthy findings, revealing substantial disparities in cognitive learning outcomes between classes that engaged with the redox reaction material through STEM-based learning media and those employing conventional instructional methods. Specifically, the study demonstrated that students exhibited elevated cognitive learning outcomes following their engagement with STEM learning modules, underscoring the efficacy of this pedagogical approach in fostering enhanced understanding and retention of the subject matter. These research outcomes contribute to the growing body of evidence supporting the positive impact of STEM-based educational tools on students' cognitive learning achievements.

Cahyani et al. (2020) conducted an empirical investigation involving the implementation of STEM-integrated project-based learning e-modules with the objective of enhancing the creative aptitude of vocational students. The research findings indicate that the utilization of these modules led to improvements in both creativity and learning outcomes among vocational students. It is noteworthy, however, that the observed enhancements were categorized as moderate and did not attain statistical significance.

In a complementary study, Pujiati (2020) explored the impact of the STEM approach on students' comprehension of chemistry material. The research revealed a notable improvement in students' understanding of the material. This positive outcome is attributed to the distinctive feature of the STEM approach, wherein students are actively engaged in project-based activities, such as creating

atomic structure posters. The active involvement in the design and preparation of materials through STEM projects contributes to a more effective and memorable learning experience for students. The research underscores the pedagogical value of incorporating STEM methodologies in fostering deeper comprehension and retention of scientific concepts.

DISCUSSION

The collective findings from the aforementioned studies highlight that, in the absence of specific learning modules, students' interest in learning chemistry is susceptible to the broader trend of their attitudes towards science. Notably, considering the relatively diminished interest in abstract chemistry among students, the incorporation of ethnochemical learning modules emerges as a potent strategy for elevating students' engagement with chemistry. Key contributors to the success of ethnochemistry in enhancing students' interest include the development and utilization of interactive modules, the exploration of local wisdom, and a dedicated focus on character values and the preservation of cultural attitudes.

The synthesis of previous research underscores the correlation between students' motivation levels and their proactive engagement in task completion and knowledge construction. This, in turn, positively influences their overall learning outcomes. This alignment is consistent across various studies (Abramova & Greer, 2013; Çalik et al., 2015; Marasinghe, 2016; Wahyudiati et al., 2019), emphasizing that high motivation levels and curiosity serve as pivotal elements influencing the efficacy of science learning. Recognizing these factors as crucial components contributes to fostering more effective and meaningful science education experiences for students.

The implementation of the representation and visualization approach within the ethnochemical framework stands out as a crucial advantage in the realm of chemistry education. This approach entails the utilization of tangible examples linked to daily life, aligning with students' personal and cultural experiences. Presenting concrete instances of elements, compounds, and mixtures in students' everyday lives enhances the appeal and significance of learning, fostering the development of their representation skills in collegiate chemistry education (Santos & Arroio, 2016).

Research by Rosa and Orey (2011) and Ajayi et al. (2017) underscores that the application of modules and ethnochemical learning approaches can enhance the effectiveness of classroom learning and elevate student learning achievements. This heightened engagement also positively influences the development of student competencies across cognitive, affective, and psychomotor domains (Febriana et al., 2014; Rahmawati et al., 2017).

In a parallel context, research conducted by Cahyani et al. (2020) and Pujiati (2020) concluded that the average cognitive and affective learning outcomes in the experimental class, following the implementation of STEM-based teaching media, surpassed those in the control class. This advantage is attributed to the inherent appeal and advantages of STEM learning media, such as its problem-based nature, which stimulates cognitive abilities, regulates the student learning process, and enhances student activity in learning endeavors. These findings resonate with the outcomes of Dewi et al. (2018) study, which demonstrated that the application of the STEM approach effectively improves physics problem-solving skills. Additionally, these results align with the broader conceptual understanding that the application of the STEM approach contributes to an enhanced comprehension of chemical concepts, as it actively involves students in the learning process.

Prior research consistently affirms that students with high motivation levels exhibit increased activity and success in science learning, underscoring the significant influence of motivation and curiosity on learning outcomes (Abramova & Greer, 2013; Çalik et al., 2015; Marasinghe, 2016; Wahyudiati et al., 2019). The incorporation of representation and visualization approaches is deemed paramount in chemistry education, leveraging concrete examples from students' daily lives to enhance the allure and meaningfulness of learning while fostering advanced representation skills in higher education (Santos & Arroio, 2016). Moreover, studies conducted by Rosa and Orey (2011) and Ajayi et al. (2017) provide evidence that the utilization of modules and ethnochemical approaches effectively enhances student learning and achievement. The application of these methodologies positively influences the development of student competencies across cognitive, affective, and psychomotor domains. Consequently, it can be concluded that the ethnochemical-based module approach is apt for theoretical chemistry materials, while the STEM-based approach is well-suited for implementing chemistry learning involving laboratory demonstrations. Both approaches find appropriateness in the context of chemistry education in vocational high school (SMK), which emphasizes applied science.

CONCLUSION

The integration of ethnochemical and STEM-based approaches in chemistry education has been examined through various studies. Ethnochemical modules, incorporating representation and visualization strategies, leverage concrete examples from students' daily lives to enhance the appeal and meaning of learning. This approach has proven effective in increasing students' interest in chemistry and improving learning outcomes. Moreover, highly motivated students tend to excel in science learning, emphasizing the critical role of motivation and curiosity. STEM-based modules, particularly in Project-Based Learning and laboratory demonstrations, have demonstrated positive impacts on students' cognitive and affective learning outcomes. These approaches encourage active student participation, problem-solving skills, and a deeper understanding of scientific concepts. The STEM approach is deemed suitable for chemistry learning that involves laboratory demonstrations. In conclusion, both ethnochemical-based and STEM-based approaches offer valuable contributions to chemistry education in vocational schools, emphasizing applied science. The successful application of these methodologies is contingent upon factors such as interactive module design, exploration of local wisdom, and attention to character values and cultural preservation attitudes. Overall, the literature supports the idea that a tailored approach, incorporating cultural relevance and active learning strategies, positively influences students' engagement and learning outcomes in chemistry education.

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AUTHOR CONTRIBUTIONS

MHK contributed to the conceptualization of the study, methodology design, investigation execution, and initial manuscript drafting. LAC involvement encompasses conceptualization, methodology design, formal analysis, data curation, investigation, manuscript editing, and project administration. All authors participated in manuscript review and editing.

CONFLICT OF INTEREST STATEMENT

With respect to the investigation, composition, and dissemination of this manuscript, the authors affirm that they do not possess any conflicting interests.

REFERENCES

Abramova, I., & Greer, A. (2013). Ethnochemistry and human rights. *Chemistry & Biodiversity*, *10*(9), 1724–1728. https://doi.org/10.1002/cbdv.201300211

Ajayi, V. O., Agamber, T., & Angura, T. (2017). Effect of gender on students' interest in standard mixture separation techniques using ethnochemistry teaching approach. *Sky Journal of Educational Research*, *5*(5), 027–033.

Arif, I. H., Lukman, A., & Tuara, Z. I. (2021). Penerapan pendekatan culturally responsive teaching terintegrasi etnokimia dalam mengembangkan keterampilan siswa abad 21 pada materi hidrolisis di MAN 1 Tikep. *Jurnal Ilmiah Wahana Pendidikan*, *7*(2), 194–204. https://doi.org/10.5281/zenodo.4661844

Cahyani, A. E. M., Mayasari, T., & Sasono, M. (2020). Efektivitas e-modul project based learning berintegrasi STEM terhadap kreativitas siswa SMK. *Jurnal Ilmiah Pendidikan Fisika*, *4*(1), 15–22. https://doi.org/10.20527/jipf.v4i1.1774

Çalık, M., Ültay, N., Kolomuc, A., & Aytar, A. (2015). A cross-age study of science student teachers' chemistry attitudes. *Chemistry Education Research and Practice*, *16*(2), 228–236. https://doi.org/10.1039/C4RP00133H

Dewi, M., Kaniawati, I., & Suwarma, I. R. (2018). Penerapan pembelajaran fisika menggunakan pendekatan STEM untuk meningkatkan kemampuan memecahkan masalah siswa pada materi listrik dinamis. In R. Resmiyanto et al. (Eds.), *Penyiapan guru profesional melalui pendidikan berkemajuan*. Proceedings of the Quantum #25: Seminar Nasional Fisika, dan Pendidikan Fisika (pp. 381–385). Yogyakarta, Indonesia.

Eriksen, M. B., & Frandsen, T. F. (2018). The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: a systematic review. *Journal of the Medical Library Association: JMLA*, *106*(4), 420–431. https://doi.org/10.5195%2Fjmla.2018.345

Fadli, A., & Irwanto, I. (2020). The effect of local wisdom-based ELSII learning model on the problem solving and communication skills of pre-service islamic teachers. *International Journal of Instruction*, *13*(1), 731–746. https://doi.org/10.29333/iji.2020.13147a

Febriana, B. W., Ashadi, A., & Masykuri, M. (2014). Pengembangan modul kimia berbasis problem-based learning (PBL) pada materi senyawa hidrokarbon dan turunannya kelas XI SMK Kesehatan Ngawi. In *Implementasi pendekatan saintifik dan karakter dalam penelitian dan pembelajaran sains menyongsong generasi emas Indonesia*. Proceedings of the SNPS (Seminar Nasional Pendidikan Sains) IV 2014. Surakarta, Indonesia.

Gazali, N., Sofyan, D., Perdima, F., Abdullah, K., Cendra, R., & Bangun, S. (2023). Trends and patterns of sports research in Islam: Bibliometric analysis using the Scopus database. *International Journal of Information Science and Management (IJISM)*, *21*(3), 311–329. https://doi.org/10.22034/ijism.2023.1977617.0

Granovskiy, B. (2018). *Science, technology, engineering, and mathematics (STEM) education: An overview* (Report No. R45223). Congressional Research Service. https://crsreports.congress.gov/product/pdf/R/R45223

Herawati, N. S., & Muhtadi, A. (2018). Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran Kimia kelas XI SMA. *Jurnal inovasi teknologi pendidikan*, *5*(2), 180–191. http://dx.doi.org/10.21831/jitp.v5i2.15424

Ismiani, S., Syukri, S., & Wahyudiati, D. (2017). Pengaruh penerapan metod problem-based learning terhadap sikap ilmiah dan hasil belajar biologi siswa kelas VII MTS NW 01 Kembang Kerang. *Biota*, *10*(1), 68–75. https://doi.org/10.20414/jb.v10i1.27

Jofrishal, J., & Seprianto, S. (2020). Implementasi modul kimia pangan melalui pendekatan etnokimia di SMK Negeri Aceh Timur program keahlian tata boga. *JIPI (Jurnal IPA & Pembelajaran IPA)*, *4*(2), 168 –177. https://doi.org/10.24815/jipi.v4i2.17262

Laisnima, L., & Siregar, T. (2020). Modul pembelajaran berbasis science, technology, engineering and mathematics (STEM) untuk meningkatkan hasil belajar dan keterampilan proses peserta didik pada materi redoks dan sel elektrolisis. *Jurnal Ilmu Pendidikan Indonesia*, *8*(2), 84–90.

Marasinghe, B. (2016). Ethnochemistry and ethnomedicine of ancient Papua New Guineans and their use in motivating students in secondary schools and universities in PNG. *Universal Journal of Educational Research*, *4*(7), 1724–1726. https://doi.org/10.13189/ujer.2016.040726

Pujiati, A. (2020). Penerapan pendekatan STEAM pada materi struktur atom terhadap pemahaman konsep kimia. In I. A. D. Astuti et al. (Eds.), *Inovasi sains dalam perkembangan teknologi dan literasi di era revolusi industri 4.0*. Proceedings of the *SINASIS (Seminar Nasional Sains)* (258–261). East Jakarta, Indonesia.

Rahmawati, Y., Ridwan, A., & Nurbaity, N. (2017). Should we learn culture in chemistry classroom? Integration ethnochemistry in culturally responsive teaching. In *Research and education for developing scientific attitude in sciences and mathematics*. Proceedings of the 4th International Conference on Research, Implementation, and Education of Mathematics and Science (4th ICRIEMS) (p. 030009). Yogyakarta, Indonesia. https://doi.org/10.1063/1.4995108

Robo, R., & Taher, T. (2021). Analisis keterampilan abad 21 siswa dengan pendekatan culturally responsive teaching terintegrasi etnokimia. *Jurnal Ilmiah Wahana Pendidikan*, *7*(8), 225–231. https://doi.org/10.5281/zenodo.5758767

Rosa, M., & Orey, D. C. (2011). Ethnomodeling: a pedagogical action for uncovering ethnomathematical practices. *Journal of Mathematical Modelling and Application*, *1*(3), 58–67.

Safitri, D., & Iryani, I. (2021). Deskripsi hasil belajar peserta didik yang menggunakan modul inkuiri terbimbing pada pembelajaran kimia. *Edukimia*, *3*(1), 038–042. https://doi.org/10.24036/ekj.v3.i1.a215

Said-Ador, N. K. (2017). Ethnochemistry of maguindanaons' on the usage of household chemicals: Implications to chemistry education. *Journal of Social Sciences (COES&RJ-JSS)*, *6*(2S), 8–26. https://doi.org/10.25255/jss.2017.6.2S.8.26

Santos, V. C., & Arroio, A. (2016). The representational levels: Influences and contributions to research in chemical education. *Journal of Turkish Science Education*, *13*(1), 3–18. https://doi.org/10.12973/tused.10153a

Susanti, L. Y., Hasanah, R., & Khirzin, 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

Sutrisno, H., Wahyudiati, D., & Louise, I. S. Y. (2020). Ethnochemistry in the chemistry curriculum in higher education: exploring chemistry learning resources in sasak local wisdom. *Universal Journal of Educational Research*, *8*(12A), 7833–7842. https://doi.org/10.13189/ujer.2020.082572

Utari, R., Andayani, Y., Savalas, L. R. T., & Anwar, Y. A. S. (2021). Validity of ethnoscience based chemistry learning media emphasizing character values and conservation behavior. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 45–48. https://doi.org/10.29303/jppipa.v7i1.469

Wahyudiati, D., Sutrisno, H., & Supiah, I. (2019). Self-efficacy and attitudes toward chemistry of pre-service chemistry teachers: Gender and grades level perspective. *International journal of scientific & technology research*, *8*(9), 1041–1044.

Wahyudiati, D. (2020). *Pengembangan model pembelajaran berbasis masalah terintegrasi kearifan lokal Sasak (PBMTKLS) pada pembelajaran kimia untuk keterampilan proses sains, sikap ilmiah, dan prestasi kognitif mahasiswa* (Doctoral dissertation, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia). Retrieved from https://eprints.uny.ac.id/70316/

Wahyudiati, D., & Fitriani, F. (2021). Etnokimia: Eksplorasi potensi kearifan lokal sasak sebagai sumber belajar kimia. *Jurnal Pendidikan Kimia Indonesia*, *5*(2), 102–111. https://doi.org/10.23887/jpk.v5i2.38537

Winarni, J., Zubaidah, S., & Koes-Handayanto, S. (2016). STEM: Apa, mengapa, dan bagaimana. In D. Listyorini et al. (Eds.), *Inovasi pembelajaran IPA yang bermakna dan mencerdaskan*. Proceedings of the Seminar Nasional Pendidikan IPA 2016 (976–984). Malang, Indonesia.

Wulandini, A. R., Salsabila, S. R., Yazmina, S., Oktavia, T., & Sundaram, D. (2022). User acceptance of the XYZ crowdfunding application: A survey based on the UTAUT2 method. *International Journal of Emerging Technology and Advanced Engineering*, *12*(2), 124–134.