# Analysis of content development in chemical materials related to ethnoscience: a review

**Hayuni Retno Widarti[1], Antuni Wiyarsi[2], Sri Yamtinah[3], Ari Syahidul Shidiq[3], Meyga Evi Ferama Sari[1], Putri Nanda Fauziah[1], Deni Ainur Rokhim[1,4]**

[1]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Malang, Indonesia
[2]Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Sleman, Indonesia
[3]Chemistry Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia
[4]Chemistry, State Senior High School 3 Sidoarjo, Sidoarjo, Indonesia

**Article Info**

***Article history:***

Received Aug 22, 2023
Revised Apr 3, 2024
Accepted Apr 19, 2024

***Keywords:***

Chemistry learning
Ethnochemistry
Ethnoscience
Literature review
Local wisdom

**ABSTRACT**

One way to preserve culture in education is through ethnoscience-based learning, especially in chemical materials linked to various fields of science in life, including social and cultural. Ethnoscience is a process of reconstructing indigenous science knowledge with scientific science. This research aims to explore trends in ethnoscience-based chemistry learning in Indonesia and analyze the contents, focusing on topics, learning approaches and models, tools, and variables influenced. The research data collection method adopted the preferred items for systematic review and meta-analysis (PRISMA) design and obtained from 30 selected articles indicated from 2019-2024 published in journals indexed by Scopus and SINTA. Analysis results show that the process of making batik is one of the ethnoscience topics that are widely used in chemistry learning. Ethnoscience learning can also be done by combining local wisdom (culture), traditional foods, and natural phenomena of the environment. Ethnoscience learning can be integrated into various learning models, such as contextual teaching and learning (CTL), problem-based, and project-based learning (PjBL). Learning tools often used in ethnoscience-based chemistry learning are modules, evaluation instruments, and worksheets. Ethnoscience is interesting to learn because it positively affects critical thinking and creativity, cultural and conservation character, and scientific literacy.



***Corresponding Author:***

Hayuni Retno Widarti
Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang
Cakrawala Road No. 5, Malang, East Java, Indonesia
Email: hayuni.retno.fmipa@um.ac.id

## 1. INTRODUCTION

Indonesia has enormous diversity and cultural complexity, with more than 300 ethnicities, languages, and socio-cultural backgrounds [1]. As a country rich in local culture and full of values contained therein, Indonesia has a wealth of culture in the form of physical, artistic, culinary, and life norms spread throughout the archipelago [2]. Cultural diversity in each region covers social aspects and has the potential to contain scientific aspects that have yet to be explored optimally. There are many indigenous sciences in the form of local wisdom or traditions passed down from generation to generation [3]. However, the facts state that the rapid flow of globalization and modernization will change the values and threaten the nation's culture if there is no effort to preserve it [4]. One way to preserve culture is through education.

The Indonesian government's current policy program in education is the implementation of a Merdeka Curriculum. Merdeka Curriculum aims to provide a holistic and student-centered approach to teaching by providing opportunities to access knowledge from various learning sources and ensuring that students have adequate access to explore concepts and improve the necessary competencies [5]. Merdeka Curriculum has a novelty in the development of character education, namely the Pancasila student profile [6]. One form of realization of the seven competencies (dimensions) of the Pancasila student profile is integrating local wisdom as a learning resource [7]. The importance of local wisdom in education broadly is helping students to understand science comprehensively and effectively so that they can understand their environment scientifically.

Chemistry is a scientific discipline that explores the structure, properties, and changes in matter and the energy changes associated with these transformations [8]. In the realm of chemistry, there are three levels of representation, namely the macroscopic level, which involves observations that can be made with our senses; the submicroscopic level, where we examine entities such as atoms, ions, and molecules; and the symbolic level, where we use formulas or models to express these entities [9], [10]. Several concepts in chemistry create difficulties and different perceptions for students because chemistry is dominated by abstract concepts [11], [12]. Chemistry, with its characteristics, has links in various fields of knowledge in life, including social and cultural [13]. As in the Merdeka Curriculum, the ethnoscience approach is considered suitable and relevant for teaching chemistry.

Learning using a cultural approach or knowledge of local wisdom of an area and integrating it with science is known as ethnoscience. Ethnoscience is a process of reconstructing indigenous science that develops in society to be transformed into scientific science [14]. Ethnoscience integrates knowledge of local wisdom, potential, and natural phenomena into the scientific process [15], [16]. Ethnoscience encourages students to explore and learn science by utilizing the surrounding environment. Related to this, research on optimizing ethnoscience-based chemistry learning can be integrated with topics, learning models, tools, and learning outcomes. This research aims to explore trends in ethnoscience-based chemistry learning in Indonesia. The findings to be generated are analyzing the contents of the synthesis articles with a focus on topics, learning approaches and models, learning tools, and variables influenced by ethnoscience in chemistry learning.

## 2. METHOD

Analysis of content development in chemical materials related to ethnoscience was carried out using qualitative research through a literature review. A systematic review was carried out using a modified procedure that adopted the preferred items for systematic review and meta-analysis (PRISMA) design, which consisted of four stages: Identification, Screening, Eligibility, and Inclusion [17], [18]. The PRISMA flow diagram for this systematic review can be seen in Figure 1.

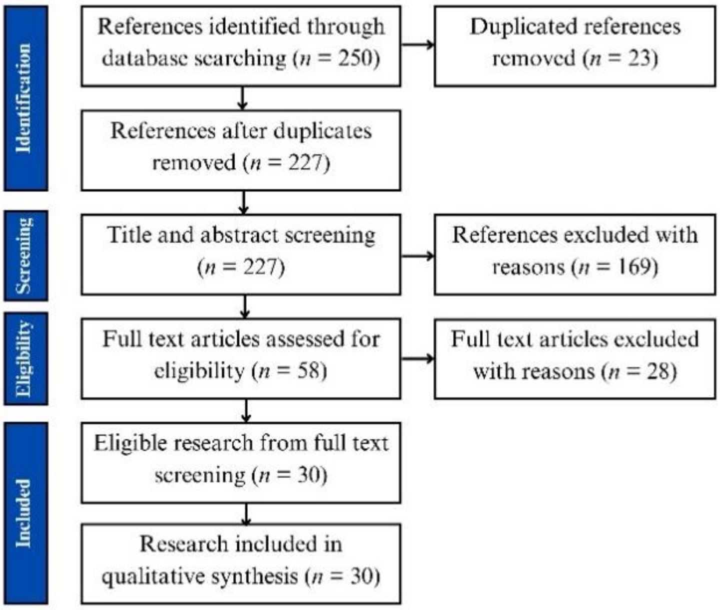


Figure 1. PRISMA flow diagram

The first stage is identification. The literature review in this study involved searching for scientific research articles by utilizing various academic research databases, namely Crossref, Scopus, ERIC, and Google Scholar. The keywords used were "ethnoscience", “ethnochemistry”, and "local wisdom" in chemistry learning. The search results found 250 articles related to the topic to be studied. Of the 250 articles found, 23 are the same, so it is reduced to 227, which will be selected based on the abstract and title. Furthermore, 58 article manuscripts were obtained to be read in full text, and 30 articles were obtained that met all the inclusion criteria that had been set. Inclusion criteria for article searches were: i) Research site in Indonesia; ii) Journal specifications are international journals indexed by Scopus and national journals indexed by at least SINTA 2; iii) Publication between 2019-2024; and iv) Full text and open access. The next step was to extract and synthesize data from the 30 selected articles focusing on findings on topics, learning approaches and models, learning tools, and variables influenced by ethnoscience in chemistry learning.

## 3. RESULTS AND DISCUSSION

### 3.1. Ethnoscience topics in chemistry learning

The number of ethnoscience research in Indonesia related to chemistry learning continues to increase yearly and uses various topics. Table 1 shows examples of ethnoscience topics used in chemistry learning according to the results of the article analysis.

Table 1. Details of examples of ethnoscience topics used in chemistry learning

| Category | Examples | Chemical Concept | References |
|---|---|---|---|
| Local Wisdom (Culture) | Process of making batik | Chemical bond, electrolyte, and non-electrolyte solution, redox reaction, functional groups, acid-base, environmental chemistry | [19]–[24] |
| | The essential oil traditional distillation at Kacurkan, Boyolali District, Central Java, Indonesia | Refining and fractional distillation | [25], [26] |
| | *Nginang, Moci,* and *Jamasan* traditions | Acid-base, buffer solution | [27]–[29] |
| | *Sorong Serah* and *Srah-srahan* in the *Merariq* of the *Sasak* or *Javanese Mantenan* tradition | Electron configuration, compounds, and mixtures | [30] |
| | Banjar activities in the *Sasak* community | Chemistry subject matter, electron configuration | [30], [31] |
| | *Sasirangan,* local crafts in Banjarmasin City | Chemical environment, periodic system of elements, colloid, elemental chemistry | [32] |
| | *Laduman*, a local tradition in Barito Kuala Regency | Chemical reaction, hydrocarbons, acid-base | [32] |
| | *Mamaq* tradition | Compounds and mixtures, chemicals in life, acid-base | [33], [34] |
| | Preparation of *Bledug Kuwu* salts | Solubility and constant of a solubility product | [35] |
| | The process of washing batik using lerak extract (traditional detergent) | Saponification reaction | [35] |
| | Ink for *Dayak Maanyan* Tattoos | Colloid | [36] |
| Traditional Foods | Jeruk Nipis and Green Coconut Water | Electrolyte and non-electrolyte solution | [27] |
| | Banjar soup | Compounds and mixtures, benzene and its derivatives, macromolecules | [32] |
| | *Tapai Gambut* fermentation | Oxidation reaction, alkane derivative compounds | [32] |
| | Salting process of Sepat fish; frying process of Selangat shredded fish | Chemical bonds and molecular shapes, salt hydrolysis | [32] |
| | Coconut milk in a typical Tangerang city *Mie Laksa* | Colloid | [37] |
| | *Rusip* typical Bangka | Acid-base | [37] |
| | *Cuko Pempek* | Electrolyte and non-electrolyte solution | [37] |
| | Making *TerasiNisa* Samawa tribe | Buffer solution | [34] |
| | Production of traditional foods (making *Tofu* and *Cincau*) | Synthesis of colloidal substances | [35] |
| | Dayak traditional food such as *Kelumpe* and *Juhu Umbut Rattan* | Colloid | [36] |

Based on Table 1, one of the most widely used ethnoscience topics is making batik [19]–[24]. This is because batik contains the value of local wisdom and becomes the superior potential of each region [38], [39], such as the typical *Batik Lurik, Batik Parang, Batik Ciwaringin, Batik Cirebon, Batik Artisan, Batik Pekalongan,* and *Batik Sogan*. Each region has unique characteristics in its decoration and color system [40]. However, there are similarities in the manufacturing process. Making batik can be integrated into various types of chemistry materials.

In addition to the batik-making process, other ethnoscience topics related to their environment are used in chemistry learning. Ethnoscience learning can be done by combining local wisdom (culture), traditional foods, and natural phenomena of the environment [15]. However, before using the type or topic of ethnoscience, teachers should first conduct a preliminary study and look for links with the learning materials to be implemented. This initial step ensures that ethnoscience integration is meaningful, relevant, and aligned with learning objectives.

### 3.2. Ethnoscience integration in chemistry learning

Learning development uses various integrations, such as learning models and approaches, to support chemistry learning. The learning model is a form of learning illustrated from beginning to end and presented characteristically by the teacher [41]. The learning model includes a broad learning approach. An example of ethnoscience integration in chemistry learning can be seen in Figure 2.

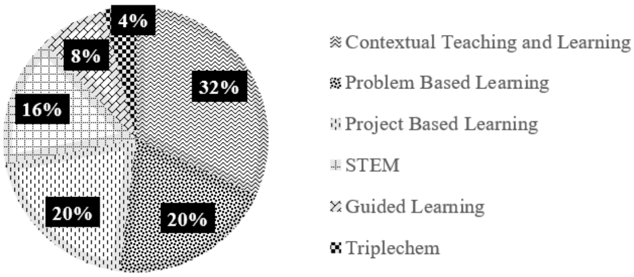


Figure 2. Ethnoscience integration in chemistry learning

Figure 2 shows that most ethnoscience-based chemistry learning is dominated by contextual teaching and learning (CTL), with a percentage of 32%. The ethnoscience approach aims to enable students to learn contextually and introduce the potential of the surrounding environment and local wisdom as a learning resource. CTL is a student-centered approach that seeks to facilitate students' understanding and learning of science and direct teaching. CTL connects real-world context and scientific concepts to increase students' interest and science knowledge [30], [42]. In addition, CTL will make learning more exciting and challenging for students [31].

Other learning models that dominate ethnoscience-based chemistry learning are problem-based learning (PBL) and project-based learning (PjBL), with a percentage of 20%. PBL is a learning model that involves student activeness in thinking critically to answer problems and find solutions as a way out of these problems. PBL is suitable for ethnoscience learning because there is a PBL syntax that organizes students to learn or research and assists independent or group investigations [28], [43], [44]. However, PjBL can also be a solution for teachers to train students' problem-solving, innovative, and creative thinking skills in ethnoscience-based learning [20], [35]. PjBL integrates PBL and project-based completion, where projects effectively solve cognitive and psychomotor improvement [45]. PjBl effectively improves students' higher-order thinking skills, such as analysis, synthesis, and evaluation. To distinguish between PBL and PjBL, PBL generates a plan or strategy, while PjBL implements the plan [46].

### 3.3. Learning tools related to ethnoscience in chemistry learning

Learning tools are some of the facilities and media used by teachers and students in carrying out the learning process [47]. Learning tools are a planned, systematic, and patterned process. Therefore, learning tools guide teachers to ensure the learning process runs systematically and facilitate students in the learning process to achieve learning outcomes. Learning tools needed in managing the learning process can be in the form of learning resources (such as textbooks and modules), syllabi, lesson plans, worksheets, evaluation instruments or learning outcomes tests, and learning media [44]. Figure 3 shows the search results for learning tools related to ethnoscience in chemistry learning.

Based on Figure 3, learning tools that dominate ethnoscience-based chemistry learning are modules with a percentage of 28%. The module is one of the learning resources in the learning process. Ethnoscience-based modules aim to enrich students' understanding of scientific concepts by applying cultural knowledge and relevant local contexts [48]. A learning unit with various components is included in the module so that students can complete their learning outcomes and are directed to find a concept or principle systematically [36]. Therefore, learning chemistry with ethnoscience-based modules is expected to increase students' curiosity in learning chemistry [49].

Other learning tools that dominate ethnoscience-based chemistry learning are evaluation instruments, which have a percentage of 24%. Evaluation instruments are tools teachers use to measure the extent to which students have achieved learning objectives in the teaching and learning process. Evaluation instruments include three domains, namely cognitive, affective, and psychomotor, as each student's competence scope. The instruments used in evaluation activities can be tests and non-tests. Test instruments include description tests (objective descriptions and free descriptions), multiple-choice tests, short answers, matching, and true false [35], [50]. Meanwhile, non-test instruments include interviews, questionnaires, and observations [25], [51]. Utari *et al.* [44] stated that the ethnoscience-based evaluation instruments developed were suitable for use in learning.

Furthermore, the learning tool that dominates ethnoscience-based chemistry learning is worksheets, which have a percentage of 20%. Worksheets are one type of learning resource that teachers systematically prepare to support students' independent learning [52], [53]. Worksheets contain sheets that include tasks to be completed by students in alignment with the learning outcomes to be achieved [28]. Sudarmin *et al.* [43] stated that problem-based worksheets integrated with ethnoscience help improve students' thinking skills in three domains of thinking: cognitive, affective, and psychomotor.

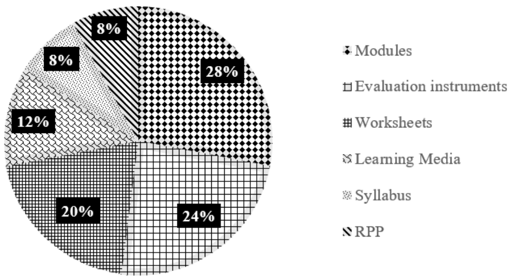


Figure 3. Learning tools related to ethnoscience in chemistry learning

### 3.4. Variables influenced by ethnoscience in chemistry learning

The application of ethnoscience in chemistry learning positively impacts students' abilities. Figure 4 illustrates the variables that influence ethnoscience in chemistry learning. Figure 4 shows that critical thinking and creativity dominate chemistry ethnoscience research with a percentage of 27%. The ethnoscience-based learning process encourages students to use their intellectual abilities. Thus, students indirectly develop critical thinking and creativity [27], [31], [54]. Critical thinking and creativity are the process of thinking and how to respond. For example, Rahmawati *et al.* [27] explained that most students already knew the typical culture of Tegal but didn’t know the chemical concepts in it. In this case, an integrated learning approach between culture and chemistry makes students curious and want to learn more about the culture. Curiosity can stimulate students' critical questions. In critical thinking, students sometimes have to think at a higher level and consider unusual alternatives before drawing conclusions. In this case, creativity can help students by providing new ways to solve problems or consider options that have never been considered before.

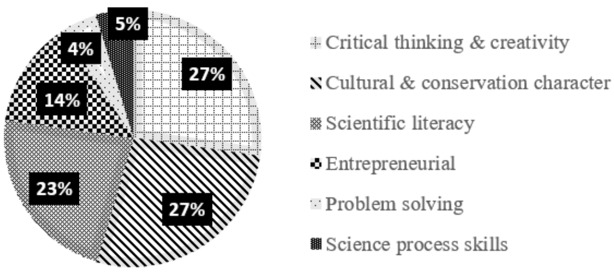


Figure 4. Variables influenced by ethnoscience in chemistry learning

In addition to critical thinking and creativity, the variable with the most significant percentage is cultural and conservation character, with a rate of 27%. This is because ethnoscience encourages teachers to teach science based on culture, local wisdom, and problems that exist in society. This aims to provide students with meaningful learning and inspire curiosity about the role of science in everyday life [26], [37],

[44], [55]. The implementation of learning by linking ethnoscience and the value of local wisdom around them is so that students know the value of local wisdom around them and can maintain and preserve it. Therefore, ethnoscience-based learning is one way that can be done so that the nation's culture remains eternal amid globalization.

The following variable is scientific literacy, with a percentage of 23%. Scientific literacy refers to several things, namely identifying questions and explaining phenomena scientifically, designing scientific investigations, and using scientific evidence [48], [50]. Efforts to integrate the indigenous culture with the science of the community as a form of comprehensive understanding of science are the essence of the concept of science literacy. The context aspect of science literacy learning aims to teach chemical concepts beginning with observations from real-world contexts and linking them to molecular and symbolic representations of depictions of chemical phenomena [34].

## 4. CONCLUSION

Based on the systematic review study, it can be concluded that the process of making batik is one of the ethnoscience topics widely used in chemistry learning. Ethnoscience learning can be done by combining local wisdom (culture), traditional foods, and natural environment phenomena that support learning materials and the reconstruction of indigenous science knowledge with scientific science. Ethnoscience learning can be integrated into various learning models, such as CTL, problem-based, and PjBL. Learning tools often used in ethnoscience-based chemistry learning are modules, evaluation instruments, and worksheets. The findings show that ethnoscience is interesting to learn because it positively affects critical thinking and creativity, cultural and conservation character, and scientific literacy.

## ACKNOWLEDGEMENTS

The authors would like to thank the Institute for Research and Community Services Institute (LPPM) of the Universitas Negeri Malang for supporting and funding this research. The authors would also like to thank the Universitas Negeri Yogyakarta and Universitas Sebelas Maret as the partner research team in the Indonesian Collaborative Research (RKI) scheme.

## REFERENCES


[1] B. T. Sari, A. Chasiotis, F. J. R. van de Vijver, and M. Bender, "The importance of language vocabulary and language usage for sociocultural adjustment among Indonesian adolescents from three bilingual ethnic groups," *J Multiling Multicult Dev*, vol. 41, no. 6, pp. 531–546, Jul. 2020, doi: 10.1080/01434632.2019.1630417.

[2] S. Sumartias, A. A. Unde, I. P. Wibisana, and A. R. Nugraha, "The Importance of Local Wisdom in Building National Character in the Industrial Age 4.0," in *Proceedings of the 3rd International Conference on Learning Innovation and Quality Education (ICLIQE 2019)*, Paris, France: Atlantis Press, 2020. doi: 10.2991/assehr.k.200129.159.

[3] A. Abas, A. Aziz, and A. Awang, "A Systematic Review on the Local Wisdom of Indigenous People in Nature Conservation," *Sustainability (Switzerland)*, vol. 14, no. 6, p. 3415, Mar. 2022, doi: 10.3390/su14063415.

[4] E. S. Abdulaeva, N. U. Yarychev, B. B. Abdulvahabova, L. T. Eskerkhanova, and S. A. Vakhabova, "Socio-cultural Transformations in Traditional Societies in the Context of Globalization," *KnE Social Sciences*, vol. 3, no. 16, pp. 93–101, Apr. 2019, doi: 10.18502/kss.v3i16.4477.

[5] K. Novia, M. Mawardi, and O. Suryani, "Development of Teaching Materials to Support Merdeka Curriculum Learning on Solubility and Solubility Product in F Phase," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 7, pp. 5481–5491, Jul. 2023, doi: 10.29303/jppipa.v9i7.4312.

[6] H. Y. Hasibuan, E. Syarifudin, Suherman, and C. A. H. F. Santosa, "Ethnoscience as the Policy Implementation of Kurikulum Merdeka in Science Learning: A Systematic Literature Review," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 8, pp. 366–372, Aug. 2023, doi: 10.29303/jppipa.v9i8.4500.

[7] I. W. Widana, I. W. Sumandya, and I. W. Citrawan, "The special education teachers' ability to develop an integrated learning evaluation of Pancasila student profiles based on local wisdom for special needs students in Indonesia," *Kasetsart Journal of Social Sciences*, vol. 44, no. 2, pp. 527–536, 2023, doi: 10.34044/j.kjss.2023.44.2.23.

[8] H. R. Widarti *et al.*, "Developing Integrated Triplet Multi-Representation Virtual Laboratory in Analytic Chemical Materials," *International Journal of Interactive Mobile Technologies*, vol. 15, no. 8, pp. 119–135, Apr. 2021, doi: 10.3991/ijim.v15i08.21573.

[9] V. Gkitzia, K. Salta, and C. Tzougraki, "Students' competence in translating between different types of chemical representations," *Chemistry Education Research and Practice*, vol. 21, no. 1, pp. 307–330, 2020, doi: 10.1039/c8rp00301g.

[10] H. R. Widarti, "Multiple representations in chemistry learning: A study on teachers' literacy," 2021, p. 020042. doi: 10.1063/5.0043360.

[11] H. R. Widarti, "Multiple Representation-Based Cognitive Dissonance: A Strategy to Reduce Misconception in Chemistry Learning," in *AIP Conference Proceedings*, 2023, p. 030003. doi: 10.1063/5.0112157.

[12] K. T. Schütt, M. Gastegger, A. Tkatchenko, K. R. Müller, and R. J. Maurer, "Unifying machine learning and quantum chemistry with a deep neural network for molecular wavefunctions," *Nat Commun*, vol. 10, no. 1, p. 5024, Nov. 2019, doi: 10.1038/s41467-019-12875-2.

[13] F. Salsabiila, S. Yamtinah, N. D. Nurhayati, A. Wiyarsi, H. R. Widarti, and A. S. Shidiq, "Tapping into collaborative skills and learning achievement: The effect of implementing the common knowledge construction model equipped with podcasts on chemical bonds topic," *Jurnal Pendidikan Kimia*, vol. 16, no. 1, pp. 36–43, Apr. 2024, doi: 10.24114/jpkim.v16i1.54132.

[14] M. Khusniati, A. P. Heriyanti, N. P. Aryani, T. R. Fariz, and D. Harjunowibowo, "Indigenous science constructs based on Troso woven fabric local wisdom: a study in ethnoscience and ethnoecology," *Journal of Turkish Science Education*, vol. 20, no. 3, pp. 549–566, Oct. 2023, doi: 10.36681/tused.2023.031.
[15] F. P. Sari, M. Maryati, and I. Wilujeng, "Ethnoscience Studies Analysis and Their Integration in Science Learning: Literature Review," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 3, pp. 1135–1142, Mar. 2023, doi: 10.29303/jppipa.v9i3.2044.
[16] W. Sumarni, *Ethnoscience in Chemistry Learning: Principles, Development and Implementation* (in Indonesian: Etnosains dalam pembelajaran kimia: prinsip, pengembangan dan implementasi). Semarang: UNNES Press, 2018.
[17] O. Meidelina, A. Y. Saleh, C. A. Cathlin, and S. A. Winesa, "Transformational leadership and teacher well-being: A systematic review," *Journal of Education and Learning (EduLearn)*, vol. 17, no. 3, pp. 417–424, Aug. 2023, doi: 10.11591/edulearn.v17i3.20858.
[18] R. N. Analita, I. Bakti, P. W. Nugraheni, and E. Noviyanti, "The learners' conceptual understanding: Literature review of vapor-pressure lowering and boiling-point elevation," *Journal of Education and Learning (EduLearn)*, vol. 17, no. 4, pp. 641–651, Nov. 2023, doi: 10.11591/edulearn.v17i4.20805.
[19] S. N. Izzah, S. Sudarmin, Wiyanto, and A. P. B. Prasetyo, "Identification of the indigenous science concepts in the batik-manufacturing process to develop STEM integrated ethnoscience learning," *J Phys Conf Ser*, vol. 1567, no. 4, pp. 1–7, Jun. 2020, doi: 10.1088/1742-6596/1567/4/042032.
[20] Sudarmin, W. Sumarni, S. Mursiti, and S. S. Sumarti, "Students' innovative and creative thinking skill profile in designing chemical batik after experiencing ethnoscience integrated science technology engineering mathematic integrated ethnoscience (ethno-stem) learnings," *J Phys Conf Ser*, vol. 1567, no. 2, pp. 1–8, Jun. 2020, doi: 10.1088/1742-6596/1567/2/022037.
[21] N. Tresnawati, I. Saleh, Sudarmin, and S. Wardani, "Scientific reconstruction of local plants as the basic materials of Batik Natural Dyes," *J Phys Conf Ser*, vol. 1511, no. 1, pp. 1–11, Mar. 2020, doi: 10.1088/1742-6596/1511/1/012062.
[22] I. R. Anugrah, "Scientific content analysis of batik Cirebon and its potential for high school STEM-approached project-based instruction," *J Phys Conf Ser*, vol. 1806, no. 1, pp. 1–8, Mar. 2021, doi: 10.1088/1742-6596/1806/1/012215.
[23] I. R. Anugrah, "Students' perspectives on Batik Cirebon for high school chemistry embedded STEM learning," *J Phys Conf Ser*, vol. 1957, no. 1, pp. 1–8, Jul. 2021, doi: 10.1088/1742-6596/1957/1/012030.
[24] Q. A. Fikrina, Sudarmin, W. Sumarni, and S. S. Sumarti, "Development of ethno-STEAM integrated solution chemistry e-modules of Pekalongan batik study material (in Indonesian: Pengembangan e-modul kimia larutan terintegrasi ethno-STEAM pada materi pembelajaran batik Pekalongan)," *Chemistry in Education*, vol. 12, no. 1, pp. 17–24, 2023, [Online]. Available: https://journal.unnes.ac.id/sju/index.php/chemined/article/view/59507
[25] S. Sudarmin, W. Sumarni, P. Rr Sri Endang, and S. Sri Susilogati, "Implementing the model of project-based learning : integrated with ETHNO-STEM to develop students' entrepreneurial characters," *J Phys Conf Ser*, vol. 1317, no. 1, pp. 1–9, Oct. 2019, doi: 10.1088/1742-6596/1317/1/012145.
[26] Sudarmin, W. Sumarni, and S. Mursiti, "The learning models of essential oil with science technology engineering mathematic (STEM) approach integrated ethnoscience," *J Phys Conf Ser*, vol. 1321, no. 3, pp. 1–8, Oct. 2019, doi: 10.1088/1742-6596/1321/3/032058.
[27] Y. Rahmawati, H. R. Baeti, A. Ridwan, S. Suhartono, and R. Rafiuddin, "A culturally responsive teaching approach and ethnochemistry integration of Tegal culture for developing chemistry students' critical thinking skills in acid-based learning," *J Phys Conf Ser*, vol. 1402, no. 5, pp. 1–7, Dec. 2019, doi: 10.1088/1742-6596/1402/5/055050.
[28] V. D. Asda, Andromeda, Yerimadesi, and Hardeli, "Development of Buffer Solution Students' Worksheet Based on Problem Based Learning with Ethnochemistry to Improve Students' Science Literacy Ability," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 7, pp. 5220–5227, Jul. 2023, doi: 10.29303/jppipa.v9i7.4369.
[29] I. W. Suja, I. M. G. Jayadiningrat, and I. N. S. Ardiyasa, "Differences in the Triplechem Learning Model with Balinese Local Wisdom and the Discovery Learning Model in Influencing Students' Visual Literacy and Mental Models about Acid-Base Solutions," *Jurnal Pendidikan IPA Indonesia*, vol. 12, no. 2, pp. 187–198, Jun. 2023, doi: 10.15294/jpii.v12i2.44456.
[30] D. Wahyudiati, "Ethnochemistry: Exploring the Potential of Sasak and Java Local Wisdom as a Teaching Materials," *Jurnal Pendidikan Kimia Indonesia*, vol. 6, no. 2, pp. 116–122, Dec. 2022, doi: 10.23887/jpki.v6i2.49890.
[31] H. Sutrisno, D. Wahyudiati, and I. S. Y. Louise, "Ethnochemistry in the Chemistry Curriculum in Higher Education: Exploring Chemistry Learning Resources in Sasak Local Wisdom," *Universal Journal of Educational Research*, vol. 8, no. 12A, pp. 7833–7842, Dec. 2020, doi: 10.13189/ujer.2020.082572.
[32] R. K. Irawati, A. T. Wicaksono, S. Salamiyah, E. W. N. Sofianto, and T. T. Wijaya, "Exploration and Inventory of Banjar Etnochemistry as a Learning Source in Indonesia Senior High School Chemistry Context," *JTK (Jurnal Tadris Kimiya)*, vol. 8, no. 1, pp. 42–58, Jun. 2023, doi: 10.15575/jtk.v8i1.22380.
[33] N. Listantia and M. Sarjan, "Review of Chemical, Biological, and Epistemological Elements: Mamaq Tradition," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 6, pp. 196–203, Jun. 2023, doi: 10.29303/jppipa.v9i6.3731.
[34] C. A. Dewi, Y. Khery, and M. Erna, "An ethnoscience study in chemistry learning to develop scientific literacy," *Jurnal Pendidikan IPA Indonesia*, vol. 8, no. 2, pp. 279–287, Jun. 2019, doi: 10.15294/jpii.v8i2.19261.
[35] W. Sumarni and S. Kadarwati, "Ethno-stem project-based learning: Its impact to critical and creative thinking skills," *Jurnal Pendidikan IPA Indonesia*, vol. 9, no. 1, pp. 11–21, Mar. 2020, doi: 10.15294/jpii.v9i1.21754.
[36] S. Syahmani, J. Rahmatilah, A. Winarti, M. Kusasi, R. Iriani, and Y. D. Prasetyo, "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*, vol. 3, no. 4, pp. 670–682, Oct. 2022, doi: 10.46843/jiecr.v3i4.363.
[37] Y. Rahmawati, A. Mardiah, E. Taylor, P. C. Taylor, and A. Ridwan, "Chemistry Learning through Culturally Responsive Transformative Teaching (CRTT): Educating Indonesian High School Students for Cultural Sustainability," *Sustainability (Switzerland)*, vol. 15, no. 8, pp. 1–18, Apr. 2023, doi: 10.3390/su15086925.
[38] A. I. Sulaiman, S. Prastyanti, T. Sugito, R. Windiasih, I. K. E. Wijayanti, and S. Weningsih, "Young Generation Empowerment in the Preservation of Batik As a Local Wisdom Product in the Digital Age ," *The Seybold Report Journal*, vol. 17, no. 12, pp. 550–566, 2022.
[39] S. Rohmah and N. T. Mulatsih, "Local Wisdom-Based Creative Economy Development Strategy To Achieve Competitive Advantage in the Era of the Industrial Revolution 4.0 in Gunungkidul Regency," *Jurnal REP (Riset Ekonomi Pembangunan)*, vol. 7, no. 2, pp. 221–243, Oct. 2022, doi: 10.31002/rep.v7i2.370.
[40] L. Setiyartiti and D. Rachmawatie, "Batik industrydevelopment based on rural economic development: the case study of Gunungkidul Regency," *E3S Web of Conferences*, vol. 316, pp. 1–19, Nov. 2021, doi: 10.1051/e3sconf/202131604013.

[41] H. R. Widarti, D. A. Rokhim, A. B. Syafruddin, and Ilviana, "The Use Of Instagram Media Is Integrated With The Inquiry Learning Model To Improve Critical Thinking Skills And Student Learning Motivation In The Matter Of Reaction Rates," *Pegem journal of Education and Instruction*, vol. 14, no. 2, Jan. 2024, doi: 10.47750/pegegog.14.02.18.

[42] I. Yuliana, M. E. Cahyono, W. Widodo, and I. Irwanto, "The Effect of Ethnoscience-Themed Picture Books Embedded Within Context-Based Learning on Students' Scientific Literacy," *Eurasian Journal of Educational Research*, vol. 21, no. 94, pp. 1–18, Apr. 2021, doi: 10.14689/ejer.2021.94.17.

[43] S. Sudarmin, L. Zahro, S. E. Pujiastuti, R. Asyhar, Z. Zaenuri, and A. Rosita, "The development of PBL-based worksheets integrated with green chemistry and ethnoscience to improve students' thinking skills," *Jurnal Pendidikan IPA Indonesia*, vol. 8, no. 4, pp. 492–499, Dec. 2019, doi: 10.15294/jpii.v8i4.17546.

[44] R. Utari, Y. Andayani, L. R. T. Savalas, and Y. A. S. Anwar, "Validity of Ethnoscience Based Chemistry Learning Media Emphasizing Character Values and Conservation Behavior," *Jurnal Penelitian Pendidikan IPA*, vol. 7, no. 1, pp. 45–48, Dec. 2020, doi: 10.29303/jppipa.v7i1.469.

[45] H. R. Widarti, D. A. Rokhim, and M. M. Kadafi, "Android-Based Project-Based Learning Integrated Gravimetric Analysis for Chemical Expertise Analysis of Vocational School: Development of Teaching Materials," *IJCER (International Journal of Chemistry Education Research)*, pp. 93–104, Oct. 2023, doi: 10.20885/ijcer.vol7.iss2.art10.

[46] R. Amini, B. Setiawan, Y. Fitria, and Y. Ningsih, "The difference of students learning outcomes using the project-based learning and problem-based learning model in terms of self-efficacy," *J Phys Conf Ser*, vol. 1387, no. 1, pp. 1–7, Nov. 2019, doi: 10.1088/1742-6596/1387/1/012082.

[47] M. D. Abdulrahaman *et al.*, "Multimedia tools in the teaching and learning processes: A systematic review," *Heliyon*, vol. 6, no. 11, pp. 1–14, Nov. 2020, doi: 10.1016/j.heliyon.2020.e05312.

[48] C. Dewi *et al.*, "The Development of Ethnoscience Based Acid-Base Modules to Improve Students' Scientific Literacy Ability," *International Journal of Innovation, Creativity and Change*, vol. 14, no. 1, pp. 1013–1028, 2020.

[49] D. Tahya, F. S. Dahoklory, and S. R. Dahoklory, "Development of Local Wisdom-Based Chemistry Modules to Improve Students' Science Process Skills," *Jurnal Penelitian Pendidikan IPA*, vol. 8, no. 2, pp. 731–739, Apr. 2022, doi: 10.29303/jppipa.v8i2.1424.

[50] C. A. Dewi, M. Erna, Martini, I. Haris, and I. N. Kundera, "Effect of Contextual Collaborative Learning Based Ethnoscience to Increase Student's Scientific Literacy Ability," *Journal of Turkish Science Education*, vol. 18, no. 3, pp. 525–541, Sep. 2021, doi: 10.36681/tused.2021.88.

[51] Sudarmin, Kasmui, W. Sumarni, S. Diliarosta, H. Pancawardani, and P. Listiaji, "Developing student life skills through an ethno-STEM integrated project learning about herbal tea making from tropical forest plants in Indonesia," in *AIP Conference Proceedings*, 2023, p. 030001. doi: 10.1063/5.0126097.

[52] D. T. Andani, A. Gani, A. U. T. Pada, and H. Rahmatan, "Ethnoscience-Based Student Worksheet Development to Improve Senior High School Student Creativity," *Jurnal Penelitian Pendidikan IPA*, vol. 7, no. 1, pp. 26–33, Dec. 2020, doi: 10.29303/jppipa.v7i1.457.

[53] L. K. Wardani *et al.*, "Effect of an Ethnochemistry-based Culturally Responsive Teaching Approach to Improve Cognitive Learning Outcomes on Green Chemistry Material in High School," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 12, pp. 11029–11037, Dec. 2023, doi: 10.29303/jppipa.v9i12.5532.

[54] R. Sawitri, S. Mulyani*, and S. R. Dwi Ariani, "The Effect Guided Discovery-Based Thermochemistry Module on Critical Thinking Skills of High School and Vocational Students," *Jurnal Pendidikan Sains Indonesia*, vol. 11, no. 3, pp. 625–638, Oct. 2023, doi: 10.24815/jpsi.v11i3.30569.

[55] Y. Rahmawati, A. Ridwan, A. Rahman, and F. Kurniadewi, "Chemistry students' identity empowerment through etnochemistry in culturally responsive transformative teaching (CRTT)," *J Phys Conf Ser*, vol. 1156, no. 1, pp. 1–9, Jan. 2019, doi: 10.1088/1742-6596/1156/1/012032.


## BIOGRAPHIES OF AUTHORS

**Hayuni Retno Widarti** is a Distinguished University Professor and lecturer at Departement of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Indonesia. Her primary research interest includes multiple representations, chemical literacy, and development of learning media. She can be contacted at email: hayuni.retno.fmipa@um.ac.id.

**Antuni Wiyarsi** is a Distinguished University Professor and lecturer at Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Sleman, Indonesia. Her primary research interest includes development of learning models. She can be contacted at email: antuni_w@uny.ac.id.

**Sri Yamtinah** is a lecturer at Chemistry Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia. Her primary research interest includes instrument development in learning evaluation. She can be contacted at email: jengtina@staff.uns.ac.id.

**Ari Syahidul Shidiq** is a lecturer at Chemistry Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia. His primary research interests include STEM education and systems thinking in chemistry education. He can be contacted at email: arishidiq@staff.uns.ac.id.

**Meyga Evi Ferama Sari** is a lecturer at Departement of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Indonesia. Her primary research interest includes inorganic chemistry. She can be contacted at email: meyga.evi.fmipa@um.ac.id.

**Putri Nanda Fauziah** is a Bachelor of Chemistry Education student at Universitas Negeri Malang, Indonesia with a concentration of development of learning media and ICT. Interested in issues in the field of education. She can be contacted at email: putri.nanda.2003316@students.um.ac.id.

**Deni Ainur Rokhim** is a Masters student in Chemistry Education, Universitas Negeri Malang, Indonesia with a concentration in the development of learning media and ICT. He is also a Chemistry and teacher at State Senior High School 3 Sidoarjo. He can be contacted at email: deniainurrokhim@gmail.com.