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

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Article Info

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.

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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.
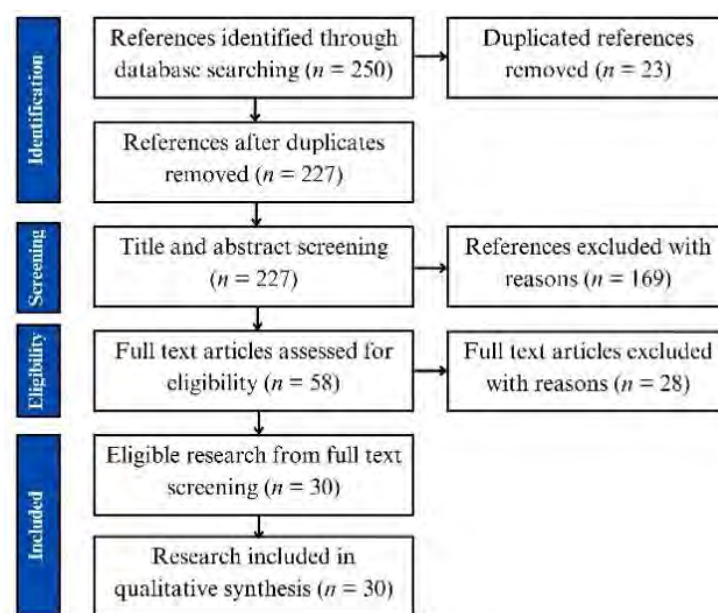

Figure 1. PRISMA flow diagram

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.
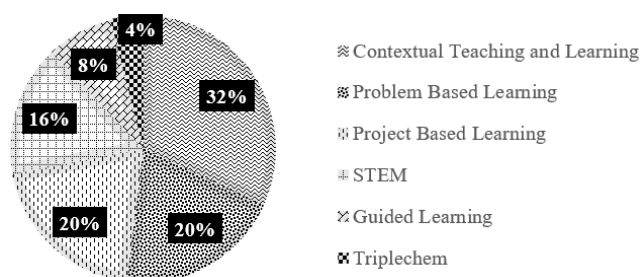
Figure 2. Ethnoscience integration in chemistry learning

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.
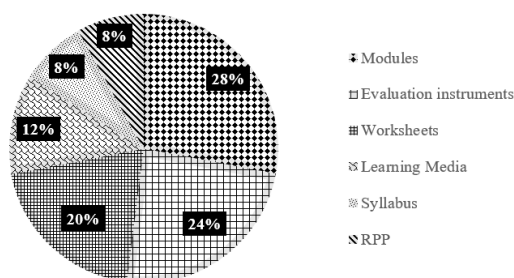
Figure 3. Learning tools related to ethnoscience in chemistry learning

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.
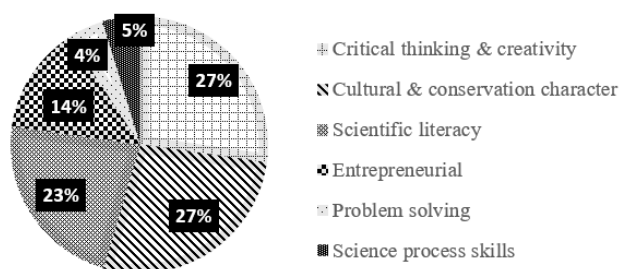

Figure 4. Variables influenced by ethnoscience in chemistry learning

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.

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