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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

Dwi Wahyudiati*, Devi Qurniati

Jurusan Tadris Kimia, Fakultas Tarbiyah dan Keguruan Universitas Islam Negeri Mataram, Mataram, Nusa Tenggara Barat, Indonesia

*Email: dwiwahyudiati@uinmataram.ac.id

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Abstract. Learning resource availability was still focused on abstract concepts without integrating them with students' daily experiences. This appears since the ethnochemistry approach implementation in universities is still rarely conducted. The purpose of this study is to analyze the relevance of Sasak and Java local wisdom with chemistry and explore the potential of Sasak and Java local wisdom as a learning resource in basic chemistry courses. The data collection instruments were observation, interviews, and documentation. In analyzing the data, the researcher used the Spradley data analysis technique. The instruments were chosen based on their suitability with the type of data to be analyzed. Furthermore, the data analysis techniques consist of four stages, namely;(1) domain analysis; (2) taxonomic analysis; (3) componential analysis; and (4) cultural themes analysis. Based on the research findings, it proved that the local wisdom of Sasak and Java, which consists of cultural products and local wisdom values in Sasak and Java culture, has relevance to chemistry material that can be used as a learning resource. Research conclusions include: (1) The relevance of Sasak and Java local wisdom with basic chemistry material can be reviewed based on the perspective or analogy approach, representation, and visualization; and (2) the potential of Sasak and Java local wisdom as learning resources in basic chemistry courses includes three subjects, namely: material and its changes, the periodic system of elements, and chemical bonds integrated with Sasak and Java local wisdom.
Keywords: Ethnochemistry, local wisdom of Sasak and Java, source of learning chemistry

Introduction

The chemistry characteristics cover three domains called the chemical triangle: the macro domain or concrete, the abstract sub-micro in atoms, ions, and molecules, and the symbolic domain in equations, formulas, mathematical equations, and graphics. Likewise, learning chemistry at the university level must generate graduates with comprehensive knowledge (microscopic, macroscopic, and symbolic) and develop affective and psychomotor aspects to compete in the globalization era (De Jong, 2018). However, various research proved that educators have difficulty integrating the chemical triangle in learning, which results in students struggling to understand chemistry concepts, especially the microscopic and symbolic domains. These difficulties impact students' low cognitive, affective, and psychomotor learning outcomes (Wahyudiati, 2021). In this way, lecturers are expected to implement chemistry learning based on the chemistry triangle, supported by the learning resources integrated with students' daily experiences. That is to meet the chemistry learning objectives optimally through constructivism-based learning practices.

The application of constructivism-based learning equipped with relevant learning resources will make learning more significant. The essence of constructivism learning theory is the acquired students' knowledge and experience are the result of construction that has been carried out through students' active involvement, both physically and mentally (Sumardi et al., 2020; Wahyudiati et al., 2020; Laksono & Wibowo, 2022; Widarta & Atika, 2021; Fitriyah & Fardhani, 2022). Knowledge and experience are acquired through sensory, motoric, and scientific thinking processes and finally formulated in the mind as knowledge and skills (Coll et al., 2002; Wahyudiati et al., 2019; Wiwit, et al., 2013). The principle of constructivism-based learning is in line with Vygotsky's theory of cognitive development which emphasizes the organization of classroom situations, the application of strategies, and the interaction between educators and students, including the influence of the social environment on students' thinking development (Fadli, 2019; Sumardi et al., 2020). The social environment can be in the form of cultural objects and symbols, social institutions, and language. Symbols produced by culture help students to think, communicate, and solve problems to adapt their thinking processes (Ador, 2017; Hasanah et al., 2016). Hence, applying constructivism-based learning (active and innovative learning models) equipped with learning resources integrated with local wisdom will activate students in constructing new knowledge to develop students' cognitive, affective, and psychomotor aspects. Nevertheless, the development of integrated chemistry learning resources with local wisdom has not been elaborated on and is still focused on abstract concepts, making chemistry a complex subject for students to understand (Abungu, et al., 2014; Abonyi, et al., 2014; Sutrisno et al., 2020; Wahyudiati, 2016). Accordingly, one of the efforts to make students easier to understand chemistry through the availability of relevant learning resources in their daily lives is integrating the chemistry material with local wisdom or the ethnochemistry implementation.

Ethnochemistry is a variety of cultural practices that exist in society and are chemically related, which describes the chemical practices of cultural groups that can be identified as the study of chemical ideas and can be found in any culture (Ador, 2017; Rahmawati et al., 2017). In other words, *ethno* refers to members of a community group in any cultural environment that can be identified through cultural traditions, codes, symbols, myths, and specific ways to consider and conclude. Previous studies of ethnochemistry learning through cultural products showed positive results. For instance, using cultural products as a learning resource had an impact on increasing students' cognitive learning outcomes, affecting students' scientific attitudes and human rights (Abramova & Greer, 2013; Ador, 2017; Rahmawati et al., 2017; Rosa & Clark, 2011; Sumardi & Wahyudiati, 2021).

However, cultural integration in chemistry learning and practice is still scarce (Abramova & Greer, 2013; Rosa & Clark, 2011). Research trends in chemistry from 2004 to 2013, which raised local culture in a study, was only 1.7% (Wahyudiati, 2016; Wahyudiati et al., 2020). The globalization era has also led to behavioral deviations and a lack of cultural-based learning guidance (Abramova & Greer, 2013; Fadli, 2018; Fadli & Irwanto, 2020; Rosa & Clark, 2011). Moreover, the real problem is the availability of chemistry teaching materials integrated with local wisdom in the basic chemistry course. Therefore, it is crucial to instill ethnochemistry in learning through cultural products and the surrounding environment as learning resources and natural laboratories since the current factual conditions have shown the shortage of ethnochemistry integration with curriculum, learning tools, and the learning materials preparation (Sutrisno et al., 2020;

Abramova & Greer, 2013). The advantages of ethnochemistry-based chemistry teaching materials can help students easier to understand chemical concepts because they are directly related to students' daily experiences, which are the implementation of constructivism learning theory.

Referring to the theoretical and empirical studies above, the urgency of this research is to provide one of the best chemistry learning solutions by integrating ethnochemistry into the curriculum. The learning process is placed in the cultural heritage context as the substance of understanding concepts and scientific investigations based on natural laboratories based on local wisdom values (Ador, 2017; Singh, 2016; Sumardi & Wahyudiati, 2021; Fiteriani, et al., 2021; Sriyati, et al., 2021; Zuhaida & Mubtasyiroh, 2022), including Sasak and Java tribes value. The Sasak and Java tribes' values are relevant to chemistry learning, which is reflected in their traditions that come from their social system, value system, and local cultural products. Therefore, by exploring the potential of Sasak and Java local wisdom as a source of learning chemistry and natural laboratories, it is hoped it could develop students' cognitive, affective, and psychomotor aspects. All in all, this research explored the potential of Sasak and Java local wisdom that can be used as a learning resource and natural laboratory in basic chemistry courses as a form of implementing ethnochemistry in the university's curriculum. The purpose of this study is to analyze the relevance of Sasak and Java local wisdom with chemistry and explore the potential of Sasak and Java local wisdom as a learning resource in basic chemistry courses.

Methods

This ethnographic research adopted the qualitative approach. The ethnography research consists of stages of description, analysis, and interpretation. The description stage was performed to explore the background of the problem through initial observations and interviews related to the research object. The analysis stage was completed to obtain precise data based on the formulation of the problem and research objectives. Lastly, interpreting and concluding the analyzed data was done in the interpretation stage.

The data collection instruments were observation, interviews, and documentation. In analyzing the data, the researcher used the Spradley data analysis technique. The instruments were chosen based on their suitability with the type of data to be analyzed. Furthermore, the data analysis techniques (Spradley, 2007) consist of four stages, namely; (1) domain analysis; (2) taxonomic analysis; (3) componential analysis; and (4) cultural themes analysis. In the interview activities, the informants involved consisted of community leaders, cultural leaders, and chemical content experts so that accurate data were obtained regarding the relevance of Sasak and Javanese culture to chemical materials. Furthermore, the observation and documentation activities aim to obtain primary data related to cultural products, value systems and social systems of the Sasak people that have relevance to chemical concepts so that the data obtained from this activity supports data from interviews that have been carried out previously.

Based on the analysis model, the data analysis stages of this research are elaborated as follows; After collecting the data, domain and taxonomy analyses were performed to select, simplify, or sort the data recorded in the observation sheets and interviews, including discarding unnecessary data. The data were sorted and grouped by type. After reducing and analyzing the data, they were arranged into a systematic arrangement and then analyzed by relating it with relevant theories and previous research results (componential analysis and cultural themes). After completing those processes, conclusions were drawn based on the data analysis result, answering the research problem formulations.

Results and Discussion

Based on the research findings, it proved that the local wisdom of Sasak and Java, which consists of cultural products and local wisdom values in Sasak and Java culture, has relevance to chemistry material that can be used as a learning resource. Chemistry concepts can be integrated with Sasak local wisdom from the analogy perspective, representation, and visualization to make students easier to understand the pictures by using culture as a learning resource and natural laboratory.

An analogy approach explains the comparative relationship by referring to the relationship between two different concepts that have relevant meanings (Samara, 2016). The application of an analogous approach between chemistry learning domains can be made by integrating students' everyday life experiences relevant to the chemistry concept (Sutrisno, et al., 2020). The analogy perspective of the implementation between domains in chemistry learning based on Sasak and Java local wisdom can be instigated in chemical bonds learning material. The relevance of Sasak and Java culture (from the perspective of analogy between domains) with chemical bonds can be seen through the tradition of *merariq* (Sasak wedding) and *manten* (Java wedding). They consist of the *nenarih* and *sorong* (proposing) process in Sasak tradition and the Java *serah-serahan* procession. The similarities between those traditions with chemistry lie in the theory or underlying concepts, meanings, and values. The values of local wisdom are based on the mutual need concepts through the handover between the male and female parties, which is legalized through marriage. The concept of needing each other through the transfer of electron pairs to achieve stability is the concept that underlies the formation of chemical bonds (Wahyudiati & Fitriani, 2021; Wahyudiati, 2021; Fadli, 2018). It is similar to the formation concept of ionic bonds through the transfer of electron pairs between positive and negative ions to achieve a stable electron configuration or resemble the electron configuration of noble gases (Prasetiawan, 2009).

Figure 1. The *sorong serah* ceremony *of Sasak* tribe in *merariq* tradition

Figure 2. The tradition of *srah-srahan* of *Java* tribe

Ionic bonds are formed due to the attraction force between positively charged ions and negatively charged ions resulting from the transfer of electrons between the atoms that form the bond. The attraction force on these bonds is called electrostatic or Coulomb. Ionic bond results from the electrostatic attraction between a cation and an anion to achieve stability with an electron configuration resembling a noble gas. An example of an ionic bond is the formation of sodium chloride or NaCl (salt). In the formation of NaCl compounds through the transfer of electrons, the sodium atom releases a valence electron to form sodium ions or Na^+. The chlorine atoms accept these electrons to form chloride or Cl^- ions. Furthermore, chloride ions and sodium ions attract each other by electrostatic force resulting in an ionic bond.

$$Na\ (2.\ 8.\ 1) \rightarrow Na^+\ (2.\ 8) + e$$

$$Cl\ (2.\ 8.\ 7) + e \rightarrow Cl^-\ (2.\ 8.\ 8).$$

The concept of ionic bonding is not only related to the Merarik tradition of the Sasak and Javanese tribesmen, but also related to the concept of metal bond formation in the chemical bond theory which is formed by the attractive force that occurs between the positive charge of metal ions and the negative charge of free moving electrons (Sukardjo, 1990). As for the relevance of the Merarik tradition, especially in Nenarih Activities, a girl is given the opportunity to make her own decisions without coercion from anyone. The submission of questions in nenarih activities can be done directly by the prospective husband or through his respected Subandar (delegation) or Jeruman (youth agency in the community) (Saito, 1996; Djelenga, 2000). The goal is to clarify the status of the girl who is currently not promising another man to marry her. Furthermore, after getting reassurance from the girl, it was determined when the girl would be brought to the groom's house. Usually in the tradition of Kawin lari (the bride and groom eloped) in the Sasak tribe, the one who picks up the girl becomes rushed (te most) beside the groom, it is also accompanied by several men and women. Furthermore, the girl who was going to be hunted was already waiting outside the house. If the girl is retrieved without interference, the girl is hidden in someone else's house, usually at a family member's place, not in the house of the future husband. This is known as the 'Sebo' (hiding the bride-to-be) tradition.

In addition, the interaction between two or more atoms is always accompanied by the expenditure of energy. The concept of energy expenditure in the chemical bonding theory has a strong relationship with the existence of Ajikrama tradition (amount of customary payment or related fees), in which the submission of all customary prices is carried out in a ceremony called sorong serah. The force that holds the atoms in a molecule together is called the chemical force of bonding. Chemical bonding is a force or interaction that causes atoms to bond together as molecules or causes atoms, ions, and molecules to bond together as more complex and stable bonds (Sukardjo, 1990; Achmad & Tupamahu, 2001). Using the analogy approach in chemistry learning creates more meaningful and joyful learning in which students become more motivated to be actively involved in the process. Likewise, the previous research (Lerman, 2003; Sutrisno, et al., 2020) showed that the analogous approach implementation in chemistry learning makes learning more exciting and significant; it improves learning outcomes. In addition, this ethnochemistry-based learning makes students more motivated and attracted to learning chemistry concepts associated with everyday life compared to studying chemistry abstract concepts.

The integration of basic chemistry 1 material with Sasak and Java local wisdom is also viewed from a visualization perspective or the chemical triangle concept approach consisting of microscopic, macroscopic, and symbolic components (Jhonstone, 2006)—implementing a visualization approach in chemistry learning by integrating the subject matter and its changes with local Sasak and Java wisdom. The concept of material and its changes are integrated with local Sasak and Java wisdom reflected in using chemical elements from various metals such as gold, silver, bronze, copper, and other metals of traditional ceremonial tools. For example, the jewelry of Sasak and Java brides is made of gold, silver, and bronze (Djelenga, 2000). A *keris* is an object that is considered sacred and is usually used at the wedding ceremony of the Sasak and Java tribes. The hilt of a *keris* for the nobility is usually gold (Au) and Ag (Djelenga, 2000; Wahyudiati, 2021). Gold has an atomic number of 79. The arrangement of the outermost electrons of gold is related to the yellow color of gold (Sukardjo, 1990; Saito, 1996). For the groom, the *keris* is attached to the right waist and symbolizes courage and masculinity (Figure 3). Similarly, the Java groom also wears *keris*, namely the *ronce keris melati* decorated with jasmine flowers (Figure 4).

Figure 3. The *keris* attribute on a groom

Figure 4. *Keris ronce melati*

Compounds and mixtures are widely used in the Sasak and Java lives, for instance, in the manufacture of traditional art tools such as *gong, terumpang, kenceng,* which are made from a combination of two or more metals. *Gong* musical instruments in the Sasak community are made of brass or copper in the shape of a large frying pan, and there is a small circle in the middle in the form of a lump, as shown in Figure 5. The Java gong musical instrument is a part of the traditional Java *Gamelan* art made of brass or copper, as shown in Figure 6.

Figure 5. *Gong* of *Sasak Lombok* tribe

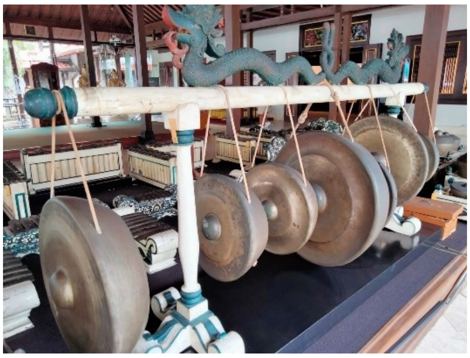

Figure 6. *Gong of Java musical instrument*

The physical changes found in Sasak and Java local wisdom include the coloring of *Sesek* cloth, the manufacture of *sia* or salt, and the *belulut* tradition (covering the floor of a traditional Sasak house with cow feces). Examples of chemical changes are the manufacture of *gule beaq*, fermentation of *oncom* and *peuyeum*, *poteng reket* (fermented sticky rice), *poteng ambon* (fermented cassava), and the coloring of *Sesek* cloth. Kitchen salt in the Sasak language, known as "sia" is one of the local potentials owned by Lombok, known as a seaweed-producing area and a producer of local salt. Kitchen salt is traditionally produced by salt farmers in several areas such as East Lombok, North Lombok, and West Lombok by heating seawater with the help of sunlight, as shown in Figure 7. The principle of chemical change application can be found in the local wisdom of the Java, namely in *Oncom* manufacture. Oncom is a traditional food typically from West Java, as shown in Figure 8. The *oncom* fermentation process is obtained from a mixture of molds mixed with remaining peanut meal, tofu pulp, soybean pulp, or coconut pulp, which is fermented to the spore stage. There are two types of *oncom*, namely red *oncom* and black *oncom*. Usually, red *oncom* is made from tofu cake or soybeans that have been extracted for protein in the tofu manufacture. Meanwhile, black *oncom* is generally made from peanut cake mixed with cassava pulp.

Figure 7. The process of producing kitchen salt in West Lombok

Figure 8. Java special food, *Oncom*

Salt is an ionic compound consisting of positive ions (cations) and negative ions (anions) to form neutral compounds (without charge). The salt formation can also occur through acid-base reactions. Cation and anion components can be created from inorganic compounds such as chloride ions (Cl^-) or organic compounds like acetate compounds (CH_3COO^-), and monatomic ions such as fluoride (F^-), or can be from polyatomic ions such as sulfate (SO_4^{2-}). Sodium chloride (NaCl) is the main component of kitchen salt that people widely use. Kitchen salt is obtained from processing sea water (salt solution); after being heated by sunlight, the water content will evaporate and form crystals/solids. The chemical reactions that occur in the processing of seawater into salt are:

$$NaCl_{(aq)} \longrightarrow NaCl_{(s)}$$

The advantages of applying the visualization approach are essential for chemistry learning through providing examples of the existence of elements, compounds, and mixtures found in everyday life that are relevant to everyday experiences or the culture of the students themselves. These findings are also supported by previous studies, which proved that providing concrete examples in students' daily lives can make learning more exciting and meaningful. Students become more motivated to learn to develop representational skills in chemistry learning in college (Santos & Arroio, 2016; Wahyudiati, 2016). Likewise, previous studies explained that high motivation students would be more active in doing assignments and constructing knowledge that positively impacts learning outcomes obtained by Fadli, 2019; Wahyudiati, et al., 2019; Wahyudiati, 2021.

In addition, the findings also showed that the local wisdom of Sasak and Java has very relevant potential to be integrated with the subject matter of introductory chemistry courses. Those are matter and its changes, the periodic system of elements, and chemical bonds integrated with Sasak and Java local wisdom. The advantages of basic chemistry teaching materials integrated with Sasak local wisdom can increase students' interest, motivation, and activeness in understanding basic chemistry 1 material which has relevance to students' daily lives. The meaning of learning is realized by integrating chemical concepts with the values of local wisdom of the community, which is widely applied in people's daily activities, for instance, the making of *poteng* (sticky rice tape) and *oncom,* which in the process apply the concept of chemical change. Learning activities that refer to the context of students' lives are implementing constructivism learning theory. The findings of previous studies asserted that the constructs of students' new knowledge and experiences would be more meaningful if it is associated with their prior knowledge and experiences. Therefore, it will positively impact students' cognitive, affective, and psychomotor abilities (Sumardi et al., 2020; Wahyudiati et al., 2020; Fadli, 2018; Wahyudiati, 2020; Wahyudiati, 2021).

Furthermore, the previous relevant studies also believed that ethnochemistry-based learning processes or activities affect learning outcomes, scientific attitudes, and students' science skills (Ango, 2002; Browman, et al., 2011; Frambach, et al., 2012; Sutrisno, et al., 2020; Wahyudiati, 2022). Chemistry learning activities supported by the availability of ethnochemistry-based learning resources refer to the context of students' lives local wisdom values relevant to chemical concepts that can be used as supporting learning resources and references in conducting scientific investigations. The implementation of ethnochemistry in learning, whether in the form of integration with learning models, integration with learning strategies, or as a source of learning and scientific investigation, can develop scientific attitudes, critical thinking skills, scientific process skills, and improve cognitive learning outcomes of students (Ador, 2017; Wahyudiati, 2020; Wahyudiati, 2021; Wahyudiati & Fitriani, 2021). Thus, by exploring the potential of Sasak and Java local wisdom as a source of learning chemistry and natural laboratories is possible to develop knowledge, scientific attitude, and critical thinking and increase the younger generation's love for their culture.

Conclusion

Research conclusions include: 1) the local wisdom of Sasak and Java, which consists of cultural products and local wisdom values in Sasak and Java culture, has relevance to chemistry material that can be used as a learning resource and chemistry concepts can be integrated with Sasak local wisdom from the analogy perspective, representation, and visualization to make students easier to understand the concepts by using culture as a learning resource and natural laboratory; and 2) the potential of Sasak and Java local wisdom as learning resources in basic chemistry courses includes three subjects, namely: material and its changes, the periodic system of elements, and chemical bonds integrated with Sasak and Java local wisdom.

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