

An Ethnoscience Study in Chemistry Learning to Develop Scientific Literacy

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ABSTRACT

The low scientific literacy index of Indonesian students is due to a lack of attention to the socio-cultural environment. Also, there are still many contents, the context, and processes in chemistry learning that have not been achieved as learning resources for developing the domain of scientific literacy into four main areas; science content, competence, science process, context. This study intended to develop scientific literacy through ethnoscience pedagogic in chemistry learning. The method of this study was qualitative descriptive with the retrieval of data through direct observation, questionnaires, and interviews. The results of the study showed the needs of (1) a curriculum emphasizing on the development of chemistry literacy for students; (2) the skills of chemistry lecturers in designing learning programs by using local potential in their respective regions; (3) the early discussion on the material coverage of basic chemistry concepts; and (4) a curriculum emphasizing on not only chemistry content but also on context, processes, and attitudes. Thus, it can be concluded that the development of scientific literacy needs to be done by focusing on the preparation of future generations' scientific literacy through contextual, cultural, and practical curriculum content.

Keywords: chemistry learning, ethnoscience, science literacy

2 INTRODUCTION

Education has a tight relation with the culture of a nation. Through education, moral values, and national excellence in the past could be reintroduced, developed, and examined into an acceptable current culture. (Daryanto, 2014). Nowadays, culture can be integrated into students learning at school, particularly science lessons (Sudarmin, 2014). Science is a set of knowledge as a result of the research designed comprehensively into a knowledge grouped following the study fields, such as physics, biology, and chemistry. Also, science is an inquiry method which means that science supplies illustrations or descriptions of the approaches used in the preparation of knowledge (Kun, 2013).

The implementation of 2013 Curriculum 2013 is for the advancement of education in Indonesia. Curriculum 2013 leads students to think critically and learn actively in seeking information, explaining a phenomenon, and giving solutions to a problem. Such learning will be more effective if students have the provision of literacy skill

(Anjarsari, 2014). The scientific literacy of Indonesian students was still at level 2 or remains below average.

In 2006, PISA-OECD (Program for International Student Assessment-Organization for Economic Cooperation and Development) had measured students' scientific literacy. The result strengthens the fact that Indonesian students are low in the scientific literacy in which there were 29% for the content, 34% for the process, 32% for context (Kelly et al., 2013). The low scientific literacy level of Indonesian students was closely related to the students' incomplete understanding of science learning. In the case of content, it was caused by the science learning process, which only focused on memorizing than understanding. (Jufri et al., 2016). As a consequence, the teacher needs to give great attention to this case. (Jurecki & Wander, 2012).

During this time, the students acted as a good listener. They tend to listen to the teacher explanation. The important one was the product instead of the learning process, attitude, and application. The next one is the contextual

aspect; teachers are not entirely integrating the materials with the students' environment (Treacy & Kosinski-Collins, 2011). The low level of student chemistry literacy shows that there are still many contexts, content, and processes in basic chemistry concepts that have not been achieved (Sujana et al., 2014). Furthermore, phases of teaching and learning in scientific literacy according to Holbrook (2011) comprise contact phase, curiosity, collaboration, decision making, and re-contextual.

One way that can be used to improve students' scientific literacy skill is by integrating ethnoscience or local wisdom into learning materials. Ethnoscience derives from the word "ethnos," which means nation and "scientia," which denotes knowledge. The function of ethnoscience would ease students to explore the facts and phenomenon existing in society and be integrated with scientific knowledge (Melyasari et al., 2018). Ethnoscience can captivate students interested in learning because it is related to their own regional identity. Also, ethnoscience could promote a sense of awe with regional culture and preserve it. The chemistry learning model based ethnoscience can improve students' critical thinking (Arfiyawati et al., 2016).

Learning the integrated science applied, at this time, intends to introduce numerous benefits around certain regions. Scientific explanations about cultural phenomenon around students can assist them in understanding the surrounding environment and what they learn in school. Ethnoscience, which is rooted in the lives of students, is a form of contextual experience (Sudarmin, 2014). The concept that is contextual science learning can be related to ethnoscience. In general, ethnoscience-based learning to increase scientific literacy skill is so far rarely found in Indonesia. Therefore, the researchers are willing to develop science literacy through ethnoscience pedagogic in chemistry learning. Chemistry learning can be integrated into ethnoscience because chemistry learning involves contextual experience in everyday life about local wisdom into learning materials and a phenomenon that exists in society.

Learning chemistry is theoretically teaching students to have the ability to identify chemical problems and making a conclusion based on evidence for the sake of recognizing natural changes and the effect of human's interaction to nature (Gorokhov, 2010). This complex world changes quickly, which requires the

understanding of chemistry to handle it (Gilbert & Treagust, 2009). Due to the understanding, literacy of chemistry from formal education is highly demanded (Rahayu, 2017). It means that the students should not only know and memorize things related to the concepts of chemistry but also understand and implement it in their daily life (Marks & Eilks, 2009).

The application of chemistry concepts in social life is directly related to local wisdom. Local wisdom is a stimulus of motivation for students to construct their knowledge. The integration of cultural competence in the different profession will become the determining key for professional service, including in education. Thus, the lecturer should be able to utilize local culture to accommodate the demand in the learning process (Nieto & Zoller Booth, 2010). The importance of cultural integration in science as an ethnoscience is explained by (Nieto & Zoller Booth, 2010) as by the social constructivism of Vygotsky (Sumarni, 2018).

The importance of cultural integration in science as an ethnoscience is explained by (Nieto & Zoller Booth, 2010) as by the social constructivism of Vygotsky (Sumarni, 2018). The concept discusses the urgency of cultural competence in education. Vygotsky has more emphasis on the sociocultural concept, which is the social and interactional context of students in learning. Vygotsky is also sure that the learning process is not only at school, but it can also occur when the students do tasks they never did in school, which they can do it well in the society. Therefore, a future teacher should obtain the experiences of integrating culture to their learning process.

Based on the facts, considering teachers are essential in the learning process, there should be an innovation in the learning process of the teaching institution. Following the suggestions of (Bacanak & Gökdere, 2009), teaching institution should be able to improve the literacy rate of a future chemistry teacher. Thus, the writer proposes ethnoscience learning process for chemistry to achieve the objective. This research has a specific purpose to develop scientific literacy of the chemistry students through ethnoscience based chemistry learning. According to Ariningtyas et al. (2017), scientific literacy can be increased through learning chemistry charge ethnoscience. Perwitasari et al. (2017) the result showed that learning application the concept of energy and its amendments charge

ethnoscience fish curing used to improve the scientific literacy of students.

Practically, the advantages of this research are:

1. To become the guidance of consideration in educational policy, especially in developing teaching education.
2. To become a suggestion for lecturer to develop chemistry education that students will have the literacy of chemistry.
3. To motivate another researcher to conduct further researches regarding the development of chemistry based on local wisdom.
4. Ethnoscience based learning processes in chemistry learning can increase chemistry literacy.
5. The students' interest in conducting ethnoscience based learning process is positively correlated to students' learning outcomes.

METHODS

This research has been conducted at the Chemistry Education Study Program FPMIPA IKIP Mataram from January to February 2019. The research subjects were Chemistry Education lecturers of basic chemistry or course. This type of research is descriptive qualitative research. There were two types of data used in this research; primary and secondary data. The primary data collection is done through direct observation and interviews. It aims to make a direct observation of the object under study in the form of syllabus, PPS, and chemical teaching materials used during the learning process in the classroom. The results of the interviews were carried out directly to the basic chemistry lecturer at the Chemistry Education Study Program FPMIPA IKIP Mataram. Secondary data collection is done through the study of literature to obtain theoretical foundations and support data relating to the learning of chemistry in the study of ethnoscience.

RESULTS AND DISCUSSION

1. Student's Chemistry Literacy Ability FPMIPA IKIP Mataram

Students	Chemistry Literacy Ability	Chemistry Literacy Ability Category
Students 1	56	Low

Students 2	25	Low
Students 3	43	Low
Students 4	41	Low
Students 5	21	Low
Students 6	40	Low
Students 7	55	Low
Students 8	10	Low
Students 9	47	Low
Students 10	26	Low
Students 11	21	Low
Students 12	56	Low
Students 13	57	Low
Students 14	50	Low
Students 15	31	Low
Students 16	30	Low
Students 17	35	Low
Students 18	31	Low
Students 19	20	Low
Students 20	32	Low
Average	36.35	Low

The pretest results showed that the students' chemistry literacy was relatively low. This state is mainly caused by classroom activity in which they only listen to and memorize a teacher's presentation. Moreover, the teacher does not completely connect materials with the students' environment. This fact is similar to Jurecki & Wander (2012) and Treacy & Kosinski-Collins (2011). As a result, there are many content, contexts, and processes in basic chemistry concepts that have not been achieved (Sujana et al., 2014). In other words, this rote science learning does not help students' understanding at all (Jufri et al., 2016).

The influenced scientific literacy the low by many things, including the curriculum and education system, selection of teaching methods and models, learning facilities and facilities, learning resources, teaching materials and others (Celik, 2014). So that need to be the skills of lecturers in develop students' scientific literacy.

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transfer their capability through learning science to accelerate government targets.

3. Chemistry lectures, in particular, can design learning programs using local potentials in their respective regions

Based on the results of the interviews conducted at the basic chemistry lecturer in January 2019, most lecturers did not understand the meaning of science in local cultures so that they had difficulty in connecting learning material with local cultural values. As a result, the students lack knowledge of local culture and understanding a natural phenomenon. The teacher used the following learning tools during the basic chemistry learning process in the class. It is presented in Figure 1.2.

Material	Learning Objectives	Reference
Periodic System of Elements	1. Determine atomic number, mass number and isotope. 2. Explain Grouping of Elements and its Development. 3. Explain the Short Periodic System. 4. Distinguishing Electron, Protons, and Electrons Configuration in the Long Periodic System. 5. Describe the Periodic Characteristics of Elements.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
Chemical Bonds	1. Explain Atomic Orbital in Chemical Bonds. 2. Explaining the Ion Formation Process. 3. Explain the Process of the Occurrence of Covalent Bonds. 4. Determine the Polar and Non-Polar Covalent Association in the Chemical Association. 5. Determining the Nomenclature of Compounds in the Chemical Association. 6. Determine Molecular Form in Chemical Bonds.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
MID SEMESTER		
Substance	1. Describe the Form of Gas. 2. Describe Liquid Form. 3. Describe Solid Form. 4. Describe Morphology Form. 5. Describe Phase Equilibrium.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
Exergon	1. Explain Thermodynamic Theory. 2. Explaining the Thermodynamic System. 3. Explain the rate of thermodynamic. 4. Explain the First Law of Thermodynamics. 5. Explain Entropy and Free Energy Relationship in Thermodynamics.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
Colloid System	1. Describe the Difference in Solution, Colloid, and Suspension. 2. Describe the properties of colloid. 3. Explain the Colloid Purification Process. 4. Explain the Use of Colloid.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
Hydrocarbon	1. Describe the Unsaturation / Saturation of Carbon Atom. 2. Describe the Position of the Carbon Atom. 3. Explain the classification of hydrocarbon compounds. 4. Describe Alkane, Alkene, and Alkyne in hydrocarbon. 5. Explain Functions of Hydrocarbon Compounds.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
FINAL EXAMS		

Course	: Basic Chemistry
Study Program	: Chemistry Education
Course Code	: 202206
SKS	: 4 (3-1)
Teacher	: Gudi
Course Lecture	: Gayatri, N.P.H
Course Description	: This course discusses principles and concepts in stoichiometry, atomic structure, element periodic system, chemical bonds, substances, exergonics, colloid system and hydrocarbons and performs supporting laboratory activities.
Media / tools used	: Animation / ICT / 3D / Learning Media
Model / approach / method	: Discussion of information, questions and answers, practice questions in assignments and projects.
References	<ol style="list-style-type: none"> 1. Chang, R. 2005. <i>Kimia Dasar: Konsep-Konsep Dasar</i>. Edisi 3. Jilid 1. Edisi 3. PT. Galeri Aksara Pustaka. 2. Devri, Citra Arya dila. 2011. <i>Skripsi Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.</i> 3. Kuran, Y. 2000. <i>Kimia Dasar: Konsep-Konsep Dasar</i>. Edisi 3. Jilid 1. Edisi 3. PT. Galeri Aksara Pustaka. 4. Yudi, S. 2015. <i>Kimia Dasar: Konsep-Konsep Dasar</i>. Edisi 3. Jilid 1. Edisi 3. PT. Galeri Aksara Pustaka. 5. Brady, J.E. dan Holum, B. 2008. <i>General Chemistry</i>. 9th Edition. John Wiley and Sons.

LEARNING PROGRAM

Weeks	Basic Competence	Material	Indicator	Reference
1	Introduction	Teaching Contents	1. Learning objectives. 2. Course description. 3. Reference sources. 4. Role of instructor. 5. No Breaking	Reference: Abadinda PPGM SDP Monoran.
2-3	Students can understand the concept of stoichiometry	Stoichiometry	1. Explain the basic laws of chemistry. 2. Describe examples of basic chemical laws in everyday life. 3. Explain chemical calculations that are used in basic chemical laws. 4. Determine the chemical formula in the basic laws of chemistry. 5. Determine chemical equations in basic chemical laws.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.
4	Students can understand the structure of atom	Atomic Structure	1. Describe the development of an atomic model. 2. Explain the shape and orientation of orbitals in atomic structure. 3. Determine the orbital and electron configuration in the atomic structure. 4. Describe atomic particles.	Devri, Citra Arya dila 2011. Tesis Dose 1 PPGM SDP Monoran: Duta Pustaka Baru.

The lecturer's role is very crucial to support the students' success. The lecturer's teaching skill determines student success in learning. Therefore, a lecturer must have a high proficiency in chemistry literacy, as well as other knowledge and the skills to guide and direct students so that they have high scientific literacy. It has been appropriately stated that a teacher should support the development of chemistry literacy to allow students to construct meaning in scientific literacy (Holbrook & Rannikmae, 2009). Because of its crucial role as agents of learning, the prospective teacher must have high chemical literacy skills as it positively will affect future learning: the lower chemical literacy, the lower the quality of teaching chemistry. Lectures with a low level of scientific literacy cannot be expected to develop scientifically-literate people nor implement the curriculum effectively so that the university curriculum should enhance the literacy level of future teachers (Bacanak & Gökder, 2009).

Also, the learning process that combines community science and scientific science can increase students' understanding of scientific science concepts and experience more meaningful learning. Local culture in learning can improve student science literacy skills. Students learn more effectively if they utilize the environment or equipment around them. It can stimulate their curiosity to do the observations and trigger them

to ask questions (Hindarto et al., 2017) so that they can conclude, and gain experience through scientific processes. The experience gained from the scientific process is more durable. Thus, it is necessary to introduce local culture to the young generation through education by developing scientific literacy through the study of ethnoscience in chemistry learning. The use of local culture in learning allows students to do direct observations and train students to be able to discover for themselves diverse concepts that are thoroughly studied (holistic), meaningful, authentic, and active. Integrated ethnoscience chemistry learning is also complemented by supporting factors, namely integrated syllabi, RPS of integrated ethnoscience, integrated teaching materials on ethnoscience, and the question of integrated ethnoscience. Preparation of syllabus and teaching materials adapted to the conditions of the region based on excellence and uniqueness that are characteristic of the region, in this study centered on regional characteristics in the preparation of syllabus and teaching materials carried out by analyzing traditional knowledge (ethnoscience) that can be adapted and integrated with science in learning chemistry.

Chemistry learning integrated with local wisdom is done by reconstructing original science. The intended reconstruction is the realignment or translation of original science into western science concepts or scientific science. This original science is obtained through observation of the cultures that exist in society. Therefore it can be said that this learning model is based on local wisdom, because it is derived from indigenous knowledge or local intelligence of a community derived from the noble values of cultural traditions to regulate the order of people's lives in order to achieve community progress both in creating peace and improvement in people's welfare. (Suastara, 2010) Stated that future science learning needs to be sought so that there is a balance between the knowledge of science and the cultivation of scientific attitudes, as well as the values that exist and develop in local wisdom and the community. Therefore, the socio-cultural environment of students needs to get serious attention in developing science education in higher education because it contains original science that can be useful for their lives. The statement above shows how important local wisdom is in chemistry learning to develop scientific literacy. It is an effect to increase student scientific literacy. The statement above

strengthens the function of science education to improve the responsible individual.

4. The scope of the materials comprising the basic concepts of chemistry should be discussed; the emphasis should be not only on the content of chemistry but also on the context, process, and attitudes.

Based on the discussion results, basic chemical concepts that have the potential to emerge ethnoscience in chemistry learning include; (1) a tradition of "mamaq" Sasak tribe to strengthen teeth in acid-base topic; (2) making "TerasiNisa" by Samawa tribe in buffer solution topic; (3) durable "Tamban" used original Sasak tribe salt in salt hydrolysis topic; (4) turmeric, Water girlfriend Leaves, discolor rhoeo leaves, and Hibiscus are natural acid-base indicators in acid-base titration topic; (5) making "ilo" by Mbojo tribe in hydrocarbon topic; and (6) "Celilong" jaje by Sasak tribe in colloid system topic. These topics contained in basic chemistry can could raise aspects of local culture in learning to become an object of learning chemistry so that chemistry literacy can be developed through the study of ethnoscience. The following ethnoscience study in basic chemistry learning is presented in table 1.

Topics related to chemical content	Context of ethnoscience	Aspects of scientific literacy developed	Indicator of aspects scientific literacy
Acid-Base	Tradition "mamaq" Sasak tribe to strengthen teeth	1. Science content or knowledge	<ul style="list-style-type: none"> Recognizing chemical concepts Defining some key concepts Using knowledge in chemistry to get information
Buffer Solution	Making "TerasiNisa" Samawa tribe	2. Science process or competence	<ul style="list-style-type: none"> Planning scientific research Using scientific evidence Identifying scientific question
Acid-base titration	Natural acid-base indicators are Turmeric, Water girlfriend Leaves, discolor rhoeo leaves, and Shoe flowers		<ul style="list-style-type: none"> Issue Identifying Explain a phenomena of chemistry concepts Analyze the information given

Hydrocarbons	Making "Ilo" typical of the Mbojo tribe	3. Context of the application of science	<ul style="list-style-type: none"> ▪ Apply science ability to problem-solving ▪ Apply science ability to communication ▪ Able to use science products well
Colloid System	"Celilong" jaje typical of the Sasak tribe		
		4. Attitude	

CONCLUSION

This study concluded that the development of scientific literacy needs to be done focusing on the preparation of future generations of scientific literacy through cultural-based curriculum to produce a more contextual learnings, particularly learning resources used in the classroom learning process to elevate local culture related to basic chemistry learning. This type of learning source will ease students conceptual understanding as it connects to community culture and everyday life. Thus, the ethnoscience pedagogic in chemistry learning can develop student scientific literacy in terms of content, competence, context, and attitude.

Acknowledgments

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The development of chemistry literacy, especially the chemistry students at the Mataram IKIP can be done through the improvement of the lecture process carried out, and the scope of the materials on the basic concepts of chemistry given. Especially for the give basic concepts of chemistry, the emphasis should be not only on the content (content) of chemistry, but also on the context, process, and attitude. This is very important as the assessment of chemistry literacy according to PISA is not only on content, but also the context, knowledge (knowledge of science and knowledge about science), and attitudes (DeLuca & Klinger, 2010). One effort to develop the literacy of students at IKIP Mataram is through the improvement of the learning process carried out by integrating ethnoscience in chemistry learning.

Ethnoscience is a knowledge acquired by the language and culture of a person who can be tested for truth, and this can be innovated in science-based learning in the classroom (Abonyi et al., 2014). Ethnoscience is a learning approach that elevates local culture or wisdom to become an object of science learning. Science learning developed from the perspective of local culture and organized local wisdom related to certain natural phenomena and events will increase students' interest in science and will be more easily understood by students. Ethnoscience, as a national identity, is something that needs to be considered in Indonesian curriculum development especially in the chemistry curriculum. One type of the ethnoscience study is related to indigenous science mapping. Genuine science knowledge consists of all knowledge that pertains to the facts of society. The development pattern of such knowledge is inherited continuously between generations, unstructured and systematic in a curriculum, informal, and generally a knowledge of people's perceptions of a particular natural phenomenon (Sudarmin et al., 2015).

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