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Chemical Literacy of Teaching Candidates Studying The Integrated Food Chemistry Ethnosciences Course

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ABSTRACT

This research aimed to describe the chemical literacy of teaching candidates studying the integrated food chemistry ethnosciences course. The research sample comprised teaching candidates studying chemistry in a teachers' education program in Central Java, Indonesia. In this descriptive research method, data was collected by using a chemical literacy test in narrative form regarding material integrated ethnosciences carbohydrates that have been declared valid by experts with a reliability of 0.81. The results revealed that the content aspects of students' average chemical literacy achievement amounted to 31.8% included in the low category. Similarly, for science literacy achievement scores in the process domain, the indicators identifying scientific questions of 3.20 evaluate and design a scientific investigation of 2.26 and identify the scientific evidence of 2.95 from a maximum score of 5.0. These students' chemical literacy achievement is also in accordance with the results of the analysis of student explanations on selected chemical concepts that are seen mostly in the category of partially correct answers. Therefore, it is necessary to improve the quality of learning that explicitly integrates aspects necessary to improve students' chemical literacy.

Keywords: Ethnosciences, integrated food chemistry ethnoscience, chemical literacy.

INTRODUCTION

Chemistry is a science that deals with the properties of the material, the material structure, material composition, bonding that occurs in the material, material changes, as well as the energy involved in turning these materials (Kelter, Mosher, & Scott, 2009). Informally, the meaning of chemical or chemicals is often limited to the materials produced by the chemical industry, even though the chemicals needed by humans are more than that. Therefore, understanding the chemical explanation is highly important to most people because to understand the chemistry helps people to understand their daily lives and the

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environment (Celik, 2014). However, as a concept involving daily-life phenomena, applications relating to the environment are often associated with chemical literacy skills of teaching-candidates. This is evidenced by the Programme for International Student Assessment (PISA) data achievement indicating that the scientific literacy of Indonesian students is still very low (Rahayu, 2016). PISA's test of their literacy revealed that in 2006, Indonesia was ranked 50th out of 57 countries; in 2009, 57th out of 63 countries; in 2012, 64th out of 65 countries; and in 2015, 66th out of 74 countries.9

Chemical literacy is one of the essential elements that must be developed in education. It is defined as the capacity to use chemical knowledge, to identify questions, and to draw conclusions on the basis of the evidence in order to understand and help make decisions about the natural world and human interaction with nature (Cavanagh, 2008). Chemical literacy relates to people of all ages, all levels of both science and non-science education. According to Gilbert and Treagust (Lin, 2009), there are many aspects of chemical literacy that have direct applications in daily life, thus allowing a person to be a better citizen and to understand the report and discuss chemistry and chemicals; it can also solve daily environmental issues such as decrease in the quality of air, water and soil, ozone layer depletion, acid rain, corrosion, and global warming. Many chemicals are closely related to human life and are very helpful in solving problems related to daily life, such as food, beverages, medicines, bleach, cleaners, room deodorizers, vehicle, land, air, and household appliances. Thus, understanding the chemical explanation is very important to most people because it has practical applications in daily life.

Chemical literacy involves several components (Shwartz, Ben-Zvi; & Hofstein, 2005), such as the following:

1. Understand the chemical properties, norms, and methods, i.e., how the chemist worked and how the produced products are accepted as scientific knowledge;
2. Understand the theories, concepts, and models of chemistry. Subjects situated on a theory involving broad applications;
3. Understand how chemistry and chemistry-based technology relate to each other. Chemistry is trying to produce an explanation of nature, whereas chemical technology seeks to change the world itself. Concepts and models produced by the two fields have a strong relation, and thus, mutually influence each other.
4. Appreciate the impact of chemistry and chemical technology associated with the community. Understanding the nature of chemical phenomena that are applicable. Produce changes or variations to the better phenomenon by changing the world we see.

Future chemistry learning should be relevant to the settlement of social issues (Holbrook, 2005). If the learning approaches of scientific literacy develop scientific knowledge in various aspects of life, looking for solutions, on the basis of local advantages and social-science decision, it is the same with learning chemistry. As the nature of chemistry learning is a product and a process, chemical literacy requires knowledge not only of science concepts and theories but also of the general procedures and practices associated with scientific inquiry. The low contribution to the success of citizens' scientific learning caused by the release of their science lessons from the social context only focuses on a mastery of the material and the use of improper assessment so that the students were only prepared to master the knowledge (National Research Council / NRC, 1996). In lessons, students should know the relevance of learning science in daily and social life. Scientific learning in school should be directed toward the understanding of how important science is when it is associated with the community in the past, present, or future. Future scientific learning is necessary to keep a balance/harmony between the knowledge of science itself, with the generation of scientific attitudes and ethnosciences values existing and developing in society (Marks & Eilks, 2009), which applies the problem-oriented model and uses social sciences in order to improve the scientific literacy of students in Germany. Therefore, students' sociocultural environment needs to be given serious attention for developing science education in schools, including original science that can be useful for life (Suastra, Tika, & Kariasa, 2011). This is consistent with the view of present-day science education reform that stresses the importance of science education for improving social responsibility.

Good chemistry learning is chemistry learning to make students understand the concepts of chemistry that make up a branch of science, using chemical theories to explain natural phenomena; this can also help students solve problems and make decisions on the basis of chemistry concepts that have been received. To gain chemical knowledge, one must have a realistic view of the chemistry (Shwartz, Ben-Zvi, & Hofstein, 2006). Someone with knowledge of chemicals should also know the basic objectives of chemistry, including the chemical principle that teaches us to understand the phenomenon that is macroscopic, microscopic, and symbolic, as well as to investigate the chemical dynamics of the process and energies changes in the reaction. Such literates should appreciate and be able to use the knowledge in their daily lives. If students do not have a good interest in and understanding of chemistry, they will face difficulty in understanding the overall nature in the future. Therefore, an increase in scientific literacy and chemistry in school is significant to future prospects (Kelly, 2007).

As scientific literacy is a broad concept, mastery of chemistry will affect the quality of life. Individual achievement in science/chemistry knowledge and skills will have implications of their readiness to face the utilization of advanced technology in the future (OECD, 2009). This is consistent with the statement of (Glenn & Janusa, 2010) that described chemistry a powerful motivation for developing technology that can make someone's life better, easier, and cheaper. A person with scientific literacy is able to use this knowledge in daily life (Shwartz, Ben-Zvi, & Hofstein, 2006) (Anelli, 2011). Scientific literacy is able to prepare students as responsible citizens and as sensitive to surrounding issues. This is due to the scientific literacy emphasis on decision-making about social issues if the terms of the scientific knowledge have been obtained and problems can be solved using that knowledge (Murcia, 2007) (Gunstone, 2014)

Till date, research on chemical literacy has been largely based on the same study with scientific literacy measurement (Bond, 1989) (Shwartz, Ben-Zvi, & Hofstein, 2006). But many years ago, Bond provided sufficient pressure to support the understanding of the atomic theory, the concept of the mole, radioactivity, or other fundamental chemistry concepts (Bond, 1989). Chemical literacy has been suggested to have a characteristic in which the materials must be attributed with examples in daily life, and it should also be extracted chemical concepts connection with the information you've obtained the students through print and electronic media (Mann & Treagust, 2010). Hirca, Celik, & Akdenis also expressed the need for context relating to the actual problems that occur in the community.

If scientific literacy is the focus of science education chemical literacy is the focus of chemistry education (American Association for the Advancement of Science [AAAS]. , 1993), (NRC, 1996). Study of science literacy by AAAS in 1993 and NSES (NRC, 1996) has been used as a framework for the science of the 21st century that has been widely applied in various countries through curriculum development, model learning, and assessment form (Wei & Thomas, 2005) (Shwartz, Ben-Zvi, & Hofstein, 2006) (Millar, 2006) (Bybee, Mc Crae, & Laurie, 2009) to prepare the students for global challenges.

The result development measurement (Shwartz, Ben-Zvi, & Hofstein, 2006) is used to measure the level of literacy of students, including their skills of defining key concepts of chemistry, using the understanding of chemical concepts to explain phenomena, and understanding every article about the chemistry based on terms of scientific literacy.

The teacher's role is very vital to become one of the important components that determine the students' success. Student success in learning is largely determined by the ability of teachers to teach. Therefore, a teacher must have a strong ability in chemical 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 chemical literacy in order to allow students to construct meaning in scientific literacy (Shwartz, Ben-Zvi, & Hofstein, 2005). Given the important role of teachers as agents of learning, the teaching candidates must have high chemical literacy skills as their skills certainly affect future learning. If chemical literacy is low, it is feared that the implementation of teaching chemistry is less than optimal. Teachers with a low level of scientific literacy cannot be expected to develop science-literate people or implementing the curriculum effectively so that the university curriculum should improve the literacy level of scientific literacy teacher candidates (Bacanak & Gőkdere, 2009).

A research was conducted to determine the extent of chemical literacy of the teaching candidates. On the basis of the formulation of the problem, the following research question can be proposed: What is the chemical literacy of teaching candidates in the domain of science content and process? The results of chemical literacy analysis are valuable information for the lecturer in order to prepare appropriate learning strategies for fostering chemistry literacy for chemistry teaching candidates.

METHODS

The method used in this research is a descriptive method; the research is directed to collect data about the actual condition. As a method to uncover the candidates' chemistry literacy, in the aspects of knowledge/content, processes, and attitudes, the research was conducted at the lecture entitled "Chemical Food Ingredients integrated ethnosciences." This course aims to introduce the component-based food ingredients ethnosciences of the Java community and make the teaching candidates aware of the positive sides of the cultural heritage of the Javanese society relevant to be maintained in the face of various challenges of the times. Through these efforts, teaching candidates are expected to learn of the conditions of the community and making capital in improving the meaningfulness of learning more open.

The study was conducted in one of the education workforce education institutions of Central Java. Subjects in this study comprised fourth-semester students of chemical food ingredients courses in the academic year 2015–2016, amounting to 148 people (84% women and 16% men). They were grouped into high-, medium-, and low-achievement categories on the basis of the semester GPA 3. Their GPAs range 0–4. The calculations revealed that the value average GPA to be 3.31 and SD to be 0.217733. Of the 148 teaching candidates, 29 were in the high category (GPA >3, 53), 110 were in the medium category (GPA between 3.09 and 3.53), and 9 were in the low category (GPA <3.09).

Instruments used to test chemistry literacy in the context of Javanese culture, among others related to the culture of making palm sugar is traditionally making salted eggs, palm oil processing and ***Gatot & Tiwul*** as food knowledge characteristics of local wisdom in Central Java have been developed (Sumarni, Sudarmin, Wiyanto, & Supartono, 2016a) (Sumarni, Sudarmin, Wiyanto, & Supartono, 2016b). Test item refers to the form of test questions developed by Witte & Beers (2003) and Schwartz, Ben-Zvi, & Hofstein (2005) to reveal the students' chemical literacy skills and competency in content domain. Aspects which revealed, among other things: a) to recognize chemical concepts, b) define some key concepts, c) use their understanding of chemistry concepts to explain phenomena and d) use their knowledge in chemistry to read or analyse the information given in a passage (Thummathong & Thathong, 2016). Sample questions for the literacy test are listed in Appendix 1. In this research, we used 30 test items in a narrative form, consisting of 10 items related to carbohydrates, 10 items related to fats, and 10 items related to proteins. Each item's test scores differed but highest score limit of each topic was 100.

Problem literacy test chemical used for data retrieval has been declared invalid by 3 experts chemical materials, chemistry lecturer foodstuffs 3, and 3 expert measurements and evaluation. A small scale and a large scale test were also conducted to determine the response of the students and the faculty considering that the users against the chemical literacy test questions were developed as a reference for revising the product. On the basis of trial results, either limited or broad scale, several revisions have been made by the advice of the test item validator and user feedback. The internal consistency reliability (Cronbach's alpha) of the assessment instrument is 0, 81.

In the implementation of data retrieval, all students are provided a set of chemical literacy problem to be solved within as long as 120 minutes. Data were analyzed using quantitative descriptive analysis. The analysis was performed by calculating the scores obtained on each topic, then on average. The minimum score-limit was decided as 64, which refers the students' chemistry literacy scores, defined by minimum completeness criteria present in the sample, concerning the subject of chemistry food ingredients.

RESULTS AND DISCUSSION

1). Chemical literacy test results per domain content

Student chemical literacy in the content domain can be seen in Figure 1 and Table 1.

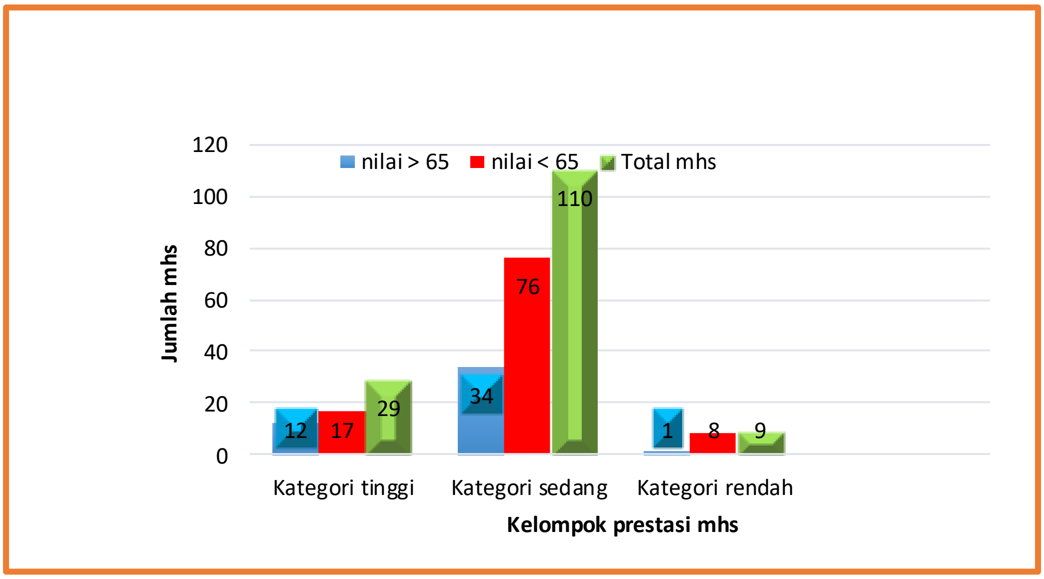

Figure 1. Number of students with chemical literacy in the content domain (N = 148)

Figure 1 shows that there are still many teaching candidates who do not have chemical literacy. Of the 148 candidates, only 47 (31.8%) had chemistry literacy in the context of content, while the remaining 101 (68.2%) did not have such literacy. Judging by student achievement and creating a row of high-, medium-, and low-achievement group, the number of candidates surpassing the minimum criteria (>65) was 12, 34, and 1 student (8%, 23%, and 0.8%), respectively. Similarly, the terms of the average value of chemical literacy in each of the groups still showed capabilities far below the standards set (Table 1).

Table 1. The mean value of chemistry student literacy in the content domain

o.	Groups of student achievement	The mean value of chemical literacy achievement in the content domain
	High	53
	Medium	46
	Low	40

2) The results of tests per domain competence chemical literacy

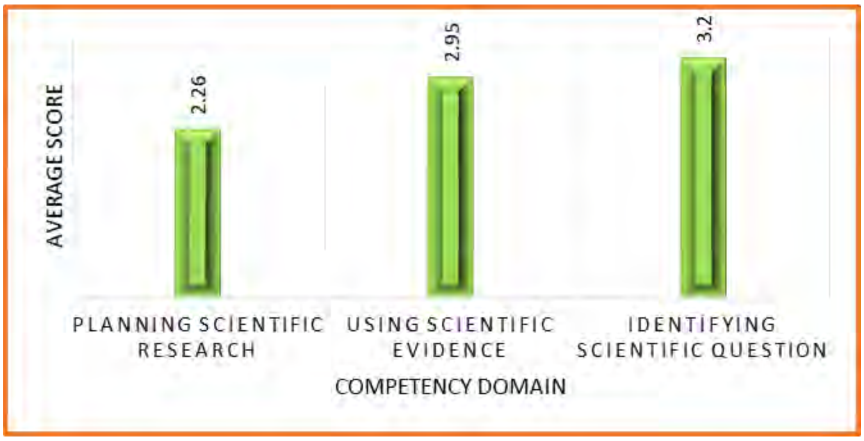

Figure 2. Mean value of scientific literacy achievement in competency domain (n = 148, the maximum score 5.0)

Results of the analysis of student explanations related to the selected chemical concepts data can be classified into true answer, partially true answer, and false answer, as shown in Table 2.

Table 2. Results of students explanation in concepts of chemistry

Concept	Type of explanation	True	Partially true	False
Photosynthesis	Molecular	11	24	19
	Macroscopic	26	50	18
	Total	37	74	37
Chemical reaction	Molecular	20	10	13
	Macroscopic	41	44	20
	Total	61	54	33
Carbohydrate	Molecular	-	13	-
	Macroscopic	44	75	18
	Total	44	86	18
Evaporation	Molecular	12	32	16
	Macroscopic	32	22	34
	Total	44	54	50
Monosaccharide	Molecular	1	5	1
	Macroscopic	39	74	28
	Total	40	79	29
Disaccharides	Molecular	-	-	-
	Macroscopic	32	66	50
	Total	32	66	50
Carbohydrates test	Molecular	-	-	-
	Macroscopic	29	58	61
	Total	29	58	61

1) Chemical literacy on domain content

Figure 1 indicates that the results of the course for three semesters particularly with regard to the basic concepts of chemistry have, however, been able to equip students to be chemical literates. Some evidence suggests that teaching candidates who have passed have not demonstrated the ability of scientific literacy (Çepni & Bacanak, 2002), which is possible because the learning they receive does not associate with the content of science and daily life. Similarly, the terms of the average value of the chemical literacy in each of the groups still showed capabilities far below the standards set (Table 1). Table 1 shows that the group with a higher understanding of the concept is better than the low group. This is possible because the high-achievement group had thinking skills of analysis and its long-term memory retention is better than medium- and low-achievement group.

2) Chemical literacy in domain competence

In the domain of competence, Figure 2 shows that the mean achievement for all indicators has not yet reached the level of success (score >3.5). However, the aspects of not achieving the identifying scientific questions or not explaining the phenomenon scientifically aligned with the study's results (Celik, 2014) that of the 112 teaching candidates, only 56% give the correct explanation related to functional literacy, that most students have very limited knowledge about the concept, and that most of their explanation are only partially right and are on a macroscopic level. In his thesis, Bacanak shows that the average results of two scientific literacy tests applied to prospective science teachers were 54.30% and 59.10% (Bacanak, A., 2002). Therefore, teaching candidates of science must enhance their chemical scientific literacy in order to raise the level of scientific literacy of future generation.

The achievement of scientific literacy in the domain process for identifying/recognizing scientific questions indicators, as depicted in Figure 2, shows the highest score compared with the other two aspects but has not reached the stipulated minimum score of >3.5. This suggests that although the chemical knowledge already acquired by students started from since secondary education and went up till college, which should ideally enhance their chemical literacy, it has not made them chemical literate as expected. This further reinforces the results of the PISA findings that science learning in Indonesia has not succeeded in improving the scientific literacy skills in the aspects of content, the context of the application of science, the science, and the attitudes. PISA results in 2012 revealed that Indonesia ranked 64th out of the 65 participating countries, with an average score of 382 scientific capabilities (OECD., 2013)

We modelled the literacy level from the lowest to the highest. No changes were found in the low level of the sense of competence or capabilities *(low level)* and the highest level was an already complex ability *(high level)* (Bybee, 1997). Having good chemical literacy means not panicking while facing issues in chemistry and appropriately judging and determining proper action as per the concepts of their chemical knowledge. A person with chemical literacy can become the link between the content and context of chemistry, resulting in scientific decisions.

The results in Table 2 indicate that most students have very limited knowledge about the concept. Most of their explanation is partly true and is at the macroscopic level. Except for the explanation of the chemical reaction, the explanation provided by the students was partly true and partly false. For the process of photosynthesis, a partially correct explanation, even though it contains a chemical reaction. For example, one student explained as follows: "Cassava is formed from the reaction of photosynthesis that occurs in cassava. The reaction of photosynthesis occurs because of their gas CO_2 and water." This explanation is categorized as partially true because it does not refer to the concept of photosynthesis and does not clarify that the reaction of photosynthesis was the reaction of the formation of carbohydrates that occur in chlorophyll when their gas CO_2 from the air and the water are absorbed through the roots with the help of sunlight to the equation as follows: $CO_{2\ (g)} + H_2O_{\ (l)} \rightarrow C_6H_{12}O_{6\ (glucose)} + O_{2\ (g)}$. Due to the responses including chemical symbols, the explanation is considered molecular. Another explanation is an example of the bitter taste in cassava that saved in a few days: "Oxidation is the interaction between compounds in cassava with oxygen in the air so that the chemical structure of substances changed after the interaction." In actuality, the correct explanation is as follows: "In certain circumstances, especially when oxidized, glycoside toxins are formed in cassava, which in turn form cyanide (HCN). The cyanide leaves a bitter taste. The sweet tuber produces at least 20 mg of HCN per kilogramme of fresh tubers and 50 times more tuber that tastes bitter." They mostly can answer the question by mentioning concepts that match the content, such as compounds HCN as toxic compounds, carbohydrate testing with Lugol; they also believe that they are familiar with these concepts but only 56% of them explain correctly.

A considerable gap exists between the knowledge of the students and the application; numerous students who know and remember the subject matter are unable to use their knowledge (Semiawan, 2000). This happens because their learning presented facts, knowledge, and then the law, and thus, it is usually memorised and not associated with empirical real-life experiences. This has been proved; there are many teaching candidates who do not understand the depth of the concepts in chemistry, especially in the matter of carbohydrates, even though these concepts are closely related to their daily lives. In the concept of simple sugars/saccharides, there are still many students who have been unable to determine the chemical and structural formulas of carbohydrates. In writing compilers of carbohydrates, they experience difficulty while changing the name of the compound to the chemical formula and turn the chemical formula into a compound name instead.

As for the functionality or usability of carbohydrates, in general, the students were able to write it in full. The same thing happened when asked to write the chemical equation. However, many students face difficulty in explaining the process of carbohydrate formation in plants. Many students have been unable to explain the concepts in carbohydrates because, so far, the lecturer considers that these concepts have been "acknowledged" by students, and thus, even the students were already feeling out of the concept. Interviews with some of the students revealed that they are still facing trouble due to ethnosciences-based questions that they have never encountered and are still uncommon to them. According to the students, in a test or examination on the subjects or course, questions only focused on memorization of concepts, applying the formula and almost never associating it with its application in daily life, especially the ethnosciences-based questions.

From these findings, other contributors emphasize the importance of chemical literacy controlled by the teaching candidates as literacy is chemically related to various aspects of life and to the activities of people of all ages. Literacy is chemically related to people of all ages and thus, it needs to be increased to achieve higher chemical literacy (Lin, 2009). Obtaining a student's knowledge depends on the students' thinking while getting a learning experience associated with understanding the concept of previously owned.

Referring to the results of the chemical literacy analysis of teaching candidates, a lecturer should provide a briefing during the learning process in the classroom. During the learning process, the lecturer must use a scientific approach to train students, should observe and ask stages, and students should be trained in identifying scientific issues such as **making questions related to the scientific phenomenon** that is delivered by lecturers. This can also enhance the students' skill in explaining phenomena scientifically and using scientific evidence. This is because both these capabilities need to be trained at the stage of associating or processing the data and communicating during the implementation phase of learning. Students' ability to identify evidence should also be trained at the **stage** of **collecting**

information or experimenting. At this stage of associating, lecturers have to guide each group in processing and analysing the results of experiments that have been conducted and in attracting and **communicating conclusions** on the basis of experimental data. At the data-processing stage, students are trained to use scientific evidence (experimental results) to explain scientific phenomena and communicate conclusions based on the data they collect.

Learners' increased scientific literacy is characterised by their ability in creative thinking and problem-solving challenges and making personally and socially responsible decisions (Holbrook & Rannikmae, 2009). Similarly, the result obtained by Marks & Eilks, applies the model of problem-oriented and uses social sciences to get the results of increasing science literacy among learners. The relevance of learning chemistry in daily life according to Holbrook can be checked in the following stages: 1) how teaching should be reconsidered, 2) the relevance of the subject material in people's lives and how it directly engages learners, 3) the structure of the teaching shows concern for the lives of the people, leading to better learning, and 4) the structure of the chemical material that is not only in theory.

CONCLUSİON

On the basis of the results this research and discussion, it can be concluded that teaching candidates' chemistry literacy achievement in the content domain has reached as much as 31.8%, literacy achievement while scores of chemical science to process domain recognize scientific questions of 3.20, evaluate and design a scientific investigation by 2.26 and identifying the scientific evidence by 2.95 of a maximum score of 5.0. Thus, it is known that the chemical literacy of teaching candidates is still low. Candidates' chemistry literacy attainment is also in accordance with the results of the analysis of student explanations of selected chemical concepts that mostly show partially correct answers.

Therefore, in view of the above discussed aspects, we suggest the following to increase chemistry literacy of teaching candidates: (1) emphasis on a curriculum that involves the importance of the development of chemistry literacy for students, (2) teachers' chemistry skills in particular can design learning programs using local potentials in their respective regions, and (3) the scope of the material comprising the basic concepts of chemistry should be discusses; emphasis should be not only on content of chemistry but also on the context, process, and attitudes. This is highly important due to the assessment of literacy chemicals according to PISA not only including content but also including Context, Knowledge (knowledge of science and knowledge about science), as well as attitudes. Learning should use a scientific approach (PBL, IBL) associated with ethnosciences. In practice, the learning can be carried out independently and under guidance. Learning should be conducted independently, especially on things that are simple and familiar to them, including ethnosciences. And lastly, guided learning (classroom-learning) should be conducted for a rather complex matter, especially in solving daily-life problems.

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Appendix 1
Example Test instrument

GATOT AND TIWUL, POPULAR FOOD OF INFERTILE AREA

Food knowledge characteristics of local wisdom in Central Java, Indonesia

Source: https://www.google.co.id

Figure 1. *Gatot and Tiwul* as food knowledge characteristics of local wisdom in Central Java, Indonesia

Food shown in the Fig. 1 is an example of local wisdom special food, people called it *Gatot* and *Tiwul,* local food made by *gaplek* (dried cassava) that is popular in Gunung Kidul and is consumed from Gunung Kidul in Yogyakarta, Indonesia to Pacitan Regency, East Java. The name *Gatot* came from *Gagal Total* due to the failure of gaining rice or *white Gaplek*, while *Tiwul c*ame from the production process called *pathi di awul-awul*.

Cassava is a yearly tropical and subtropical clump. Its root is well-known as main food and its leaves as a vegetable.

Source: https://www.google.co.id

Figure 2. Cassava and harvested cassava.

Mr.Surani, a cassava farmer from Gunungpati said that the production process of *gaplek* is very easy; cassava root, called *Pohung* in Javanese is harvested, peeled, and dried. The drying is done by *Gaplek* makers by drying it in the sunlight. In the drying process, the cassavas are laid in a narrow field without any coverage all day and night long. Dried gaplek was mashed as flour and can be stored for a month and can be used as delicious *Tiwul*.

Based on Ngatini's story, there are two kinds of *Gaplek.* First *Gaplek* is white and commonly made as flour or *Tiwul,* and the second *Gaplek* is black and made as *Gatot*. According to Mr Surani, initially, it was just white *Gaplek,* but because of the bad process of drying (rain factor), they got black *Gaplek.* They feel pity if the *Gaplek* is thrown to the garbage, then *Gatot* was appeared and become popular to the society.

Source: https://www.google.co.id

Figure 3. White and black *gaplek* as ingredients to make local wisdom special food of Central Java, Indonesia

Answer all of these questions.

From the passages above, it is showed that cassava is a yearly tropical and sub-tropical clump. Its root is well-known as main food and its leaves as a vegetable.

1. a) Scientifically explain how roots and leaves of those cassavas can be made from its plant. Write down the occurred reaction similarity (Explain scientific phenomena) **Score 4**

b) Through arrow diagrams equipped by picture and label, draw the growing and developing of the process of cassavas' roots and leaves in its tree (design scientific investigations) **Score 6**

2. From the farmers' experience, cassava is one of the food ingredients that is not durable. In the fresh condition, it can only survive for three days. If it is saved more than three days, the root will become blue and brownish and will taste bitter. Farmers said that do not choose the cassava if there are blue parts in it because it is poisonous. Is it true? Give logical answer! (science process of conclusion evaluation) **Score 4**

3. Carbohydrate had been tested in the laboratory of fresh cassava, *gaplek*, and some other food ingredients with the result in the following Table 2.

Table 2. The test results of carbohydrate

No	Food Ingredients	Colors		Information
		Before Yodiumize	After Yodiumize	
1	Banana	Yellowish	Rather purple	Rather thick
2	Rice	White	Rather purple	Thick
3	White tofu	White	White	-
4	Biscuit	Brown	Violet	Quick
5	Flour	White	Purple	Thick
6	Potato	Yellowish	Purple	Rather Pale
7	Fresh cassava	Yellowish	Purple	-
8	Gaplek	Yellowish	purple	-

a) From the experiment result above, why did the tested white tofu not turn purple? (cause and effect law) (science concept comprehension demonstration) **Score 3**

b) Write down your conclusion related to the experiment result above! (science process of making conclusion) **Score 3**

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