PAPER NAME

3. APFSLT 2021 sugi.pdf

WORD COUNT

7581 Words

CHARACTER COUNT

41191 Characters

PAGE COUNT

17 Pages

FILE SIZE

315.1KB

SUBMISSION DATE

Mar 31, 2022 7:19 PM GMT+8

REPORT DATE

Mar 31, 2022 7:21 PM GMT+8

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Students' scientific literacy skill: The starting point of chemistry learning in the junior high school

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Received 16 Oct., 2020
Revised 28 Jun., 2021

Abstract

This study aimed to learn more about the results of the research on the chemical literacy ability of junior high school students in South Sulawesi based on atomic, ionic and molecular materials. The samples in this study were Public Middle School 6 Makassar, Public Middle School 2 Maros and Public Middle School 4 Sinjai. Samples were taken randomly and as many as 181 students. The data were collected by using instruments consisting of multiple-choice tests that were used to collect data on knowledge and literacy competencies in chemical science. Aspects of knowledge discussed consisted of three indicators, and four indicators in aspects of literacy. The data that has been obtained were analyzed quantitatively. The results of research showed that there were differences between indicators of literacy skills, school level and interactions between students' chemical literacy competencies. The teacher must try to practice the students' scientific literacy skills. One effort that can be taken is the use of the appropriate learning models.

Keywords: scientific literacy ability, chemistry course, 21st century skill, science learning, teaching and learning

Introduction

Natural Science is one of the subjects in Junior High School included in the PISA program. Students were expected to be able to understand the knowledge content, context and its implementation (Utami, Saputro, & Masykuri, 2016). Bahri et al. (2021) stated that science was important to develop the human resources quality. On of the lesson in Natural Science is the

Chemistry lesson. Chemistry materials in junior high school are introduced starting from the smallest material, namely atoms. Students are introduced to the composition, structure, and properties of substances or from the atomic to molecular and compound scales. In addition, students really need this knowledge because in their daily lives they can not be separated from the chemicals they consume, the need for clothing and boards. Therefore, only through their scientific abilities, they can use their knowledge to lead a better life. Given the complexity and very abstract nature of chemistry, the teacher has carried out comprehensive learning by giving assignments and looking for examples of chemicals that are around them. This learning activity serves to direct students to organize and identify and analyze the relationship between the assigned chemistry and the materials that are around them on a daily basis, so that in the end they have the ability to express and make conclusions from the results of learning in class and in the environment obtained.

One of the studies that measured the literacy ability of chemical science is PISA which is conducted every three years. To measure chemical science literacy, there are three competency indicators, namely explaining phenomena scientifically, evaluating and designing scientific questions, and interpreting data and evidence scientifically. The implementation of the three indicators for students is the meaning of scientific knowledge, the ability to organize and interpret data and information, improve students' ability to reflect and draw conclusions from the results of their learning experiences. Based on the latest PISA study report in 2018, the achievement of students' scientific literacy scores in Indonesia decreased with a score of only 396. From the results of the report score of the study, it can be concluded that the scientific literacy ability of students in Indonesia is still relatively low.

The results of chemistry lessons for students in junior high school are also very low, they have difficulty to understand related to an atom in forming a compound, it is difficult to interpret the meaning and difference between atomic number and atomic mass. This situation makes it difficult for students to understand the formation of a compound, even though theoretically they memorize the meaning of atom, ion, atomic number and atomic mass. Students studying chemistry are only limited to the demands of the curriculum, so students are forced to take chemistry lessons, and the results are very unsatisfactory.

The others difficulties in learning chemistry were caused by the characteristics of the chemical material itself which seems to be difficult, lack of interest and motivation to learn and no encouragement for the students to learn both from within themselves, or from outside such as family, friends or the surrounding community (Abdul, 2013). This is in line with Bahri & Corebima (2015) who stated that learning motivation was contributed to students' achievements. Interest to read or write and analyze in understanding the lesson was still low. On the other hand, now in the era of global competition, the students inevitably have to follow the quality requirements of education as a determinant of the future, one of which is measured through PISA. In the PISA 2009, reading literacy test, Indonesia ranked 57th out of 65 participating countries with a score of 402 from the standard score of 493. Finally in PISA 2015 based on text, Indonesia ranked 64th out of 72 participant countries with a score of 397 out of a specified score of 450.

The science literacy was the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence, in order to understand and make decisions regarding nature and changes made to nature through human activities (OECD, 2003). To be successful in life, students must have good scientific literacy skills (Hernawati, et. al., 2019), and thinking skills (Bahri, et al.,

2021). This understanding could be interpreted in detail as scientific knowledge and skills to be able to identify questions, obtain new knowledge, explain scientific phenomenon, and draw conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual, and cultural environment, and will to get involved and care about issues related to science (Literacy Association, 2016).

Furthermore, the OECD mentions four aspects of PISA science literacy, namely: 1) aspects of context such as personal, local/national and global issues, both current and past, which require an understanding of science and technology, 2) aspects of knowledge in the form of an understanding of facts, concepts, and theories of the main explanations that form the basis of scientific knowledge, 3) aspects of competence, namely the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and facts scientifically, and 4) aspects of attitude namely attitudes towards science that are indicated by an interest in science and technology, assessing the appropriate scientific approach to an investigation, as well as perceptions and awareness of environmental problems. Especially for Chemistry course, literacy required not only the result of thinking (mind-on) but also the ability of skills (hands-on) and attitude (Eilks, Sjöström, & Hofstein, 2017). This literacy ability was a part of 21st century skills that begins with the curriculum program for all subjects by implementing literacy strategies in learning that refer to higher order thinking skills (HOTS and high-level reasoning skills) (Muhammad, 2018; Bahri, *et al.,* 2019).

The big effort of teachers and parents as the main companion who strongly supports the child's learning achievement is needed to enhance the students' achievements include scientific literacy. One way is the simultaneous collaboration of teachers and parents. Teachers should maximize the use of models/methods of teaching in depth and more widespread application in daily life as a content application, like discovery, inquiry learning models, problem-based learning (Listiana & Bahri, 2019). But the reality has not been maximally done, not yet applied totally by the teacher in each learning because of inequality between the task of the teacher in the classroom with the task of the teacher as a substitute for laboratory workers who prepare practicum needs. The concepts of these learning models are still in the form of discourse and archives as plans for implementing teacher learning. Through learning with discovery models or project work, students will be trained to find and solve their own problems found according to their abilities and potential. Teachers should create a comprehensive understanding for students to achieve learning goals (Shwartz, Ben-Zvi, & Hofstein, 2006).

The results of observations in a number of junior high schools in South Sulawesi Province, Indonesia, in April to May 2019 specifically for Chemistry course, it seems that learning still needs to use an appropriate model, at least using an effective direct learning model used for a greater number of students. Much earlier, the results of Al-Shammari's research (2008) have also found that students lack of the opportunity to explore understanding, the teacher only gives questions classically and do not provide adequate explanations that further confuse them. Less of active learning methods than can encourage students to ask questions and answer. The questions posed by the teacher are still at the cognitive level of remembering and understanding (C1 and C2). Students have not been led to study at a high cognitive level such as application, analysis or synthesis levels, as the characteristics of literacy questions with an assessment target are reading comprehension, mathematics and natural science lessons. The test items were created by combining the problem-solving process with the collaboration of competency solving.

In each subject matter it is possible to lead students to think at a high level. For example in the chemistry course, matter of atoms, ions and molecules could be created in various forms of understanding (Joelipoo, 2012) starting from marking the symbol with the name of the element, giving exercise the ionization process and predicting the reason, writing the symbol of the element itself, training associating the element symbol of a compound with the name of the compound appropriately, and other creativeness that gives rise to intersecting thoughts so that students' understanding is really strong.

The Indonesian education curriculum emphasizes the achievement of learning for students on three abilities, namely cognitive abilities from the level of remember to the level of create, attitude (affective), mental and psychomotor skills (Bloom's Taxonomy) (Bloom, 1956). In this study the focus of the study is on scientific literacy skills that emphasize aspects of knowledge and aspects of science competence in junior high school students on atomic, ionic and molecular materials. So the purpose of this study is to find out how much the ability of chemistry literacy in the aspects of knowledge and science competence of the junior high school students in South Sulawesi.

Methods

The design of this research was a quantitative descriptive research with survey method. In this study the results obtained were described descriptively in the form of the median frequency and the average frequency percentage (Arikunto, 2009). Research conducted does not provide treatment, manipulation or alteration of the variable. The form of research was a survey research with no real determination of hypotheses and variables (Denzin, 2009). In addition to being described descriptively, the study also compared the scores of each indicator of chemistry literacy ability based on differences in school locations.

The population of this study were all students of grade VIII junior high school in four locations in South Sulawesi Province, Indonesia, namely Makassar City as a big city, Maros Regency as a middle city, and Sinjai Regency as a small city. The sample of the study was taken by simple random sampling (Arikunto, 2009) and selected 1 school in each location, namely 62 students in SMPN 6 in Makassar City, 60 students in SMPN 2 in Maros Regency, and 59 students in SMPN 4 in Sinjai Regency, so the total sample as many as 181 students. Each school was represented by two parallel classes in class VIII registered in the academic year of 2019-2020.

This study used instruments in the form of scientific literacy tests for aspects of knowledge and competence of scientific literacy of students. For the aspect of knowledge testing about science content by using multiple choice tests as many as 15 questions consisting of four indicators that have been tested for reliability and validity by lecturers who are experts on chemistry especially atoms, ions and molecules. The instruments were declared valid with a value of validity as much as 3.5. For the competency aspect, 15 multiple-choice tests consist of four indicators, which have been tested for validity with a validity level as much as 3.6. The instrument in the form of questionnaire with high validity as much as 3.7 was given to students to gather supporting data about the profiles of teachers and parents relating to learning at school and at home. The indicators and distribution of questions in both aspects can be seen in Table 1 and Table 2.

Table 1. Indicator of Knowledge Aspect and Distribution of Item Test

Indicator	Item Number	Cognitive Level (C)	Total Test Item
Atom, ion, and molecule	1, 2, 4	C1, C2, C4	3
Identify atom number, mass number, proton, neutron, and electron	8,9,19,11,13	C3, C6, C6, C4, C3	5
Connect atom concept, ion, and mollecule with chemical daily product	3, 5, 15	C2, C3, C3	3
Compare the uncure and compound molecule	6, 7, 12, 14	C4, C6, C5, C3	4

In Table 1 above the item items tested are equipped with a grid of questions and cognitive levels that are spread from level C1 to level C6, but in general the questions are focused on level C3 to Level C6. Because it is appropriate for students to work on questions oriented to high-level questions (HOTS) because the learning models applied in these schools are cooperative and discovery models, problem base learning that activates students with the aim of their chemical science knowledge can be better the result (Priatmoko, 2013).

Table 2. Indicators of Scientific Literacy and Distribution of Chemistry Test Item

Indicator	Sub indicator	Total Test Item
Understand the methods/meaning of questions that lead to scientific knowledge (LS1)	Understanding the scientific questions or statements Identifying the valid scientific opinions Understand the elements in research design	4
Carry out an effective literature search (LS2)	Evaluating the use and misuse of scientific information Reading and interpreting the charts precisely from data	4
Organize, analyze, and interpret the scientific data and information (LS3)	Making a precise graph of the data Solving the problems using quantitative skills, including basic statistics	5
Draw the conclusions based on learning experiences (LS4)	Understanding and interpreting the basic statistics Making inference, prediction and conclusion based on data.	2

In addition to measuring students' literacy abilities in Chemistry course, researcher also distributed questionnaires to students and teachers to be filled in a form to record data about the involvement of the teacher in school and the role of parents at home to guide students.

The research data were analyzed using descriptive analysis of percentages to determine the understanding and achievement of students' scientific literacy competencies. Furthermore, the

results of the analysis are interpreted through the presentation of tables and explanations in accordance with the criteria shown (Arikunto, 2009), namely Very Good (80-100), Good (66-79), Fair (56-65), Low (40-55), and Failed (<40). The category is as a reference to describe the understanding of knowledge of atoms, ions and molecules, and the achievement of scientific literacy competencies of students based on their respective indicators. Data on the difference in scores of scientific literacy abilities based on differences in the indicators of scientific literacy and school location were analyzed using inferential statistics with the two-way ANOVA test with a significance level of 5%, if the ANOVA results showed significant then continued with the Least Significance Different (LSD) test. Before ANOVA test was carried out, the prerequisite test was normality test and homogeneity test. Normality test used Kolmogorov Smirnov one-sample test and homogeneity test used Leven's test of equality of error variances.

Results

The results of the study are presented in tabular form and to facilitate the analysis of descriptive analysis results on the two aspects studied, namely aspects of chemical knowledge and aspects of scientific literacy competencies. The results of the analysis for aspects of knowledge are presented in Table 3.

Table 3. Result of Chemistry Knowledge in all Aspect

Knowledge Indicators	SMPN 6 Makassar		SMPN 2 Maros		SMPN 4 Sinjai		Average/ Category
	%	C	%	C	%	C	
Atom, ion, and molecule	67.18	Good	63.23	Fair	68.17	Good	66.19 Good
Identify atom number, mass number, proton, neutron, and electron	74.40	Good	65.43	Fair	62.22	Fair	67.35 Good
Connect atom concept, ion, and molecule with chemical daily product	63.45	Fair	67.83	Good	60.41	Fair	63.89 Fair
Compare the uncure and compound molecule	63.41	Fair	69.24	Good	61.35	Fair	64.73 Fair
Average	**67.11**	**Good**	**66.43**	**Good**	**63.04**	**Fair**	**65.53 Good**

Note: % = percentage C = Category

The results of data analysis regarding the aspects of students' knowledge on chemical materials about atoms, ions and molecules shown in Table 4 informs that the highest indicator achievement (74.40%) is achieved by SMPN 6 Makassar for indicators of identification of atomic number,

mass number, protons, neutrons and electrons. The mean score of students' knowledge on chemical materials is in the good category.

Table 4. Test Result of Scientific Literacy Ability to Science

Indicator	SMPN 6 Makassar		SMPN 2 Maros		SMPN 4 Sinjai		Average/ Category
	(%)	C	(%)	C	(%)	C	
Understand the methods/meaning of questions that lead to scientific knowledge (LS1)	73.6	Good	72.0	Good	66.4	Good	70.67 Good
Carry out an effective literature search (LS2)	86.8	Very Good	78.5	Good	78.5	Good	81.27 Very Good
Drawing conclusions based on learning experiences (LS4)	64.3	Fair	58.6	Fair	56.7	Fair	60.03 Cukup
Organize, analyze, and interpret scientific data and information (LS3)	71.5	Good	65.3	Fair	60.6	Fair	65.80 Good
Average	**74.5**	**Good**	**68.5**	**Good**	**53.1**	**Fair**	**65.37 Good**

Note: % = percentage C = Category

In Table 4 illustrates the average achievement score of the indicators of scientific literacy ability, which consists of four indicators in three schools in both categories. The score of scientific literacy ability of SMPN 6 Makassar and SMPN 2 Maros students is in the good category while SMPN 4 Sinjai is in the sufficient category.

The results of the normality test of the data literacy abilities of chemical science in each indicator showed a value of p> 0.05 (p = 0.153-0.295) so that the data is said to be normally distributed. Homogeneity test results of the ability of chemical science literacy in each indicator shows a value of p> 0.05 (0.723-0.967) so that the data was to be homogeneous.

A summary of the results of the ANOVA test on the literacy abilities of chemical science in students at SMP Negeri 6 Makassar, SMP Negeri 2 Maros, and SMP Negeri 4 Sinjai is shown in table 5.

Table 5. Summary of ANOVA Test on Scientific Literacy Abilities

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2345.482a	8	291.935	15.277	.000
Intercept	2970.961	1	2969.931	155.416	.000
Indicator	470.547	3	156.508	8.190	.000
School level	631.297	1	621.297	32.512	.000
Indicator*School level	193.882	3	64.627	3.382	.020
Error	2651.583	133	19.109		
Total	847095.985	142			
Corrected Total	4777.035	141			

Table 5 shows that there are differences in the scores of each indicator on the literacy ability of students in chemical science where p <0.05 (sig. 0.000), there are differences in the scores of students in chemical science literacy in the three schools where p <0.05 (sig. 0.000), and there are differences in scores indicators of the literacy abilities of students' chemical science based on the level of the scale where p> 0.05 (sig. 0.020).

The difference in scores between indicators of the students' literacy abilities in chemical science, then continued with LSD test. The LSD test results on the four indicators of chemical science literacy ability are shown in Table 6.

Table 6. LSD Test in Scientific Literacy

Indicator	Mean	LSD Notation
Carry out an effective literature search (LS2)	80.543	a
Understand the methods/meaning of questions that lead to scientific knowledge (LS1)	70.766	b
Draw the conclusions based on the learning experience (LS4)	67.654	b c
Organize, analyze, and interpret scientific data and information (LS3)	60.481	c

Table 6 shows that the ability of the students to carry out an effective literature search (LS2) indicator had the highest score and was significantly different from the other indicators. The ability of the students' indicators to understand the methods/meaning of questions that lead to

scientific knowledge (LS1) is not significantly different from the indicators of drawing conclusions based on learning experiences (LS4). The ability of the students on the indicators of organizing, analyzing, and interpreting data and scientific information (LS3) has the lowest score compared to other indicators of ability.

There is a difference in the score of chemical science literacy ability between the students of SMPN 6 Makassar, SMPN 2 Maros, and SMPN 4 Sinjai, then it was continued with LSD test. The results of the LSD test on the literacy ability of chemical sciences in the three schools are shown in Table 7.

Table 7. LSD Test Result According to The Difference on School Level

Name of School	Mean	LSD Notation
SMP Negeri 6 Makassar	74.543	a
SMP Negeri 2 Maros	68.654	b
SMP Negeri 4 Sinjai	53.446	c

Table 7 shows that the literacy ability of chemical science of the students in SMPN 6 Makassar achieved the highest score and was significantly different from the literacy abilities of chemical science of the students in SMPN 2 Maros and SMPN 4 Sinjai. The lowest literacy score of chemistry was the students in SMPN 4 Sinjai.

The difference in the score indicators of chemical science literacy abilities between the students of SMP Negeri 6 Makassar, SMP Negeri 2 Maros, and SMPN Negeri 4 Sinjai, then continued with LSD test. The results of the LSD test on the literacy ability of chemical sciences in the three schools are shown in Table 8.

Table 8. Result of LSD Test on Scientific Literacy in Different School

Interaction	Mean	LSD Notation
LS2*SMP6Makassar	86.765	a
LS2*SMPN2Maros	78.432	b
LS2*SMP4Sinjai	78.023	b
LS1*SMP6Makassar	73.654	c
LS1*SMP2Maros	72.778	c
LS4*SMP6Makassar	71.767	c
LS1*SMP4Sinjai	66.113	d
LS4*SMP2Maros	65.098	d

LS3*SMP6Makassar	64.674	d
LS4*SMP4Sinjai	60.655	e
LS3*SMP2Maros	58.876	e f
LS3*SMP4Sinjai	56.996	f

The results of the LSD interaction between the indicators and school level in Table 8 show that the ability to conduct an effective literature search (LS2) on SMP 6 Makassar students achieved the highest score and was significantly different from other abilities at other schools. As for the same ability (LS2), SMP 2 Maros students were not significantly different from SMP 4 Sinjai students. The ability to understand the methods/meaning of questions that lead to scientific knowledge (LS1) of SMPN 6 Makassar students is not significantly different from the students of SMPN 2 Maros but it is significantly different from the students of SMPN 4 Sinjai. The ability to draw conclusions based on the learning experience (LS4) of SMPN 6 Makassar students was significantly different from students of SMPN 2 Maros and SMPN 4 Sinjai. The ability to organize, analyze, and interpret scientific data and information (LS3) for SMPN 2 Maros students was not significantly different from SMPN 4 Sinjai students, but both were significantly different from SMPN 6 Makassar students.

Discussion

The results showed that in the aspects of the students' knowledge of the chemistry of atoms, ions and molecules the highest indicator achievement (74.40%) was achieved by SMPN 6 Makassar for indicators of identification of atomic numbers, mass numbers, protons, neutrons and electrons. The mean score of students' knowledge on chemical materials is in the good category. When comparing understanding of students' knowledge concepts between schools, SMPN 6 Makassar and SMPN 2 Maros are in the good category, while SMPN 4 Sinjai is in the fair category. Based on this percentage data, the level of knowledge of the students has varied their abilities ranging from the ability to know to the ability to synthesize.

Based on the results of the data analysis for the aspect of knowledge, it can be seen that the average score obtained by the students is included in both categories of all tested chemical concepts. Scores obtained by the students on the concept of understanding the concepts of atoms, ions and molecules, and materials identification of atomic numbers, mass numbers, protons, neutrons, and electrons are in the good category. Scores obtained by the students in the material connecting the concepts of atoms, ions, and molecules with daily chemical products and comparing elemental molecules and compound molecules are in the sufficient category. This shows that the role of the teacher in the learning process in the classroom is needed to further involve students in cultivating their understanding and potential so that learning outcomes especially in the aspect of knowledge are even more increased (Bastin & Dicks, 2019; Rusiani, 2017).

This research was a survey research that uses data collection in addition to providing knowledge and competency tests, also given a questionnaire to students and teachers. The questionnaire is used to provide support for student learning outcomes and competencies. The questionnaire

includes the education of parents, the form and frequency of guidance, the teacher's last education, the model/method used by the teacher in the learning process, as well as the learning resources of students (Chohan & Khan, 2014). The results shows that students' scientific literacy in making conclusions based on experience learning outcomes are still low, as well as in literacy activities to analyze information and data on test questions it is very difficult to observe its function in the formation of chemical compounds, and it is difficult to make conclusions from the learning outcomes obtained. In the ability of chemistry, students are very difficult to understand the meaning of atoms, ions and molecules in forming compounds, difficult to understand the concepts of atoms, ions and molecules related to everyday life.

Achieving the ability in this aspect of knowledge can be associated with the involvement of the teachers and parents at school and at home to guide students. The results of the questionnaire analysis of the profiles of teachers and parents, and obtained the qualifications of teaching teachers of natural science subjects came from biology, physics and mathematics study programs consisting of 90% S1 degrees, S2 and S3 degrees as much as 10%. Teaching experience of teachers above 6 years and all of them have obtained educator certification, learning models used in general discovery, a small portion using PBL and inquiry models as a result of research (Widiastuti & Santosa, 2014). The background of the study program of teachers who teach science (there are chemistry lessons), as mentioned above where there are no teachers who have a background in science or chemistry study programs, so that learning for chemical materials has not been carried out optimally, it is evident that the attainment of learners is only 60 % only.

The factor of parents as the main guide and laying the foundation of attitude for students also contributes to an increase in student knowledge which is very important. Parents' education in general is S1 degree or 65%, S2 and S3 degrees are 10%, the rest are SD, SMP, SMA and Diploma 1 certificates are 25%. Parents have paid more attention to their children's education which is marked by guiding work or completing homework, advising and paying attention to their child's learning time. Parents' activities in guiding children's learning are included in the "always" category, which means that parents have given high support to their child's learning success. There is collaboration between the teacher as an advisor for aspects of knowledge, attitudes and mental skills of students in school, and parents can guide children in terms of discipline and social behavior to make students more diligent in learning and aware of the meaning of what is learned so that their learning achievement is increased (Umar, 2015).

The ability of the students in the aspect of knowledge from the results of this study is improved, especially in the ability to analyze, evaluate and synthesize, when learning in schools was carried out by teachers consistently using learning models that arouse students' curiosity such as discovery models especially when combined with approaches to everyday life the days of students (Sugiarti, 2015), as well as what is planned by the curriculum in force in Indonesia today, it is expected to enable the students to explore their mental potential and skills to be more diligent so that their chemistry learning outcomes would be better.

The results of the study for the indicators of the chemical science literacy competencies illustrate that the average achievement score of the four indicators of chemical science literacy competencies in four schools is in the "good" category. The indicator of chemical science literacy ability to conduct effective literature searches (LS2) is the highest competency. This means that students have been trained to carry out literature searches effectively as part of scientific literacy.

The students in learning are free to explore learning resources both print and online to collect data from the problems made, so they easily find the answers sought.

The indicators of the ability to understand the method/meaning of questions that lead to scientific knowledge (LS1) and the ability to draw conclusions based on learning experiences (LS4) are abilities that are already possessed by students. Based on the learning model that is commonly used by teachers, namely the discovery model, allowing the students to be able to understand the questions that are scientific through a stimulus phase that provokes curiosity, the verification phase clarifies findings that emphasize the certainty of answers from the previous questions on the stimulus (Eilks et al. , 2017) and the ability of the students to draw conclusions based on learning experiences. Conclusion drawing is the final phase of learning with discovery models, greatly helping the students to understand the conclusions of the lesson.

As for the indicators of the ability to organize, analyze, and interpret scientific data and information (LS3), it is still relatively low. Implicitly this third indicator instills a high affection attitude for the students (Gen, 2015). This ability indicator is indeed very difficult for junior high school students when compared to other science competency indicators. This is because it requires high-level thinking and the complexity of linking abstract concepts of atoms, ions and molecules requires concentration of the teacher thought and guidance during the learning process. Students need a thorough understanding between the concepts, reasoning was needed by involving expert advisors in the field of chemistry who continuously practice structured thinking as Vygotsky said (Ayuningsih, 2010). The teachers must not have low literacy abilities and competencies because it will be difficult to develop the realm of personal, social and social chemical literacy in students (Shah & Sharma, 2013). One of the initial efforts of the teachers that need to be endeavored is to promote the chemical literacy to the students and even the surrounding community (Shwartz et al., 2006), especially for junior high school students who have never studied before.

The results also showed that the literacy abilities of chemical science in the three schools showed differences. The students with the highest literacy ability of chemistry are at SMPN 6 Makassar and are significantly different from the literacy abilities of chemical science students at SMPN 2 Maros and SMPN 4 Sinjai. One of the factors causing the high literacy ability of chemical science in SMPN 6 Makassar is because of the location of schools in the big cities. A various learning supporting facilities and the teacher with high proviciency in the school is one of the factors that cause the high literacy ability of students in chemical science compared to other schools. Furthermore, the second highest literacy ability of chemical science is students at SMPN 2 Maros. This is because the distance of Maros Regency is closer to Makassar City as one of the major cities in Eastern Indonesia. This allows for a rapid flow of information and communication for both the teacher and the students. The students at SMPN 4 Sinjaihe have the lowest literacy ability of chemical science. One of the factors causing the low literacy ability of chemical science is due to the location of Sinjai Regency, which is far from the center of Makassar. Long distance is also a factor that causes the lack of willingness of teachers to attend professional training which further impacts on the lack of innovative chemistry learning that can increase the chemistry literacy of students.

The school differences also show differences in the indicators of students' literacy of chemical science. Where SMPN 6 Makassar students have the highest scores on all indicators of chemical science literacy compared to the two other schools having lower scores for these indicators. The high scores for indicator effective literature search (LS2) are supported by adequate facilitation to

search for literature in schools in big cities. As for the indicator of understanding the method/meaning of questions that lead to scientific knowledge (LS1), the students of SMPN 6 Makassar also achieved the highest score compared to the two other schools. The students in the schools that are located in big cities like Makassar tend to understand questions more quickly than schools in the middle and small cities due to language factors that are used more often than regional languages. For the indicator of drawing conclusions based on learning experiences (LS4), the students in SMPN 6 have the highest scores because teachers are accustomed to using learning models that are able to practice scientific methods in students where one of the final stages is drawing conclusions. For the indicators of organizing, analyzing, and interpreting data and scientific information (LS3), the students of SMPN 6 Makassar achieved the highest score compared to the two other schools, even though the scores obtained were still in the low category. This indicates that the students in all sample schools tend to be rarely trained at a higher level of ability.

The results of this study are in line with the results of Shah & Sharma's (2013) research where the students have a very low level of chemical science literacy in terms of four things, first, the students are not able to understand chemistry in their lives, second, they can not respond to the benefits of chemistry in the community, third, They do not understand the concept of chemistry in food, and forth, they have not been able to voice global issues. The same result also found by Adnan et al. (2021) research. That research showed that the biological science literacy of students was still low.

Based on the above, the recommendation that can be given by researchers is the teacher must try to practice the students' scientific literacy skills. One effort that can be taken is the use of the appropriate learning models. The learning models that are considered suitable are not only transferring the knowledge, but building the concepts/knowledge by the students. The knowledge is obtained through the process of titrating through reading, counting, interpreting nature and the physical environment as well as the community environment which is carried out gradually starting from discussing the terms, definitions and explanations of the nature of the material being studied (Kurniawati, 2013). Followed by understanding the meaning, application, procedure and development of science that explains the nature, role of science (science) in his life and society.

Through mastering knowledge in education will build skills in a person (Merril, 1994). Through knowledge there are a number of skills that can be developed including procedural, conceptual and implications. Procedural knowledge is useful for completing certain tasks and participating in certain activities, this includes specific skills strategies. Knowledge is conceptual when knowledge is based on concepts that drive factual information from the world around us, and focuses on regrouping large understandings and corresponding relationships between them. Conceptual knowledge highlights the relationship between the concepts themselves (Bloom, 1956). This type of knowledge can only be obtained through purposeful and reflective learning. Next is the implication, the tendency is to express standards in terms of only factual knowledge, rather than procedural and conceptual knowledge. Estuary practice of learning parts can be implemented through practical learning for example in the laboratory (Nuic, 1968).

Literacy chemistry competencies of students can be implemented through learning that uses learning models (Hadinugrahaningsih, Rahmawati, & Ridwan, 2017) to help students interpret concepts, identify problems and draw conclusions. At present competence is very important in all fields and sectors. The purpose of this competency is to guarantee the quality of someone in their

field, for example the competency of students' skills, meaning students are expected to be able to develop skills both acquired through learning and from industry. Competence is not limited to physical and intellectual abilities. But more than that, competence is related to human knowledge and behavior, and it can be said that behavior is the peak of the competency itself (Yulianti, 2017).

Literacy competency achievement can be measured through three things according to PISA, namely through the learning process, science content, and the context of science applications. The measurement through the learning process can be conducted by observing the activities of students in learning activities as outlined in the student activity sheet (LKPD). The content measurement is taken from learning outcomes after learning, and the measurement of the application context is conducted through the behavior of students during the school environment that intersects with all the material around them both human, and the natural environment around the school (Sugiarti, 2015).

Conclusions

Based on the results of the research on the analysis of the ability of the chemical literacy of the junior high school students in Sulawesi as a whole from the aspect of knowledge and competency aspects of 67.5% the category of "good". In this aspect of knowledge, there are two indicators which are categorized as good and two indicators that are categorized as fair. The indicators that fall into either successive category are: explaining the concepts of atoms, ions and molecules and identifying atomic numbers, mass numbers, protons, neutrons, and electrons. For indicators that fall into the sufficient category are: connecting the concepts of atoms, ions and molecules with everyday chemical products, and comparing molecular elements and molecular compounds. While in the aspect of science competence, which consists of four indicators. There are three indicators that are categorized as good, first, understanding the methods/meaning of questions that lead to scientific knowledge, second, carrying out effective literature searches, and third drawing conclusions based on learning experiences. There is only one indicator included in the good category, namely organizing, analyzing, and interpreting scientific data and information. Overall, the indicators shown in the aspects of knowledge and competence aspects of scientific literacy, implicitly meet the three expected domains of ability namely cognitive, affective and psychomotor domains as the objectives of the curriculum.

Acknowledgements

This project was supported and funded by Research and Community Service Institute, Universitas Negeri Makassar. We would like to thank to everyone who has contributed in the completion of this paper.

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