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The Effect of Mastery of Science Concepts and Critical Thinking Ability on the Science Literacy Ability of Science Teachers

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Abstract

Based on PISA data, the literacy ability of Indonesian students is still low, in 2015 Indonesia was ranked 62 out of 69 countries. The ability of scientific literacy is the capacity to use scientific knowledge, identify questions to draw conclusions in making decisions in everyday life in human interaction with nature. The low scientific literacy ability of these students provides a reflection of the quality of learning in the classroom is still low, so in an effort to improve the ability of scientific literacy students need to test the teacher's scientific literacy ability and the factors that influence it, such as mastery of science concepts and critical thinking skills. The study aims to determine the effect of the mastery of science concepts and critical thinking skills on the science literacy skills of science teachers. Research subjects numbered 90 natural science teachers in West Jakarta region 2. The study was conducted in May 2018 using the Ex Post Facto method with a 2 x 2 factorial design. The research data were normally distributed and homogeneous. So by using the 2-way ANAVA statistical test the results are obtained: (1) the mastery of the science concept influences the teacher's scientific literacy, (2) the ability to think critically influences the teacher's scientific literacy (3) the mastery of the concept of science and the ability to think critically together influence on teacher science literacy. The results of this study are expected to be the basis for the development of the quality of science teachers in order to increase student scientific literacy and refer to other research.

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Keyword : Critical Thinking, Science Concepts, Science Literacy

INTRUDUCTION

The results of the achievement of Indonesian students' scientific literacy abilities in the Program for International Student Assessment (PISA) in 2015 showed that the scientific literacy abilities of Indonesian students in the low category, ranked 62 out of 69 member countries of the Organization for Economic Co-operation and Development (OECD, 2016). Almost the same results are also shown by the data of PISA test results in 2012 Indonesia ranks 64 out of 65 countries (OECD, 2014), and the 2009 PISA data Indonesia is ranked 60 out of 65 countries (OECD, 2010).

Understanding scientific literacy or scientific literacy according to PISA is the ability to manage

science to understand problems so that they can make conclusions based on data used to analyze and help make decisions about daily life in human interactions with nature (OECD, 2009a).

The ability of students' scientific literacy is still low provides a reflection that the quality of learning in the classroom is still low. The low quality of learning is influenced by many factors such as teacher quality, learning media, learning resources, and the process of learning. The teacher is the main determinant of the quality of learning in the classroom, because all learning resources, media, models, and learning strategies used can be successful because of the quality of the teacher (Bagiarta et al, 2015). Qualified teachers must have pedagogical competencies, professional competencies, personality competencies and social competencies. The professional abilities of a science teacher are closely related to the mastery of the concept of science (Lederman et al, 2013). Teachers who have good mastery of the concept of science will have a good level of scientific literacy ability, because mastery of the concept of science is the most important part of scientific literacy (Hardianty, 2015). Science Literacy is the ability to use science to draw conclusions from natural phenomena, so mastery of the concept of science is very important in scientific literacy. The basis of scientific literacy is to understand the concept of science (Odja et al. 2014).

Science studies cover physics, biology, chemistry and earth science with complex problems and are related to many disciplines (multidisciplinary). The ability to think critically must be possessed by a teacher in studying a problem that will be discussed together in class (Bailin, 2002). Science literacy is influenced by the ability to think critically, because scientific literacy is related in decision making to provide a solution to a problem. Problem solving requires critical thinking skills (Anderson, 2015).

Students will have a learning experience that contains elements of scientific literacy if the teacher has a good mastery of science concepts and critical thinking skills. This study aims to obtain information about the influence of the mastery of science concepts and critical thinking skills on the science literacy skills of science teachers.

METHODS

The method used in this study is exspost facto, which looks at the effect of variables on other variables that have been owned by previous respondents with a 2 x 2 factorial design. This study consists of three variables, namely mastery of the concept of Natural Sciences (X1) and critical thinking skills (X2) as the independent variable and the ability of scientific literacy as the dependent variable (Y). The affordable population in this study was 116 natural sciences in West Jakarta region 2. The sample size was determined by the Slovin formula so that the random sampling technique obtained 90 natural science teachers as samples.

The first stage of this research is the validation of the mastery of the concept of science concepts by expert lecturers and empirical validation by the instrument testing. The trial of the mastery of the science concept concept was carried out on 25 science teachers in South Jakarta region region 1 so that 27 items were valid and reliable. Instrument of scientific literacy ability using instruments from PISA as many as 35 items and for critical thinking skills using instruments from Dhelpi team and have been adapted by Kawiati (2014) and Pujawan (2014) as many as 30 items.

RESULT

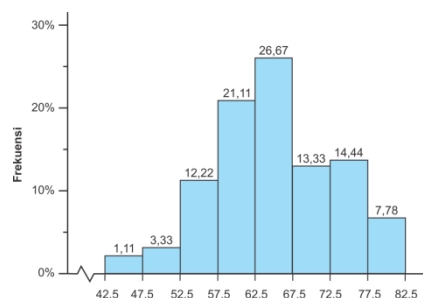


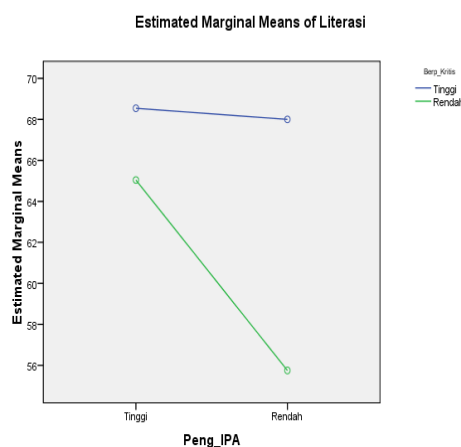
Figure 1. Value of Science Literacy Ability of Science Teachers

Table 1. Description of Science Literacy Data Based on Mastery of Science Concepts and Critical Thinking Ability

Mastery of the Concept of Science	Critical Thinking Ability	Group	N	Average	Stand Deviation	Lowest	Highest
High	High	A1B1	24	69.00	7.53	52	82
High	Low	A1B2	47	65.00	8.66	45	81
Low	High	A2B1	7	68.00	6.11	59	75
Low	Low	A2B2	12	56.00	4.55	53	69
Total			90	65,00	8,61	45	82

Table 2. Test Results of Two Way Anova Hypothesis Effect of Mastery of the Concept of Natural Sciences and Critical Thinking Ability Towards Literature Sanis of Science Teachers.

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	1390.777a	3	463.592	7.649	.000
Intercept	229032.07733	1	229032.077	3.779	.000
Mastery of the concept of science	4.448	1	334.448	5.519	.021
Critical Thinking	857.854	1	857.854	14.155	.000
Science*Critical	264.853	1	264.853	4.370	.040
Error	5212.123	86	60.606		
Total	386463.000	90			
Corrected total	6602.900	89			

**Figure 2. Graphic Effect of Interaction between the mastery of the concept of science and the ability to think critically on the ability of teacher literacy**

**Table 3. Results of Calculation of Mastery Interaction of Science Concepts and Capabilities
Critical Thinking About Science Literacy Ability of Science Teachers**

Critical Thinking About Science Literacy Ability of Science Teachers									
(I) Group Data				(J) Group Data			Sig.	95% Confidence Interval	
								Lower Bound	Upper Bound
High Thinking (A1B1)	Science, High Critical	High Critical	High Science Critical Thinking Low (A1B2)				.284	-1.62	8.62
High Thinking (A1B1)	Science, High Critical	High Critical	Low Critical Thinking High Critical (A2B1)				.998	-8.22	9.30
High Thinking (A1B1)	Science, High Critical	High Critical	Low Natural Science Critical Low Thinking (A2B2)				.000	5.58	20.00
High Low (A1B2)	Science Critical Thinking	Critical Thinking	Low Critical Thinking High Critical (A2B1)				.785	-11.22	5.31
High Low (A1B2)	Science Critical Thinking	Critical Thinking	Low Natural Science Critical Low Thinking (A2B2)				.002	2.70	15.89
Low thinking (A2B1)	science High critical	High critical	Low Natural Science Critical Low Thinking (A2B2)				.007	-21.95	-2.55

DISCUSSION

Based on the data in Figure 1 the average value of a teacher's literacy ability is 65, this shows that the achievement is categorized as low. The low ability of science teacher's scientific circumference is caused by teachers accustomed to mastering concepts theoretically, lacking in connection with solving problems in daily life. While the ability of scientific literacy is the competence to apply scientific knowledge to understand questions in order to make decisions for everyday life. The achievement of the teacher's scientific literacy is in accordance with the results of the experiment conducted by Handayani (2018), which is the average value of scientific literacy in Biology Education students of FPMIPA UNJ, which is categorized as very poor at 45.58 and also by Diana et al. (2015) that the acquisition of scientific literacy of students of biology education at the Indonesian Education University was classified as very poor. The achievement of the average science teacher's literacy is also almost the same as the research conducted by Rubini et al. (2017) in Bogor City and district which shows the average science literacy ability of science teachers has only reached 63 for all aspects of scientific literacy.

Data on the average score of mastery of the science concept is 60. Based on this data, the mastery of the science concept of junior high school teachers is relatively low, even though the material being tested is essential for junior high school students. The low average value of the mastery of the concept of science teachers is caused by the background of the natural science teacher educator, teachers with biological education backgrounds lack mastering of physics material and vice versa teachers with physics education background lack mastering of biological material. The achievement of the mastery value of the science concept is almost the same as the results of the 2015 Science Teacher Competency Test in Yogyakarta Province, which is 62.16 (Kemendikbud, 2016a). The average result of mastering the concept of Natural Sciences is also almost the same as the average results of the achievement of UKG in 2015 which is 56.69 (Kemendikbud, 2016b)

Data on the achievement of critical thinking skills of science teachers on average is 45, this achievement is categorized as very poor, even though critical thinking skills are needed by a science teacher in studying science studies that are multidisciplinary in science. The average abilities of critical thinking of science teachers that are categorized as very poor indicate that the teacher has not been able to interpret, analyze, evaluate, or identify. in line with the results of Jirana's (2016) study of prospective teacher students, namely the critical thinking skills of biology students at the University of West Sulawesi on evolutionary material is still low.

The results of hypothesis testing with ANAVA show that there is an influence of the mastery of the concept of science on the science literacy ability of junior high school science teachers. Data from this study indicate that the ability of scientific literacy is influenced by the mastery of the concept of science. Based on the description above, it appears that one aspect of scientific literacy is the aspect of mastery of science concepts or knowledge. Then this also confirmed Mathelitsch (2013) that teacher competencies in science include teacher competencies in teaching Natural Sciences, competencies in working together, and reading and writing abilities. Furthermore Ardianto and Rubini (2016) in their research integrated science learning with the Shared type can maximize the ability of scientific literacy in both aspects of content, processes and science attitudes of students. Then explained also by Odja et al. (2014), the basis of scientific literacy is to understand the concept of science.

Based on the results of the second hypothesis test in Table 2, there is an influence of the ability to think critically on the science literacy skills of junior high school science teachers. Research data shows that indicators of critical thinking skills mastered by the teacher will support the achievement of the teacher's scientific literacy abilities. Indicators of critical thinking ability according to the Delphi Team consist of interpretation, analysis, evaluation, inference, explanation, and self-regulation capabilities. Arief (2012) states that critical thinking is to use cognitive skills or strategies to choose goals and the ability to solve problems. In the study of science such as biology, the ability to think critically is very important because to study nature requires critical thinking skills. With the ability to think critically students can study natural events well and can discuss broadly and deeply about a problem or phenomenon related to nature (Bailin, 2002). From the results of research conducted by Facione in Fahmawati (2018) states that critical thinking is a process of thinking broadly and deeply to obtain knowledge. Students who have good critical thinking skills can identify and solve problems broadly and deeply and can understand problems from various points of view.

The description of critical thinking above is in accordance with Rahayuni (2016) research results revealed that there is a strong correlation between critical thinking and scientific literacy. Also strengthened by the results of Susiati's research (2018) the ability to think at a higher level contributes to the scientific literacy skills of biology teachers by 6.4%, critical thinking skills are part of higher order thinking skills. A similar research result by Emilia (2018) states that higher-order thinking skills contribute 17.8% to the ability of scientific literacy.

Based on the third hypothesis test in table 2 there is an influence of interaction between the mastery of the concept of science and the ability of critical thinking to the ability of teacher's scientific literacy. Teacher mastery of the concept of science and critical thinking skills are two things that support each other in solving problems in everyday life. This is consistent with what was stated by Shamos (1995) that to master science requires the ability to use language fluently, read and criticize science itself. Then the results of Miller's (1998) research show that the ability to read and write about science and technology is a parameter of scientific literacy.

CONCLUSION

Based on the results of research that has been done, it can be concluded that there is an influence of the mastery of science concepts on the science literacy ability of science teachers, there is an influence of critical thinking ability on science literacy skills of science teachers, there is an interaction effect between the mastery of science concepts with the ability to think critically on the science literacy abilities of teachers Natural science.

REFERENCES

- Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., et al. (2001). *A Taxonomy for Learning, Teaching, and Assissing: A Revision of Bloom's Taxonomy of Educational Objectives*. NewYork: Longman..
- Ardianto, D dan Rubini, B. (2016). Komparasi Literasi Sains Siswa Pada Pembelajaran IPA Terpadu dengan Model Guided Discovery dan Problem Based Learning. *Jurnal Pendidikan IPA Indonesia* Volume.5(1): 31-37
- Arief, A. 2012. *Memahami Berpikir Kritis*. Diakses dari <http://researchenginer.com/1007arief3.html>.
- Bailin, S. 2002. Critical Thinking and Science Education. *Science and education* Volume.11.pp 361 -375

- Bagiarta, I.N, I.W Karyasa, dan I.N.Suardana. Komparas Literasi Sains antara Siswa yang dibelajarkan dengan Model Pembelajaran Kooperatif tipe GI dan Model Pembelajaran *Guided Inuiry* ditinjau dari Motivasi. *Jurnal Pasca Sarjana Undiksha*. 5 (1): 1-11.
- Diana, S, A.Rachmatulloh, dan E.S Rachmawati. 2015. Profil Kemampuan Literasi Sains Siswa SMA Berdasarkan Instrumen *Scientific Literacy Assesments* (SLA). *Seminar Nasional XII Pendidikan Biologi FKIP UNS*. 1: 285-291.
- Emilia. P. 2018. Hubungan kemampuan Membaca Pemahaman, Berpikir Tingkat Tinggi Terhadap Literasi Sains Siswa. *Tesis*. Program Magister Pendidikan Biologi Universitas Negeri Jakarta.
- Fahmawati, F.2018.Pengaruh pembelajaran Survei, Question, Read, Recite Review (SQ3R) dan kemampuan berpikir Kritis terhadap Hasil Belajar peserta Didik SMA. *Tesis*. Program Magister Pendidikan Biologi Universitas Negeri Jakarta.
- Handayani, G. 2018 Hubungan Ketampilan Proses Sains Terintegrasi dan Kemampuan Membaca Pemahaman Terhadap Literasi Sains Mahasiswa Calon Guru Biologi. *Biosfer* (11): 21-31
- Hardianty, N. 2015. Nature of Science: Bagian Penting dari Literasi Sains. *SNIPS*. 1 (1): 441-444.
- Jirana, Muhammad.A, Endang.S, dan Betty. L. Analisis Keterampilan Berpikir Kritis Mahasiswa Pada Mata kuliah Evolusi di Universitas Sulawesi Barat. *Seminar Nasional saintek ISSN (2557-533X)*: 953-958
- Kawiwati, N.M. 2014. Pengaruh Model Pembelajaran dan Keterampilan Berpikir Kritis Terhadap Hasil Belajar Matematika Dengan Mengontrol Bakat Numerik. *Disertasi*. Pasca Sarjana UNJ
- Kementerian Pendidikan dan Kebudayaan. 2016. Analisis Gambaran Kompetensi Guru Terhadap Prestasi Belajar Siswa SMP Pada Ujian Nasional Tahun 2015 Provinsi Daerah Istimewa Yogyakarta. Pusat Data Statistik Kemendikbud.
- Kementerian Pendidikan dan Kebudayaan. 2016. Petunjuk Teknis Program Peningkatan Kompetensi Guru Pembelajar. Dirjen Guru dan tenaga kependidikan
- Lederman, N.G., J.S. Lederman, and A. Antink. 2013. Nature of Science and Scientific Inquiry as Contexts for the Learning of Science and Achievement of Scientific Literacy. *International Journal of Education in Mathematics, Science and Technology*, (1), 3: 138-147.
- Mathelitsch, Leopold. 2013. Competencies in Science Teaching. *CEPS Journal*. 3(3): 49-64.
- Miller, J.D. 1998.The Measurement Of Civic Scientific Literacy. *Public Understanding Of Science*. (7). 203-223
- Odja, A. Haris, dan C.S. Payu. 2014. Analisis Kemampuan Awal Literasi Sains Siswa Pada Konsep IPA. *Prosiding Seminar Nasional Kimia Universitas Negeri Surabaya* 1: 40-47.
- OECD. 2009a. *PISA 2006 Technical Report*. Paris: OECD Publishing.
- OECD. 2009b. *PISA 2009 Assessment Framework: Key Competencies in Reading, Mathematics, and Science*. Paris: OECD Publishing.
- OECD. 2009c. *Take The Test: Sample Questions from OECD's PISA Assessment*. Paris: OECD Publishing.
- OECD. 2010. *PISA 2009 Results: Executive Summary*. Paris: OECD Publishing.
- OECD. 2014. *PISA 2012 Results: What Student is Know And Can Do*. Paris: OECD Publishing.
- OECD. 2016. *PISA 2015 Results in Focus*. Paris: OECD Publishing.
- Pujawan, I.G.N . 2014. Pengaruh Pendekatan Pembelajaran Dan Assesmen Formatif Terhadap Hasil Belajar Statistik Dengan Mengontrol Kemampuan Berpikir Kritis. *Disertasi*. Pasca sarjana UNJ
- Rahayuni, G. 2016. Hubungan Keterampilan Berpikir Kritis dan Literasi Sains Pada Pembelajaran IPA terpadu Dengan Model PBM dan STM. *JPPI.2* : 131-146
- Rubini, B, I.D. Puspitasari, dan D. Ardianto. 2017. *Model Pembinaan Guru IPA Berbasis Literasi Sains*. Program Pasca sarjana Universitas Pakuan.
- Shamos, M.H. 1995. *The myth of Scientific literacy* New Brunswick, NJ: Rutgers University Press
- Susiati. A, 2018. Hubungan kemampuan Membaca Pemahaman dan Kemampuan Berpikir Tingkat Tinggi dengan Kemampuan Literasi Sains Guru Biologi. *Biosfer* 11 (1-12).