

## Ability Improvement and Critical Literacy With Science Textbook Literacy of Buffer Solution

Syafrina Yani Lubis<sup>1✉</sup>, Ani Rusilowati<sup>2</sup>, Jumaeri<sup>3</sup>

<sup>1,2,3</sup> Science Education Program, Postgraduate, Universitas Negeri Semarang, Indonesia

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### Abstract

The goals of this study is to test the increasing of ability, critical literacy and to describe the ability profile and critical literacy profile of the students using science text book based on scientific literacy buffer solution. The type of this research is a mixed method with Concurrent Triangulation model. Science text book based on scientific literacy used in this study met the valid criteria with score 3,75. Increased ability with N-gain achievement of 0.79 with high achievement criteria. Based on the one-party t test with  $\alpha = 5\%$  and descriptive analysis, it was found that the improvement of ability and critical literacy using science text book based on scientific literacy is better than using BSE teaching materials. Aspects of science as a body of knowledge has increased 83%, science as way of investigation has increased 74%, science as way of thinking has increased 82%, and interaction of science, technology, society and environment has increased 81%. Increased critical literacy with N-gain achievement of 0,76 by the criteria of achievement level high. Aspects of reading comprehension have improved 85%, and aspects of using information from reading material have increased 70%. It can be concluded that there is an increase of ability and critical literacy of the students using science text book based on scientific literacy of buffer solution.

### Abstrak

Tujuan dari penelitian ini adalah menguji peningkatan *ability* dan *critical literacy* serta mendeskripsikan profil *ability*, dan *critical literacy* siswa menggunakan bahan ajar berbasis literasi sains materi larutan penyangga. Penelitian ini merupakan penelitian *mixed method* dengan model *Concurrent Triangulation*. Bahan Ajar berbasis literasi sains yang digunakan pada penelitian ini memenuhi kriteria sangat valid dengan perolehan skor 3,75. Peningkatan *ability* dengan capaian N-gain sebesar 0,79 dengan kriteria tingkat pencapaian tinggi. Berdasarkan uji t satu pihak dengan  $\alpha = 5\%$  dan analisis deskriptif, diperoleh bahwa peningkatan *ability* dan *critical literacy* menggunakan bahan ajar berbasis literasi sains lebih baik di bandingkan menggunakan bahan ajar BSE. Aspek sains sebagai batang tubuh pengetahuan mengalami peningkatan 83%, sains sebagai penyelidikan hakikat sains mengalami peningkatan 74%, sains sebagai cara berpikir mengalami peningkatan 82%, dan hubungan sains, teknologi, masyarakat dan lingkungan mengalami peningkatan 81%. Peningkatan *critical literacy* dengan capaian N-gain sebesar 0,76 dengan kriteria tingkat pencapaian tinggi. Aspek memahami bacaan mengalami peningkatan 85%, dan aspek menggunakan informasi dari bahan bacaan mengalami peningkatan 70%. Hasil penelitian menyimpulkan bahwa terjadi peningkatan *ability* dan *critical literacy* siswa yang menggunakan bahan ajar berbasis literasi sains materi larutan penyangga.

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✉ Correspondent Address:

Kampus PPS UNNES Jl. Kelud Utara III Semarang 50237

E-mail: [syafrina.yani@yahoo.com](mailto:syafrina.yani@yahoo.com)

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## INTRODUCTION

Countries in the world are increasingly aggressive in racing to win the era of global competition marked by advances in science and technology. The ability of students' understanding of science between countries is measured using the PISA test. Information obtained from the PISA test found that PISA scores achieved by Indonesian students are still below the average score and the ranking achieved still occupies the lowest position. The weakness of Indonesian students in PISA science competence analyzed by Puspendik Science Literacy Team in 2004 revealed that (1) the composition of students' answers indicates the students' lack of understanding about the basic concepts of science that have actually been taught; (2) low ability of students in reading and interpreting data in the form of drawings, tables, diagrams and other presentation forms; (3) students' reading accuracy is still low; (4) scientific reasoning ability is still low; And (5) the lack of student mastery of basic concepts of science and its interrelationships with everyday life and technology.

Weaknesses at points (3) and (4) when associated with reading Literacy on PIRLS Indonesian students still occupy the bottom five positions. Based on PISA test results and PIRLS tests indicate that the literacy ability of science and literacy of Indonesian students is still low. The low literacy rate of Indonesian students' sciences is caused by lessons that are applied at the level of non-contextual educational units, too theoretical, students are not introduced to actual environmental conditions and do not give students the opportunity to respond to solve a problem. As a result, students consider chemistry to be very abstract and not applicative in life so that students become not literate towards chemistry. Science for All American as quoted by Rusilowati (2013) defines that science literacy is the ability, understanding concept and principle of science and has the ability to think scientifically to solve daily problems related to science.

Seeing the ability of science literacy students then done giving science literacy. Overcoming those weaknesses requires a critical

literacy learning strategy using reading texts that can bring the reader to interact with the text so that the reader argues, to feel each side of the reading so that the reader first conducts an investigation and does not believe in the issue before the truth evaluation. This is in line with Comber (2001) who says that Critical literacy can bring readers to interact with text, take action on information, and develop ideas from information derived from reading material that can make the reader argue that it is capable of improving students' understanding and can be used against Various disciplines of science so as to solve a problem.

The material of buffer solution is a material that is difficult to be understood by the students, there are many applications in everyday life. However, there is not much material delivery is associated with problems in everyday life. Teachers more often explain the material, then proceed with doing the questions. Learning activities and learning outcomes obtained by the students are still far from ideal learning conditions. Presentation of the material has not been based on science literacy, in doing the questions, students have not been able to relate between the concept of material obtained with environmental problems. Students also have not been able to answer questions about the cause of an event, as well as difficulty in giving opinions, accuracy in reading matter is still low and less able in analyzing data in the form of graphs and tables.

One of the efforts to stimulate learning activities so as to improve learning outcomes is through the use of science textbook literacy (Rusilowati et al, 2016a). Learning materials and learning activities need to be changed. Based on the description of the above problems, it is necessary to improve the learning, one of the teaching materials that can improve the ability (ability) and critical literacy. From these descriptions, the researcher was interested to conduct a research entitled "Improvement of Ability and Critical Literacy with science textbook based on scientific literacy of Buffer Solution".

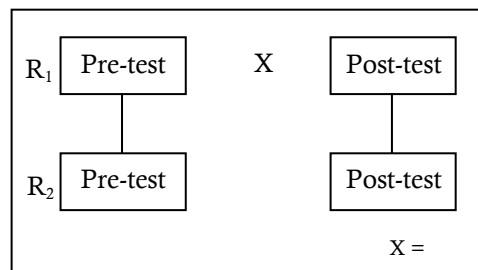
Based on the background that has been described above, then the formulation of the problem in this study are (1) whether there is an

improvement in the ability of students using science textbook based on scientific literacy of the material buffer?; (2) is there any improvement of student's critical literacy using science textbook based on scientific literacy of buffer solution?; (3) how is the ability profile of students using science textbook based on scientific literacy of buffer solution ?; (4) how is the critical literacy profile of the students using science textbook based on scientific literacy of buffer solution?

The goal of this research is to test the improvement of ability and critical literacy of the students using science textbook based on scientific literacy of buffer solution, describing the ability profile and the critical literacy of the students using science textbook based on scientific literacy of buffer solution.

**METHOD**

Population in this research was the students of class XI IPA MAN 2 Padangsidempuan in 2016/2017 academic year. There are 145 students spread in 6 class in this school. The Sample in this research was taken by random sampling.it was obtained that class XI IPA3 as control class was given treatment in the form of learning using BSE materials, and class XI IPA4 as experimental class was given learning using science-based literacy science textbook literacy teri science textbook based on scientific literacy. The variables in this study are: (1) independent variables, learning chemistry by science textbook based on scientific literacy and BSE materials. (2) dependent variables, including the increased ability and cryptical literacy of students on the material of the buffer solution. Methods of data collection used in this study were (1) test methods, (2) data analysis methods, and (3) interviews with teachers and students. The research design used in this research is Pre-test - Post-Test Control Group Design, as presented in Figure 1.



**Figure 1.** Research Design

The items used for the pre-test and post-test in this study are items that are valid criteria. Based on the data analysis of questionnaire and questionnaire, 16 items of ability and 12 critical literacy questions were valid criteria. The validity of the science textbook based on scientific literacy obtained an average score of 3.75 with the valid criteria referred to in the interval of determination of the validity of science textbook based on scientific literacy as follows:

- Va < 1 = invalid
- 1 ≤ Va < 2 = less
- 2 ≤ Va < 3 = is quite valid
- 3 ≤ Va < 4 = valid

Ability and critical literacy using science textbook literacy increases if the N-gain level gets the criteria in Table 1.

**Table. 1** N-gain Achievement Criteria

Interval	Criteria
N-gain ≥ 0,70	Height
0,30 ≤ N-gain < 0,70	Medium
N-gain < 0,30	Low

**RESULTS AND DISCUSSION**

The result of normality test and homogeneity of preliminary data (data value of final assessment of odd semester of 2016/2017 Chemistry subject) is presented in Table 2 and Table 3.

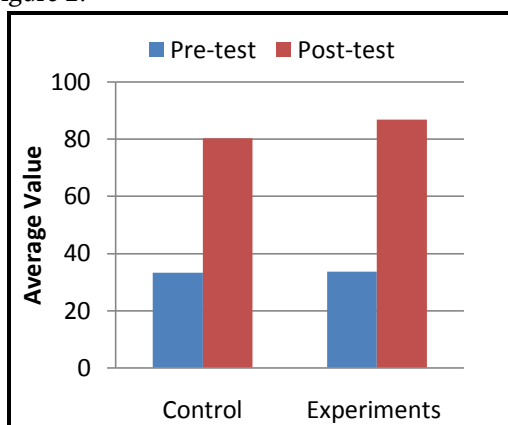
**Table 2.** The Data of Normality Test Results

Group	K-S Z score	Criteria
Control	0,162	Normal
Experiments	0,109	Normal

**Table 3.** The Data of Homogeneity Test Results

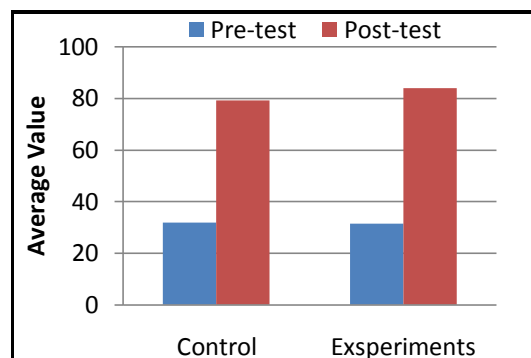
$F_{count}$	$F_{table}$	Criteria
0,99	4,04	Homogeneous

Based on the value of pre-test and post-test ability, it is found that the average value of control class from 31.21 to 80.42, while the experimental class has an average value increased from 33.71 to 86.96. Improved ability tested by using N-gain of control class obtained mean score of 0.70, while experimental class gain mean score 0,79. The result of improvement of pre-test and post-test ability of control class and experiment class is presented in Figure 2.



**Figure 2.** The Improvement of Pre-test and Post-Test Problem Ability

Result of t-test on matter ability obtained  $t_{value} \geq t_{tab} = 3,92 \geq 2.01$ . This means that the ability improvement of students who use science textbook based on scientific literacy is better than students who use the BSE book resources. Based on pretest and post-test critical literacy value, it is found that the average value of control class from 31.79 to 79.25, while the experimental class has an increasing of mean value from 31,42 to 84,08. The improvement of critical literacy tested using N-gain control class obtained N-gain average 0.68, while the experimental class obtained an average gain of 0.76. The result of the improvement of the critical literacy of the control class and experimental class is presented in Figure 3



**Figure 3.** The Improvement of Pre-test Value and Post-Test Problem Critical literacy

Mann Whitney's test of critical literacy using SPSS 20.0 shows the result that the significance of  $0.019 < 0.05$  so it can be concluded that the improvement of critical literacy of students using science textbook based on scientific literacy is better than BSE books. The profile of student's ability improvement uses four aspects of science literacy competency based on Chiapetta et al. (1991) developed by Rusilowati et al. (2016a) consisting of (1) as a body of knowledge in the control class received a 41% increase, while in the experimental class obtained a 59% increase, (2) science as the science class of control class obtained the same as the experimental class that is 53% 3) science as a way of thinking in the control group increased 48%, the experimental class increased 40%, and (4) the interaction of science, technology, society, and environment control class has increased 56%, while the experimental class 65%. Profile of dominant improvement in aspects of science, technology, society, and environment interaction. Increased critical literacy of the contrast class on aspects of reading comprehension reaches 30% during pre-test and 82% at post-test. Increased critical literacy of students that occurred between pretest and posttest by 52%. Aspects using reading material information pre-test results 33%, while the post-test results reached 77%, seen students achieved a 44% increase.

Based on the N-gain and t-test description on the results of the study showed that the increased ability and critical literacy of students using science textbook based on scientific literacy better than appeals using BSE books. The analysis results of increasing the ability of

each aspect of science literacy are presented in Table 4. Increasing the critical literacy of eachn spect is presented in Table 5.

**Table 4.** Increased ability of every aspect of science literacy

Aspects of Literacy Science	ClassControl			Class Exsperiments		
	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
Aspects of science as a body of knowledge	41	82	0,66	30	89	0,83
science as way of investigation	17	70	0,63	31	84	0,74
science as way of thinking	33	81	0,69	51	91	0,82
interaction of science,, technology, society and environment	24	80	0,74	19	85	0,81

**Table 5** Increased critical literacy of each aspect

Aspects	ClassControl			Class Exsperiments		
	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
Understand the content of the reading	30	82	0,73	31	90	0,85
Using reading material information	33	77	0,65	32	80	0,70

Table 4 shows that the experimental class's ability got a higher increase in every aspect of science literacy than the control class. Table 5 shows the improvement of the critical literacy of the classroom aspects of reading the

content and using higher reading information than the control class.

The acquisition of N-gain ability and critical literacy obtained when associated with the success rate of student acquisition obtained data as in Table 6 and Table 7.

**Table 6** Level of Success of Student Power on Aspect of Literacy of Science

Aspects of Literacy Science	ClassControl			Class Exsperiments		
	Value	Power (%)	Criteria	Value	Power (%)	Criteria
Aspects of science as a body of knowledge	66	66	Enough	83	83	Good
science as way of investigation	63	63	Enough	74	74	Enough
science as way of thinking	69	69	Enough	82	82	Good
interaction of science,, technology, society and environment	74	74	Enough	81	81	Good

**Table 7** Success Level of Student Power on Critical Literacy Aspects

Aspect	ClassControl			Class Exsperiments		
	Value	Power (%)	Criteria	Nilai	Power (%)	Criteria
Understand the content of the reading	73	73	Enough	85	85	Good
Using reading material information	65	65	Enough	70	70	Enough

The profile of the dominant ability increase in the science aspect as the body of knowledge, while the critical literacy improvement profile is dominant in the comprehension aspect of reading content. The results are in line with Duschle*et al.* (2007) who find the ultimate goal of science learning is to produce individuals who are able to understand and evaluate information in making a decision so as to produce individuals with professional skills based on science.

The learning strategy used in the research on both samples was to use the Chiappetta science literacy syntax (1991) developed by Rusilowati *et al.* (2016a) consisting of contact phase, curiosity phase, elaboration phase, decision making phase, nexus phase (nexus phase), assessment stage (phase assessment). The syntax of science literacy is in accordance with the 5M stage in the 2013 curriculum that is observing, questioning, and gathering information, reasoning and communicate.

The result data showed that the increased ability and the critical literacy of the experimental class students had higher increase compared to the control class, meaning that students' ability and critical literacy of the students used better science textbook based on scientific literacy compared to those using BSE. The increase can be seen from the analysis of the N-gain test, t-test, the value of post-test and the percentage of mastery reach KKM value. The result of unfinished student analysis reaching KKM score in the matter of ability is an unfinished student achieving KKM value in critical literacy problem, it can be concluded that the ability of science literacy has an influence on the ability of student's critical literacy, it indicates that using science textbook based on scientific literacy students not only learn the content, but also the context, and the process of science in life so that students are more confident to draw conclusions, apply the knowledge they have to solve the problem, argue and criticize the information if there is an error in the information.

Fang & Wei (2010) says that science literacy improves on the concept, skill, comprehension, and generalization value of the reading aspect, because by reading can be

obtained the content of science. This is consistent with Rusilowati *et al.* (2016a) which states that science literacy teaching books are effective in improving students' science literacy. Prain (2007) also revealed that the use of teaching materials can improve students' literacy skills. This improvement is also consistent with Taslidere&Eryilmaz (2009) which revealed that the integration of reading and use of science literacy teaching materials provides improved learning outcomes of students bathed in strategies and other learning methods. Science textbook based on scientific literacy can improve the ability of students' science processes that generally students are not accustomed to linking information in the text to answering questions, still weak in reading and interpreting data in the form of images, graphs, and tables become more able to master basic concepts and Interconnectedness in everyday life.

The teaching materials used in control classes still dominate the conceptual capabilities. Science learning in Indonesia generally emphasizes on memorization (Permanasari, 2010). In contrast to science textbook based on scientific literacy that are associated with existing real-life understanding that is considered able to help solve problems in life in order to become a quality human being. This is in line with Archer-Bradshaw (2014) which reveals that science literacy is able to shape students to face the challenges of the 21st century. Poluakan (2012) also mentions that one of the most important skills in the competitive era is science literacy.

The result of capability enhancement profile is obtained that the improvement of every aspect of science literacy science textbook based on scientific literacy has increased in some aspects and has not dominated science improvement as a body of knowledge, but has increased in the aspects of investigation of the nature of science, way of thinking and interaction of science, technology, society, and the environment. This result is in accordance with Rusilowati *et al.* (2016b) concluded that science textbook based on scientific literacy evaluation instruments need to be developed so that students are familiar with problem-solving based on science literacy. The results of Shwartz

et al. (2006) also showed that learning science literacy can improve learning outcomes of chemical reactions and the results imply science literacy must be integrated in the curriculum and learning objectives.

Materials science literacy is one solution to overcome the backwardness in the world of education. Based on the results of this study found that learning chemistry using syntax literacy science can improve students' science skills. The results obtained pursuant to Holbrook & Rannikmae (2009) express science literacy learning is a development of skills based on relevant scientific knowledge in solving problems of everyday life. Research Alam et al. (2015) also found a low aspect of science literacy due to the lack of facilitated school implementation plans (RPP) that train science literacy.

The more teaching materials that students have, the more reading and increasing the knowledge, the ability to think critically also increases, so that they are better able to argue and criticize the concept of chemistry learning that is often found in books from publishers and rumors that develop in society. This is in accordance with the results of research conducted by Gustine (2013) that is critical literacy can improve students' critical thinking so as to be more careful in interpreting and trusting information. In addition, science literacy teaching materials have more interesting print to be used as teaching materials, so that students are given the material to feel happy and interested to learn it.

Reading is seen as an important component to student success, good reading skills are needed to understand and study diverse materials to increase knowledge and information. Science textbook based on scientific literacy can make students more active for that teachers should be more creative to provide teaching materials that can increase the ability, critical literacy and the results of chemistry learning so that the desire of teachers to obtain effective and quality learning can be realized. Bybee et al. (2009) said that the data obtained by PISA on science received a very apprehensive result one of the causes is due to the ability to read and availability of learning

resources. Science textbook based on scientific literacy received positive responses from chemistry subject teachers who said that science textbook literacy can attract learning and increase students' knowledge of chemical afflictions in life. This response is in accordance with Subiantoro et al. (2013) students' literacy skills can be improved by presenting science materials that are always associated with social and technological issues of society. Science textbook based on scientific literacy categories effectively increase students' science literacy (Rusilowati et al., 2015).

Teachers should take the time to make teaching materials first before teaching their students because the use of science textbook based on scientific literacy developed by teachers themselves have various benefits to their students. Prastowo (2013) mentions the making of teaching materials systematically designed based on a particular curriculum and packed in the form of the smallest learning unit and allows to be studied independently in a certain time unit so that students are able to master the competence taught.

## CONCLUSION

The conclusion is an increase of ability and critical literacy of the students using science text book based on scientific literacy of buffer solution.

## REFERENCE

- Alam, D.P., Utari, S., & Karim, S. (2015). "Rekonstruksi Rancangan Rencana Pelaksanaan Pembelajaran Sains Melalui Analisis Kesulitan Literasi Sains Peserta Didik SMP Kelas VII pada Topik Gerak Lurus". *Prosiding. Simposium Nasional Inovasi dan Pembelajaran Sains 2015 (SNIPS 2015)*. Universitas Pendidikan Indonesia 8 dan 9 Juni 2015.
- Archer-Bradshaw, R. E. (2014). Demystifying Scientific Literacy; Charting the Path for the 21st Century. *Journal of Educational and Social Research*, 4(3), 165-172.
- Bybee, R, McCrae, B., & Laurie, R. (2009). PISA 2006: An Assessment of Scientific

- Literacy. *Journal of Research in Science Teaching*, 46(8), 865-883.
- Chiappetta, E.L., Fillman, D.A., &Sethna.G.H.(1991). A Method to Quantify Major Themes of Scientific Literacy in Science Textbooks. *Journal of Research in Science Teaching*, 28 (8), 713-725.
- Comber, B. (2001). Critical literacies and local action: Teacher knowledge and a “new” research agenda. In B. Comber & A. Simpson (Eds.), *Negotiating critical literacies in classrooms*, 271-282.
- Duschl, R.A., Schweingruber, H.A., &Shouse, A. W. (Eds).(2007). *Taking Science to School: Learning and Teaching Science in Grades K-8*. National Academies.
- Gustine, G.G. (2013). Designing and Implementing a Critical Literacy-Based Approach in an Indonesian EFL Secondary School. *International Journal Of Indonesian Studie*, 1, 2-21.
- Fang, Z., & Wei, Y. (2010). Improvings Middle School Students Science Literacy Through Reading Influsion. *The Journal of Education Research*. 103, 262-273.
- Holbrook, J., &Rannikmae, M. (2009). Meaning of Scientific Literacy. *International Journal of Environmental & Science Education*, 4(3), 275-288.
- Kemendikbud.( 2014). *Permendikbud Nomor 58 Tahun 2014 Tentang Kurikulum 2013 Sekolah Menengah Pertama/ Madrasah tsanawiyah*. Jakarta: Menteri Pendidikan dan Kebudayaan Republik Indonesia.
- Permanasari, A. (2010). Membangun Keterkaitanantara Mengajar dan Belajar Pendidikan Sains SMP untuk meningkatkan *Science literacy* Peserta didik.Bandung; JICA-FMIPA UPI.
- Poluakan, C. (2012). The Effects Of High Scientific Literacy, Self-Efficacy, And Achievement Motivation On Teachers' Ability To Compose Effective Tests; Case Study From Manado, Indonesia. *Journal of College Teaching & Learning*, 9(4), 313-326.
- Prain,V. (2007). Learning from Writing in Secondary Science: Some theoretical and practical implications. *International Journal of Science Education*. 28(15), 179–201.
- Prastowo, A. (2013). *Panduan Kreatif Membuat Bahan Ajar Inovatif-Menciptakan Metode Pembelajaran yang Menarik dan Menyenangkan*. Jogyakarta : Diva Press. Algensindo.
- Rusilowati, A. (2013). *Peningkatan Literasi Sains Siswa melalui Pengembangan Instrumen Penilaian*. Pidato Pengukuhan Profesor Unnes Semarang.
- Rusilowati, A., Sunyoto, E.N., & Mulyani, S. E. S. (2015). Developing of Science Textbook Based on Scientific Literacy for Seventh Grade of Secondary School”. *InternationalConference on Mathematics, Science, and Education (ICMSE)* (Vol. 2, No.1).
- Rusilowati, A., Nugroho, S.E., &Susilowati, S. M. (2016a). Development of Science Textbook Based On Scientific Literacy For Secondary School. *Jurnal Pendidikan Fisika Indonesia*. 12(2), 98-105.
- Rusilowati, A., Kurniati, L., Nugroho, S. E., & Widiyatmoko, A. (2016b). Developing an Instrument of Scientific Literacy Assessment on the Cycle Theme. *International Journal of Environmental and Science Education*. 11(12), 5718-5727.
- Schwartz, Y., Ben-Zhi, R., &Hofstein, A. (2006). The Use Scientific Literacy Taxonomy For Assessing The Development Of Chemical Literacy Among High-School Students. *Chemistry Education Research and Practice*. 7 (4), 203 – 225.
- Subiantoro, A.W., Ariyanti, N.A., & Sulistyo. (2013). Pembelajaran Materi Ekosistem dengan Socio-Scientific Issues dan Pengaruhnya Terhadap Reflective Judgement Siswa. *JurnalPendidikan IPA Indonesia*. 2(1), 41-47.
- Taslidere, E., &Eryilmaz, A. (2009). The Relatives Effectiveness of Integrated Reading Study and Conceptual Physics Approach.*Research in Science Education*. 42(2), 181-199.