SCIENCE TECHNOLOGY SOCIETY APPROACH APPLICATION ON STUDENTS LITERACY AND PROCESS SKILLS OF SCIENCE TO STUDY DYNAMIC FLUIDS

Muhibbuddin[1*], Intan Wulan Sari[2] & Mursal[3]

[1]Dr., Universitas Syiah Kuala, Banda Aceh, Indonesia, muhib.bio@gmail.com
[2]Universitas Syiah Kuala, Banda Aceh, Indonesia, intanwulansari44@gmail.com
[3]Dr., Universitas Syiah Kuala, Banda Aceh, Indonesia, mursal@unsyiah.ac.id
Corresponding Author

Abstract

Science literacy and science process skills are important abilities which should be mastered by students to be able to survive living in the 21st century. The problems occurred in students are they did understand science but only the concepts which are not directly applied in everyday life. This showed the low science literacy and science process skills of students. Therefore, changes in the pattern of teaching and learning both in terms of teacher's approaches and methods of teaching must be immediately carried out to resolve these problems. This study aimed to answer the question of whether the application of the Science Technology Society (STS) approach affected students' science literacy and science process skills. The method used in this study was a pretest posttest control group experimental design. The research was conducted in one of the high schools in Banda Aceh, Aceh, Indonesia with 64 students as subjects divided into two classes namely the experimental class and control class consisted of 32 students each class. The research period was 20 days, from October to November 2018. The parameters were science literacy and science process skills. The instrument used was an objective test with five alternative answers. Data collection was done through pretest and post-test. Data analysis of science literacy and science process skills was carried out by comparing the initial ability (the results of the pretest) with the final ability (n-Gain) and the significance tested with two different test averages using the independent sample t-test. The results showed that the final ability of science literacy and science process skills between the experimental class and the control class had significantly different. The conclusion of the results of this study was the application of the Science Technology Society (STS) approach influencing the science literacy and science process skills of students.

Keywords: Science Technology Society, Science Literacy, Science Process Skills, Dynamic Fluids.

1. INTRODUCTION

Science literacy and science process skills are one of the four main skills of science education in facing the 21^{st} century (Hastuti, 2013; Huda, et al., 2013; Rahayu, 2014). Science literacy is an important thing to be owned by each person because it is closely related to the way where everyone could understand the environment and other problems faced by modern society that are very dependent on the development of science and technology, including social problems (Arief, 2015). Science literacy attitudes can grow if students are trained using science process skills (Yadav, 2013).

Science process skills that are trained for students will create the basis of scientific inquiry, improve scientific thinking skills and attitudes needed to understand a concept, so that science process skills can develop their scientific literacy (Andeson, 2002; Jack, 2013). An assessment for student scientific literacy skills is internationally organized by the Organization for Economic Co-operation and Development (OECD) through the Program for International Student Assessment (PISA) every three years. In 2015, the results of survey conducted by PISA with the average score still below the established international standard of <500.

According to a case study conducted on October 18, 2017 against five teachers, ten students and principals of SMAN 8 Banda Aceh through the interview results found that student science literacy is still low. The condition is frequently can be seen in several activities which were many students who measure body temperature near fans or in air-conditioned rooms, races on slippery roads, holding electric sockets in wet hands, playing in the field on when heavy rains are wheeled, throwing garbage out of place without regard to cleanliness and the impact of his actions, likes foods that contain addictive substances, not even a few students who have started smoking. It revealed that they have low science literacy and then it will influence the science process skills of students, even though in school they have gained knowledge about various conditions that have been described.

Improvisation in teaching and learning patterns for terms of curriculum content, approaches or teacher teaching methods, student learning methods need to be implemented either to develop science literacy or science process skills for students. To build science literacy and science process skills of students, learning science can be applied by learning which all relies on "student active learning". Student-centered learning is certainly focused on the process of scientific inquiry with the principle of constructivism (Permanasari, 2011). The learning approach to science technology society (STS) is a learning that carries constructivism theory, and by applying constructivism theory, students can use their concepts and skills inside and outside the classroom as well as in the daily life environment both in the life of society, nation and state intelligently, creativity and responsibility (Fajar, 2004).

The STS approach has been applied to several science subjects namely chemistry subjects (Saefuludin, 2008; Junita, 2016), physics subjects (Tucksanun, 2012), and on biology subjects (Amilda, 2017). The STS approach was identified to increase motivation and learning achievement in science. Among other things, the STS approach can improve students' analytical thinking skills (Chantaranima et al., 2013), student learning outcomes (Suprianto, 2016), student motivation (Smitha et al., 2014), understanding of science concepts (Kapici et al., 2017), scientific attitude (Akcay et al., 2015), improve critical thinking (Nurchayati, 2013), and improve student science literacy (Subratha, 2004; Kresna, 2014; Autieri et al., 2016).

One of chapters in learning physics that can be associated with the STS approach, science literacy and science process skills is dynamic fluids. Dynamic fluid material contains global issues that are closely related to the environment, society and technology that also involve students to apply their knowledge in solving problems. According to the research conducted at SMAN 3 Malang, most of students still use their knowledge naively, students fail in applying equations in solving problems related to dynamic fluid (Solehudin, 2016). Researchs which are related to the application of the STS approach to dynamic fluid material have never been done before, therefore this study was designed to look at changes in teaching and learning patterns in terms of approaches aimed at training students to apply their knowledge in life by increasing science literacy and science process skills of students. Someone who has science process skills, science literacy, culture of science and technology is one who has the ability to solve problems using scientific concepts acquired in education according to his level, know the technology products that are around him and their impact, be able to use technology products and maintain them, creative create simplified technological results, and are able to make decisions based on value. It can be concluded that science literacy skills (Rahayuni, 2016) and students' science process skills (Saefuludin, 2008; Santy, 2014) will increase by applying the learning approach to community science technology.

2. RESEACH METHOD

This research used experiment method with group control of pretest and posttest design (Sugiyono, 2010). The details of research design can be seen in Table 1.

Table 1. Pretest-posttest Control Group Design

Sample	Classes	Pretest	Treatments	Posttest
Random	Experiment	O_1	P_1	O_2
Random	Control	O_3		O_4

Information:

O_1 : Pretest before treatment is given to class of experiment

O_2 : Posttest before treatment is given to class of experiment

O_3 : Pretest before treatment is given to class of control

O_4 : Posttest before treatment is given to class of control

P_1 : Treatment to class of experiment

The population in this study was 160 students of class XI in Banda Aceh Senior High School 8, who took the science program in the odd semester of the year 2018/2019. There are 32 students as sample that was randomly carried out for both class of experiment and class of control. The experimental class uses the STS approach in the learning process while the control class is not given treatment.

To collect the data, the techniques were carried out by test techniques and the parameters measured were student literacy skills and science process skills. The instrument used was an objective test of 25 items with five alternative answers. Science literacy measured in research includes aspects of competence and aspects of scientific knowledge, while the science process skills that are measured are basic science process skills.

3. DATA AND ANALYSIS

The collection of science literacy data and science process skills of students is done through pretest and post-test. Data were analyzed using parametric analysis techniques, namely normality, homogeneity, and significance tests carried out by means of different test using independent sample t-test by comparing the initial ability (result of pretest) with final ability (n-Gain).

4. FINDINGS AND DISCUSSION

The result of measurement and analysis of science literacy skills (Figure 1) exhibited that students have the similar competency for initial test conducted in both class of experiment and class of control within 34.66 and 35.09, respectively. After being treated by special approach for class of experiment, it showed final result (n-Gain) of this class is higher that class of control. The class of experiment gained average score of 83.

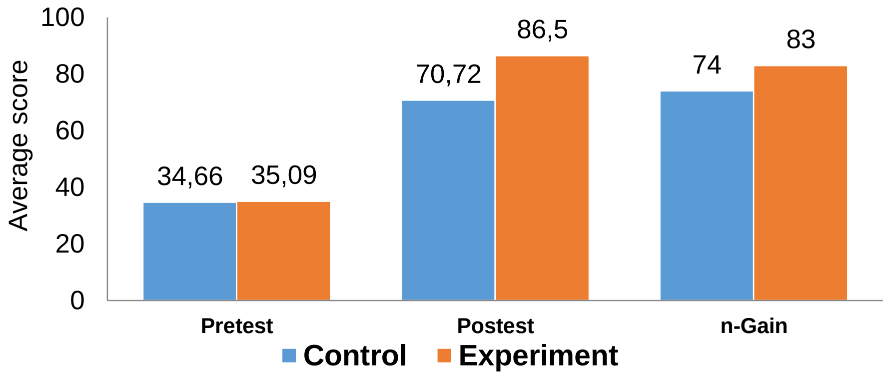

Figure 1 The proportion of average score for pretest, posttest and n-Gain for science literacy skills of students

The hypothesis test on n-Gain data for class of experiment and class of control obtained results that there were significant differences in the ability of science literacy in both classes (Table 2). These results indicate that the application of the STS approach supported student science literacy.

Table 2. Test of difference on average score of pretest and n-Gain of science literacy skills for both class of experiment and class of control

Literacy of Science	Classes	Normality*	Homogeneity**	Test of Hypothesis	Information
				t-test	
Pretest	Experiment	X^2_{count} (6.57) < X^2_{table} (9.48)(Normal)	F_{count} (1.18) < F_{table} (1.82) Homogeneous	T_{count} (0.19) < t_{table} (2.00)	Slightly different
	Control	X^2_{count} (5.75) < X^2_{table} (9.48) (Normal)			
n-Gain	Experiment	X^2_{count} (2.71) < X^2_{table} (9.48)	F_{count} (1.04) < F_{table} (1.82) Homogeneous	T_{count} (2.42) > t_{table} (2.00)	Significantly different
	Control	X^2_{count} (4.72) < X^2_{table} (9.48) (Normal)			

*Chi-quadratic test (Normal: $X^2_{count} < X^2_{table;}$ α = 0.05)

**F-test (Homogeneous: $F_{count} < F_{table}$; α = 0.05)

***t-test (Significantly different: $t_{count} > t_{table}$; α = 0.05)

The different improvement in science literacy skills of students in the experimental class and control class was caused by the learning process in the experimental class using the STS approach. During learning in class of experiment, student are given stimuli in the form of relevant cases in daily life related to the concept of dynamic fluid material then students find out the solution to the problem in a scientific way that is practicum to collect data and then draw conclusions to obtain a solution the case given by the teacher. With this learning can train students to literate science, students better understand the usefulness of their knowledge in everyday life, so that the STS learning approach can improve the science literacy of students. As stated by Sadia (2015) that STS learning is learning that has a goal to shape the students' personal science and technology literacy through its implementation in science learning in accordance with the steps and domains that are the focus of STS learning.

The percentage of achievement of pretest and posttest science literacy skills of each indicator in the aspects of competence and knowledge in class of experiment is presented in Table 3 as follows.

Table 3. The achievement recapitulation on science literacy skills for each indicator in class of experiment

Aspects of science literacy	Indicators	Percentage for indicators (%)		Persentage for Aspects science literacy (%)	
		Pretest	*Posttest*	*Pretest*	*Posttest*
Competency of science	Explaining scientific phenomena	0.27	0.78	0.32	0.86
	Identifying scientific issues	0.39	0.88		
	Using scientific evidence	0.29	0.93		
Cognition of science	Applying	0.40	0.90	0.32	0.88
	Analyzing	0.39	0.86		

Based on table 3, information is obtained that the achievement of science literacy on the competency aspects before the STS approach is applied is 32%, which falls into the category of "very poor" and on the knowledge aspect is also categorized as "very poor" by 32%. After the STS approach was applied in the learning process, there was an increase, namely achieving 86% in the aspects of science competency which belonged to the category of "very good" and achievement in the knowledge aspect of 88% which belonged to the "very good" category.

The results of the measurement and analysis of science process skills (Figure 2) show that the average score of the pretest obtained by the control class students (35.25) and the experimental class (36.5) does not have a strong difference. Furthermore, after being treated in the experimental class shows the final result (n-Gain) of the experimental class is higher than the control class. The experimental class obtained an average n-Gain score of 83.

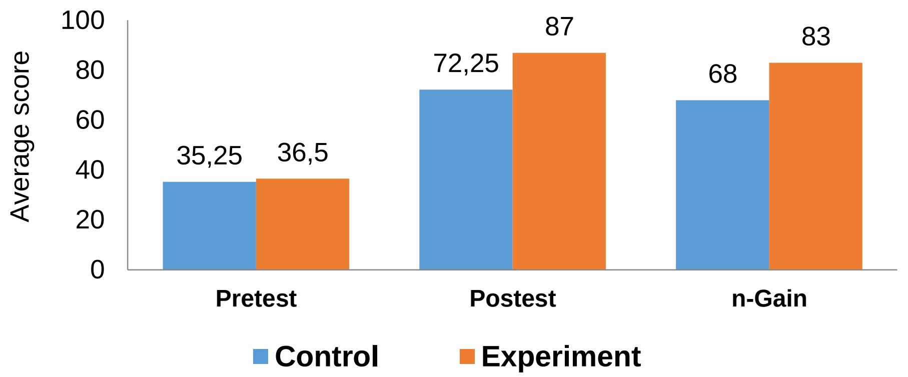

Figure 2. The comparison of average score for pretest, posttest and n-Gain to science process skills of students

Testing the hypothesis on the n-Gain data of the two classes obtained results, namely there were significant differences in science process skills between the experimental and control classes (Table 4). These results indicate that the application of the STS approach influences students' science process skills.

Table 4. Recapitulation for test of average difference of pretest and n-Gain on science process skills in class of experiment and class of control

Science process skills	Classes	Normalitas*	Homogenitas**	Uji Hipotesis	Ket
				Uji-t***	
Pretest	Experiment	X^2_{count} (4.08)<X^2_{table} (9.48) (Normal)	F_{count} (1.09) < F_{table} (1.82) Homogeneous	T_{count} (0.48) < t_{table} (2.00)	Slightly different
	Control	X^2_{count} (5.84)<X^2_{table} (9.48) (Normal)			
N-Gain	Experiment	X^2_{count} (9.42)<X^2_{table} (9.48) (Normal)	F_{count} (1.45) < F_{table} (1.82) Homogeneous	T_{count} (3.95) > t_{table} (2.00	Significantly different
	Control	X^2_{count} (4.92)<X^2_{table} (9.48) (Normal)			

*Chi-quadratic test (Normal: $X^2_{count} < X^2_{table;}$ $\alpha = 0.05$)

**F-test (Homogeneous: $F_{count} < F_{table}$; $\alpha = 0.05$)

***t-test (Significantly different: $t_{count} > t_{table}$; $\alpha = 0.05$)

The different improvement in science process skills between the two classes illustrates that learning in the experimental class is more effective in terms of increasing the science process skills of students. This is caused by the learning process of students in the experimental class can directly observe objects or natural phenomena related to the concept of dynamic fluid and record the results of observations made so as to improve the skills of observation and classification. In addition, students are trained to express ideas in accordance with the predictions of each student and then prove the truth by collecting data by doing practicum in accordance with the student worksheet (LKPD) that has been provided so that students can conclude the findings according to initial predictions. Thus the science process skills of students in the experimental class can be increased compared to the control class. The achievement of science process skill capabilities on each indicator is presented in Table 5 below:

Table 5. Recapitulation for the achievement of science process skills of students of each indicator in class of experiment

No	Indicators	Persentage for Indicators (%)	
		Pretest	*Posttest*
1	Skills of observing	0.45	0.84
2	Skills of identifying	0.33	0.95
3	Skills of communicating	0.32	0.92
4	Skills of predicting	0.34	0.85
5	Skills of creating the conclusion	0.34	0.91

The achievement student science process skills at the beginning of the test (pretest) for the indicator of skill in observing is 0.45 with the category "less", while the skills in classifying, communicating, predicting, and saving are categorized as "very poor" with a value of <40. When the final test (posttest) after the STS approach was applied in the learning process, it was seen that each indicator experienced an increase from the initial test to the category of each indicator which was "very good". The highest increase occurred in the skill of classifying that is equal to 0.95 then the communication skills of 0.92 continued on the concluding skills of 0.91 predicting skills of 0.85 and observing skills of 0.84. This happens because in the learning process in the experimental class students are required to communicate and conclude the findings obtained during practicum so that communication skills and conclusions of students will be achieved.

5. CONCLUSION

According to the results, data analysis, and discussion, it can be concluded that the application of STS approach in learning dynamic fluids is affected to the science literacy and science process skills of students. It is indicated by significant differences between score of pretest and n-Gain for both class of experiment and class of control.

REFERENCE LIST

Akcay, B., & H. Akcay. (2015). Effectiveness of Science-Technology-Society (STS) Instruction on Student Understanding of the Nature of Science and Attitudes toward Science. *International Journal of Education in Mathematics, Science and Technology*, 3 (1), p.7-45.

Amilda. (2017). Pengaruh Model Pembelajaran Sains Teknologi Masyarakat (STM) Terhadap Kemampuan Pemahaman Konsep Siswa pada Pokok Bahasan Ekosistem Kelas VII Mts Paradigma Palembang. *Bioilmi*, Januari 2017.

Andeson, R.D. (2002). Reforming Science Teaching: What Research Says About Inquiry. *Journal of Science Teacher Education*, 13(1), p.1-12.

Arief, M.K. (2015). Penerapan Levels Of Inquiry Pada Pembelajaran IPA Tema Pemanasan Global Untuk Meningkatkan Literasi Sains. *Edusentris, Jurnal Ilmu Pendidikan dan Pengajaran*, 02 (02), p. 166-176.

Autieri, S.M., A. Amirshokoohi, & M. Kazempour. (2016). The Science-Technology-Society Framework For Achieving Scientific Literacy: An Overview Of The Existing Literature. *European Journal of Science and Mathematics Education*, 4(1), p. 75-89.

Chantaranima, T., & C.Yuenyong. (2013). The Outcomes of Teaching and Learning About Sound Based on Science Technology and Society (STS) Approach. *Procedia-social and Behavioral sciences*, Unversity Thailand, 116, p. 2286-2292.

Fajar. (2004). *Portofolio Dalam Pembelajaran IPS*. Bandung: Remaja Rosdakarya.

Fiman, H. (2007). *Analisis Literasi Sains Berdasarkan Hasil PISA Nasional Tahun 2006*. Jakarta: Pusat Penilaian Pendidikan Balitbang Depdiknas.

Hastuti, P.W. (2013). Intregative Science untuk mewujudkan *21st Century Skill* dalam Pembelajaran IPA SMP. Malang. *Seminar Nasional MIPA 2013.*

Huda, N., Marhaeni, A. A. A. I. N., & Suastra, I. W. (2013). Pengaruh Pembelajaran Quantum Dalam Pembelajaran IPA Terhadap Motivasi Belajar Dan Penguasaaan Konsep Siswa Kelas IV SDN Pancor. *Jurnal Program Pascasarjana Universitas Pendidikan Ganesha*, 3 (1), p. 1-7.

Jack, G.U. (2013). The Influence of Identified Student and School Variables on Student Science Process Skill Acquisition. *Journal of Education and Practice,* 4(5), p. 16-22.

Junita, S. (2016). Penerapan Pendekatan Sains Teknologi Masyarakat (STM) Untuk Meningkatkan Kesadaran Siswa Terhadap Lingkungan Pada Pembelajaran Kimia Materi Asam Basa. *Jurnal Pendidikan Sains Indonesia*, 04 (02), p. 117-126.

Kapici, H.O., H. Akcay, & R.E.Yager. *(*2017). Comparison of Science-Technology-Society Approach and Textbook Oriented Instruction on Students' Abilities to Apply Science Concepts. *International Journal of Progressive Education*, 13 (2), p. 18-28.

Kresna, S. (2014). Pengaruh Model Pembelajaran Sains Teknologi Masyarakat Terhadap Hasil Belajar Ipa Siswa Sd Kelas IV Gugus VIII Kecamatan Buleleng. *Jurnal Mimbar Universitas Pendidikan Ganesha*, 2 (1), p. 132-148.

Nurchayati, N. (2013). Pengaruh Model Pembelajaran Sains Teknologi Masyarakat (STM) Terhadap Keterampilan Berpikir Kritis dan Sikap Sains Siswa SMP. *Jurnal Ilmiah Progessif.* 10 (30), p. 29-41.

Permanasari, A. (2011). Pembelajaran Sains: Wahana Potensial untuk Pembelajaran Soft Skill dan Karakter. *Prosiding pada Seminar Nasional Pendidikan IPA,* Universitas Lampung, 26 November 2011. (https://semnaspendmipa.files. wordpress.com/2012/02/prosiding-seminar-nasional-pendidikan-mipa-2011.pdf, diakses 20 Juni 2018).

Rahayu, S. (2014). Menuju Masyarakat Berliterasi Sains: Harapan dan Tantangan Kurikulum 2013. *Makalah disampaikan dalam Seminar Nasional Kimia dan Pembelajarannya*, FMIPA UM, 2014.

Rahayuni, G. (2016). Hubungan Keterampilan Berfikir Kritis dan Literasi Sains Pada Pembelajaran IPA Terpadu dengan Model PBM dan STM. *Jurnal Penelitian dan Pembelajaran IPA*. 2(2): 131-146

Sadia, I.W. 2014. *Model-Model Pembelajaran Sains Konstruktivistik*. Yogyakarta: Graha Ilmu.

Saefuluddin, A. (2008). *Efektivitas Pembelajaran Kimia dengan Pendekatan Sains Teknologi Masyarakat (STM) Berbantukan CD Pembelajaran*. Tesis tidak dipubikasikan. Semarang: PPs Unnes.

(http://lib.unnes.ac.id/16956/1/ 4001506026.pdf, diakses 2 Januari 2018).

Santy, D.K. (2014). Peningkatan Keterampilan Proses Sains dan Hasil Belajar IPA Menggunakan Pembelajaran Sains Teknologi Masyarakat (STM) pada Siswa Kelas VI SDN 1 Kalinanas. *Jurnal Scolaria*, 4(3), p. 122-131.

Smitha, E.T, & P.K. Aruna. (2014). Effect of Science Technology Society Approach on Achievement Motivation in Biology of Secondary School Students of Kasaragod District. *IOSR Journal Of Humanities And Social Science,* 19(4), p. 54-58.

Subratha, N. (2004). Efektivitas Pembelajaran Kontektual dengan Pendekatan Sains Teknologi Masyarakat Dalam Meningkatkan Hasil Belajar Dan Literasi Sains Siswa SLTP Negeri 2 Singaraja. *Jurnal Pendidikan dan Pengajaran IKIP Negeri Singaraja.* 37(4), p. 45-56.

Solehudin, K, & S. Sutopo. (2016). Eksplorasi Kesulitan Siswa terhadap Prinsip Kointunitas Fluida dan Persamaan Bernoulli untuk Pengembangan Instrument Test FDT. *Seminar Nasional Jurusan Fisika FMIPA UM*. (http://lib.unnes.ac.id/16956/1/4001506026.pdf, diakses 12 Juli 2018).

Sugiyono. (2010). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, Kuantitatif, dan R&D.* Bandung: Alfabeta.

Suprianto. (2016). Pengaruh Penerapan Pendekatan Pembelajaran Sains Teknologi Masyarakat (STM) terhadap Peningkatan Hasil Belajar Siswa di SMA Hidayatun Najah. *Jurnal untirta*, 2(1), p. 189-196.

Tucksanun, K. (2012). An Analysis Of Grade 12 Students Technological Capability In Learning About Electromagnetics Through Science Technology and Society Approach (STS Approach). *Procedia - Social and Behavioral Sciences*, 46, p. 5085 – 5093.

Yadav, B. & Mishra, S.K. (2013). A Study of the Impact of Laboratory Approach on Achievement and Process Skill in Science among Standard Student. *Internasional Journal of Scientific and Research Publications*. 3(1), p. 116-127.