Journal of Engineering Education Transformations ,
Volume 35 , No. 2 , October 2021 , ISSN 2349-2473, eISSN 2394-1707

STSE Collaborative Learning: Fostering Students' Learning Motivation on Electrolyte Non-Electrolyte Chemistry Unit

Erfan Priyambodo[1], Sukirno[2], Metridewi Primastuti[3], Nur Fitriyana[4], Hermas Randhanugraha[5]
[1, 2] Post Graduate Program, Universitas Negeri Yogyakarta, Indonesia. Colombo St. 01, Sleman, Indonesia 55281
[3, 4, 5] Department of Chemistry Education, Universitas Negeri Yogyakarta, Indonesia. Colombo St. 01, Sleman, Indonesia 55281
[1] erfan@uny.ac.id
[2] sukirno@uny.ac.id
[3] metridewi.primastuti@uny.ac.id
[4] nur.fitriyana@uny.ac.id
[5] hermasrandhanugraha01@gmail.com

Abstract: Chemistry teaching-learning plays an important role in the development of knowledge transfer systems that are sustainable towards the environment and technological development in the society. Student motivation is needed so that the learning objectives can be achieved. In this research, students' learning motivation was fostered through the Science, Technology, Society and Environment (STSE) learning approach on electrolyte-non electrolyte subject. Therefore, this research was conducted to analyze the differences learning motivation among students who studied using the STSE approach. Quasi-experimental, specifically non-equivalent control group design was adopted as a research design. About 68 students participated as a research sample and grouped into experimental and control groups. Students' motivation in learning chemistry as a dependent variable was measure using learning motivation questionnaire, the five-point Likert scale was used. The results shows that the average scores of students' motivation in experimental group increased from 132.21 to 135.62, meanwhile in control group slightly decreased from 121.06 to 120.65. Research data analyzed through the independent sample t-test, show the significance (2-tailed) value obtained was 0.013, less than 0.05. It means that there was a significant difference of students' learning motivation between the experimental and control groups. Moreover, STSE can be used as an alternative learning approach to foster student learning motivation.

Keywords: STSE, learning approach, collaborative learning, learning motivation

Erfan Priyambodo
Post Graduate Program, Universitas Negeri Yogyakarta, Indonesia. Colombo St. 01, Sleman, Indonesia 55281
erfan@uny.ac.id

1. Introduction

The development of the 21st century global era has influenced the human resources needed based on the sustainable knowledge. The education industry has the potential to prepare students into becoming knowledge-based society as 21st century driven. One of the 21st century characteristics in the teaching-learning process is the use of internet that students can use as a learning source (Garba, Byabazaire & Busthami, 2015). But, the acquisition of information from the internet still needs teachers' role for accompanying students. Moreover, the teacher needs a right learning strategy to motivate student in learning process, such as in chemistry teaching and learning. The most dominant learning strategy to improve students' motivation in learning is using student centered learning (Upadhya & Lynch, 2019). This learning strategy is adopted in Indonesia through Curriculum of 2013.

As a part of the study about nature, chemistry teaching-learning plays a role in the development of knowledge transfer systems that are sustainable towards the environment and technological

development. Every phenomenon occurs in nature becomes a problem question that requires scientific analysis and verification. The teaching-learning activities needs to be presented as an integrated process of knowledge discovering related to the experience of students in technological development, so that the acquired knowledge can improve their reasoning ability to describe the phenomenon through the scientific knowledge on the society (Akcay & Akcay, 2015).

Most of chemistry concepts are abstract (Zoller, 1990) and some students have difficulties in understanding its concepts (Özmen & Alipaşa, 2003). Both are the challenge for chemistry teachers to make students succeed in chemistry learning. Students' participation is the most important thing in chemistry teaching and learning. It can be obtained if students are motivated in learning (Austin, et al, 2018).

Students' learning motivation to engage in learning chemistry is more apparent if the learning topic is presented in real terms. In a good motivation the influence on the construction of knowledge that is formed will also be good (Sharaabi-Naor, Kesner & Shwartz, 2014). However, the teachers are struggle in motivating students to learn (Lin-Siegler, et al, 2016). The learning motivation trend of students decreases because their anxiety level to study science increases, thereby reducing the level of their learning effort (Gottfried, Fleming, & Gottfried, 2001; Lepper, Corpu, & Iyengar, 2005). Meanwhile, learning motivation serves to encourage students' behavior such as learning and directing actions for the achieved goals.

In terms to increasing students' participation in chemistry teaching and learning, the teacher can use innovative method in teaching through student-centered learning (Gauci, et. al., 2009; Wright, 2011). A strategy, which integrating science, technology, society and environment (STSE), can be used in implementing student-centered learning. The STSE is purposed to give the student an authentic inquiry activities to enhance understanding, skills, and inquiry which are relevant to their daily life, society, technology, and environment (Gathong & Chamrat, 2019).

These characteristic is accordance with the underlying philosophy of the STSE learning approach; students build the concepts in their cognitive structures based on what they already know. This is caused by statement of the STSE focusing on problems from the real world that have a science and technology component from the perspective of students. The concepts and processes are investigated, analyzed and applied to real situations by students NSTA (1990). Therefore, in this research, the chemistry topics taught are presented in student worksheets that relate to the environmental phenomena and scientific processes that make learning realistic.

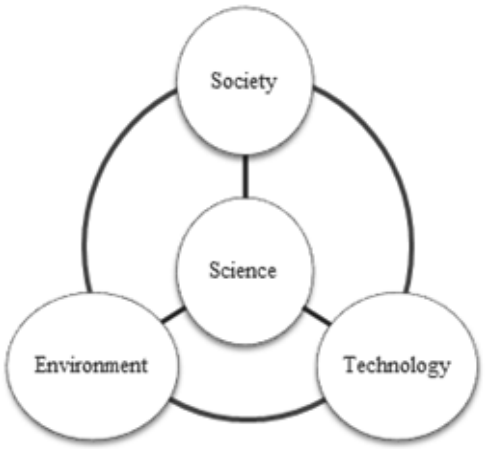

Fig. 1: The correlation between STSE learning approach elements (NSTA, 1990)

The study about STSE in chemistry learning still rarely conducted (Gathong & Chamrat, 2019; Chanapimuk, Sawangmek, & Nangngam, 2018). The characteristics of the STSE learning approach are the linkages between the elements, science (S) as the main focus attention used to form technology (T) in the needs of the society (S) that requires the various implications for the environment (E) physically and mentally (Firmino, et al 2019). The implementation of STSE in chemistry learning activities is initiated by presenting daily live phenomena relating the chemistry knowledge. This model is expected to be able to presenting the meaningful of the topic they were studying in daily life, especially in electrolyte non-electrolyte subject, so that the student motivation in learning chemistry fostered.

Motivation in this research is become an important role in students' learning achievements. If they are had learning difficulties, it will affect to their behavior towards the unit, and willingness to think. Strengthening motivation is needed to provide support and reinforcement that students have the good capability on the learning chemistry. Whether, this research aimed to analyze the differences in chemistry

learning motivation among students who studied using the STSE approach and those who did not.

2. Methods

The sole purpose of this research was to foster students' learning motivation in electrolyte non-electrolyte chemistry unit. Quasi-experimental, specifically non-equivalent control group design was adopted as a research design of this research and cluster random sampling technique was employed to establish the research samples. There were two groups employed through this design, one group was devoted as experimental group (experienced collaborative learning based STSE) and the other one as control group (perceived traditional teaching).

These research samples comprise from a public senior high school in Sleman Regency, Yogyakarta, Indonesia with a total of 68 students' grade X. As many as 34 students as experimental group (16 male and 18 female) and 34 students referred as control group (14 male and 20 female). Before assigning the research samples, characteristics of the students as research samples candidates were make sure to be similar. They have no differences in the term prior knowledge in chemistry unit and have approximately aged between 15-16 years old.

Both of groups were taught the electrolyte non-electrolyte chemistry unit by the same teacher. This unit consist of several sub-unit learning materials, such as the meaning of electrolyte non-electrolyte solution; factors affecting electrical conductivity in solution; determination of electrical conductivity in solution; and implementation of electrolyte non-electrolyte concept in daily life. The electrolyte nonelectrolyte solution subject was choosen because of students' misconception in the several concept; ionic compounds and ionization (Brandriet & Bretz, 2014). While this concept is related towards the other chemistry learning subject in a whole semester, i.e. reduction oxidation reaction, chemical bonds, etc.

Before teaching, the teacher was prepared subject specific pedagogy for each session, such as lesson plan, learning media, students' worksheet and evaluation. Students were studied during 5 meetings, including posttest exams, and laboratory work. Each meeting, students learn collaboratively using students' worksheets developed by researchers. In the worksheet, the topics studied are presented through the articles relate to electrolytes non-electrolyte phenomenon that occur in daily life, inline with STSE learning phase. The worksheet enables students to dig up the information, formulating hypotheses, and design solutions that can be applied to answer the problems identified in the article.

The students in both groups were learned through student centered learning paradigm. They focused to learn electrolyte non-electrolyte chemistry unit in a small collaborative group (one group consists of 3 – 4 students). In the experimental group, collaborative learning based STSE was adopted, i.e. invitation, exploration, solution, and application/ follow up (NSTA, 1990). Meanwhile, scientific approach was used in control group as same as a method which widely used in Indonesia. This model consists of five learning phases, which are (1) observing; (2) proposing question; (3) collecting information; (4) associating; and (5) communicating.

Through the STSE collaborative learning, the students in experimental group expanded their learning in chemistry concept, in how to implemented chemistry concept in terms science, technology, society and environment. The teaching and learning based STSE follows several phases, which are (1) invitation; (2) exploration; (3) solution; (4) application; and (5) strengthen the chemistry concept.

After teaching intervention in both groups, the students' learning motivation was measured using learning motivation questionnaire which adopted from Schunk, Pintrich & Meece (2008). Questionnaire technique can be used as a reliable and valid research instrument to assess student learning motivation through the implementation of designed learning strategies analysis (Glynn, Taasoobshirazi & Brickman, 2009). The five-point Likert scale, ranging from 1 to 5, was used in students' learning motivation which consists of positive and negative statement.

Table 1 : Students' learning motivation questionnaire

No	Indicator	Number of statements	
		Positive	Negative
1	Diligently completing the task	3	2
2	Resilient resolve difficulties	3	2
3	Interest to learn	3	2
4	Work independently	4	1
5	Bored with routine task	3	2
6	Defend the opinions	3	2
7	Firm on what is believed	3	2
8	Solve the problems	4	1
		26	14

The reliability value of the students' learning motivation questionnaire was 0.941, it means that statement in the instrument have a high reliability and qualified to be used as a research instrument.

The data of students' learning motivation were analysed according paired sample t-test and independent t-test. The paired sample t-test was performed to determine the differences between the averages score of students' learning motivation before and after learning process in both groups. The independent sample t-test was performed to determine the differences of post-test score of students' learning motivation among experimental and control groups

3. Results

The results collected from the pre-test and post-test score of students' learning motivation were presented in Table 2.

Table 2 : The descriptive data of students' motivation

Parameter	Experimental Group		Control Group	
	Pre-test	Post-test	Pre-test	Post-test
Number of students	34	34	34	34
Mean Score	132.21	135.62	121.06	120.65
Highest Score	170	170	163	141
Lowest Score	108	111	81	90
Std. Dev.	12.25	11.82	22.44	20.05

As observed in Table 4, it shows that overall students' learning motivation on experimental group were higher than the control group, for both pre-test and post-test. However, after experiencing research treatment, students' learning motivation on experimental group was increased, but slightly decreased for the control group. Statistical technique was needed to confirm the differences among the students' learning motivation in experimental and control groups; i.e. the paired sample t-test for the averages score of students' learning motivation before and after learning process in both groups and the independent sample t-test for the differences of post-test score among experimental and control groups. Before executing this analysis, the pre-requisite tests consisting normal distribution of scores and homogeneity of the data were confirmed to be fulfilled. Thus, the paired sample t-test was performed with the results of the analysis illustrated in Table 3.

Based on the paired sample t-test analysis results, the significance (2-tailed) value obtained was 0.002

Table 3 : Paired sample t-test analysis result

Group	N	df	t	Sig. (2-tailed)	Result
Experiment Group	34	33	-1.301	0.002	Significant different
Control Group	34	33	4.657	0.845	No significant different

(less than 0.05) for experimental group. It means there is a significant difference between students' learning motivation before and after STSE approach in learning electrolyte non-electrolyte unit. Moreover, the value for the control group was 0.845 (more than 0.05), it means there is no significant different on control class students' learning motivation.

Furthermore, an independent t-test analysis was conducted on the pretest-posttest n-gain motivation score, both of experiment and control classes The results of the independent t-test shown in Table 4.

Table 4. Independent sample t-test analysis result

Classes	Variable	Levene		df	t	Sig. (2-tailed)
		F	Sig.			
Experiment and Control	Motivation	15.34	0.00	66	2.544	0.013

Examining the data presented in Table 4, it can be observed that there was a significant difference of students' learning motivation between the experimental and control groups, thus the value of significance (2-tailed) was 0.013, less than 0.05.

4. Discussion

The first important finding implied that there was a positive significant different of students' learning motivation in experimental group, before and after learning treatment through STSE collaborative learning (see Table 2 and 3). In contrast, control group, which was students who learn the unit through the scientific approach, there was no significant different in students' learning motivation before and after teaching-learning activities. Another important finding from the research, there was a significant different between students' learning motivation in experimental and control groups (see Table 4). The experimental group had a better score of students' learning motivation rather than the control one that implemented traditional teaching and learning process (see Table 2).

Since STSE belongs to constructivism theory

(Salvadó, Casanoves & Novo, 2013), the students constructing their own knowledge in chemistry by their experience during teaching and learning process (Taylor, 2001). Moreover, applying STSE in chemistry teaching and learning provides a positive increase response to students' learning motivation. As a result of research conducted by Chowdury (2016) it was found that the application of STSE enhances students' epistemological views in promoting the knowledge they have through behavioral processes to analyze problems and make decisions scientifically, which is one component of indicators of learning motivation.

In this research, STSE was applied as collaborative learning in chemistry teaching and learning on electrolyte non-electrolyte unit. This model allows students to carry out learning activities in situations where there are two or more people who are trying to learn a chemistry concept together (Shibley Jr & Zimmaro, 2002). The situation provides several advantages, learning members can gain mutual connection of topics learned with real phenomena, so learning becomes more meaningful (Yoruk, Morgil & Secken, 2010). Furthermore, the cooperation among students in discussing the content will increase the students' learning motivation (Tran, 2019).

In applying the STSE in chemistry teaching and learning, students participated in all activities by bringing the knowledge they have, i.e. knowledge about nature, environment and technology that facilitates people's daily lives. The collaborative learning based STSE consists of 5 phases, which are (1) invitation; (2) exploration; (3) solution; (4) application; and (5) strengthen the chemistry concept. In order to facilitate their learning activities, students directed to be able to explain the concepts learned in school to their environment, motivation is needed, because learning motivation influences students' scientific conceptions to be assimilated into pre-existing knowledge structures (Bar, et. al., 2016).

The first phase of collaborative learning based STSE is invitation phase, which facilitating students to develop interpretation skill on a phenomena in daily life. In this phase, students collaborate in a small group, consists of 3 – 4 students, to explore and interpret the issue in daily life related to electrolyte non-electrolyte unit. This activity implied that students giving more attention to solve daily problems toward science (Chanapimuk, Sawangmek & Nangngam, 2018).

The next phase of collaborative learning based STSE is the exploration phase and followed by solution phase. Learning chemistry using collaborative learning based STSE, makes the learning materials, especially students' worksheet, of electrolyte non-electrolyte unit not only focused with the concepts, but also the application of the concepts in STSE issues. In collaborative learning, students' learning motivation can be observed from their active participation in learning process (Priyambodo, 2016). Students' enthusiasm for learning shows good motivation to learn, because STSE's learning vision based on the phenomenon of science is the main element, making learning activities more interesting (Lee & Erdogan, 2007).

The fourth phase of collaborative learning based STSE is the application phase. In this phase, students were developed an analytical thinking by constructing the chemistry concept to solve the problems given by the teacher. Students also discuss the causes and the effects of an issue to the environment and also the society within their group. Collaborative learning based STSE was contributed to a meaningful learning in chemistry teaching and learning (Pedretti, 2003) As a comparison, in the control group the teacher only delivering the electrolyte non-electrolyte unit without giving the application with real world problems. Therefore, the students on control group considering chemistry lesson meaningless for society.

The final phase of STSE is the strengthen concept phase. In this phase, the teacher was giving an opportunity for the students in making inference to draw decision towards the issues. STSE learning could help student to retain in gaining content knowledge and discern the relevant with the context of the issues (Chowdhury, 2016).

Despite, the collaborative learning based STSE approach is able to foster student interest in chemistry learning, does not mean that scientific learning approach isn't better. Some factors that influence the results of the students learning motivation are the role of teachers in providing extrinsic encouragement and the role of students in solving problems provided by teachers. Does the teacher only give assignments and students are asked to fulfill the teacher wishes, or to provides further why students must completing learning activities (Blote, Streller & Hofsein, 2013). In addition of the learning strategies designed that affect student learning motivation, students' learning motivation can be built by giving students the

opportunity to gain control of their own learning. However, students' understanding of the relationship between learning efforts, achievements, and the benefits of learning they do need to be emphasized by the teacher (Kizilgunes, Tekkaya & Sungur, 2009). Once again, this study is limited on the data that obtained from the school that have high categories, the number of teachers and learning facilities as adequate, as well as the acquisition of an average national student score of 76.72 (Puspendik Kemdikbud, 2019). Further research is needed to verify the consistency and accuracy of the findings through the various research methods, so that research results can be generalized.

5. Conclusion

Considering the results of this research, it can be concluded that the collaborative learning based STSE can be used as an alternative method in fostering students' learning motivation, since there was a significant different between students' learning motivation in experimental and control groups.

Acknowledgement

The researcher is grateful for the support from the LPPM Universitas Negeri Yogyakarta that supported the research grant through DIPA UNY 2020.

References

[1]Akcay, B. & Akcay, H. (2015) Effectiveness of Science-Techology-Society (STS) instruction on student understanding of the nature of science and attitude toward science, International Journal of Education in Mathematics, Science and Technology, 3(1), 37-45.

[2]Austin, A. C., Hammond, N. B., Barrows, N., Gould, D. L., & Gould, I. R. (2018). Relating motivation and student outcomes in general organic chemistry. Chemistry Education Research and Practice, 19(1), 331-341.

[3]Bar, V., Azaiza, E., Azaiza, D., & Shirtz, A. S. (2016). Teaching Electrolysis Using STSE Method, Multidisciplinary Approach. World Journal of Education Researvch, 3(2), 321-342.

[4]Blote, C., Streller, S. & Hofstein, A. (2013.) How to motivate students and raise their interest in chemistry education Sesne Publishers

[5]Brandriet, A. R., & Bretz, S. L. (2014). Measuring meta-ignorance through the lens of confidence: Examining students' redox misconceptions about oxidation numbers, charge, and electron transfer. Chemistry Education Research and Practice, 15(4), 729-746.

[6]Chanapimuk, K., Sawangmek, S., & Nangngam, P. (2018). Using science, technology, society, and environment (STSE) approach to improve the scientific literacy of grade 11 students in plant growth and development. Journal of Science Learning, 2(1), 14-20.

[7]Chowdhury, M. A. (2016). The Integration of Science-Technology-Society/Science-Technology-Society-Environment and Socio-Scientific-Issues for Effective Science Education and Science Teaching. Electronic Journal of Science Education, 20(5), 19-38.

[8]Firmino, E. S., Sampaio, C. G., Nojosa, A. C. B. & Saldanha, G. C. B. (2019). STSE approach in high school chemistry: A brief review in national literature. Acta Sientiace Canaos, 21(3), 196-212.

[9]Garba, S. A., Byabazaire, Y. & Busthami, A. H. (2015). Toward the use of 21st century teaching-learning approaches: The trend of development in Malaysian schools within the context of Asia Pacific, International Journal of Educational Technology, 10(4), 72-79.

[10]Gathong, S., & Chamrat, S. (2019). The implementation of science, technology and society environment (STSE)-based learning for developing pre-service general science teachers' understanding of the nature of science by empirical evidence. Jurnal Pendidikan IPA Indonesia, 8(3), 354-360.

[11]Gauci, S. A., Dantas, A. M., Williams, D. A., & Kemm, R. E. (2009). Promoting student-centered active learning in lectures with a personal response system. Advances in Physiology Education, 33(1), 60-71.

[12]Glynn, S. M., Taasoobshirazi, G. & Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience major. Journal of Research in Science Teaching, 46(2), 127-146.

[13]Gottfried, A. E., Fleming, J. S. & Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study, Journal of Educational Psychology, 93(1), 3-13.

[14]Kizilgunes, B., Tekkaya, C. & Sungur, S. (2009). Modeling the relations among students' epistemological beliefs, otivation, learning approach and achievement. The Journal of Educational Research, 102(4), 243-256.

[15]Lee, L. & Erdogan, I. (2007). The effect of science technology society teaching on students' attitude toward science and certain aspects of creativity, International Journal of Science Education, 29(11) 1315-1327

[16]Lepper, M. R., Corpu, J. H. & Iyengar, S. S. (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates, Journal of Educational Psychology, 97(2), 184-196.

[17]Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F. F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. Journal of Educational Psychology, 108(3), 314

[18]NSTA (National Science Teacher Association). (1990). Science and math events: Connecting and competing Washington: NSTA p.192

[19]Özmen, H., & Alipaşa, A. Y. A. S. (2003). Students' difficulties in understanding of the conservation of matter in open and closed system chemical reactions. Chemistry Education Research and Practice, 4(3), 279-290.

[20]Pedretti, E. (2003). Teaching science, technology, society and environment (STSE) education. In The role of moral reasoning on socioscientific issues and discourse in science education (pp. 219-239). Springer, Dordrecht.

[21]Priyambodo, E. (2016). The Effectiveness of Collaborative Academic Online Based Learning Through Students' Self-Regulated Learning. Journal of Education and Learning, 10(4), 405-410.

[22]Pusat Penilaian Pendidikan Kementerian Pendidikan dan Kebudayaan Republik Indonesia: Laporan hasil ujian nasional 2019 SMA Negeri Kabupaten Sleman Provinsi Daerah Istimewa Yogyakarta https://hasilun.puspendik.kemdikbud.go.id/#2019!sma!capaian!04&04&999!T&T&T&N&1&!3!&

[23]Salvadó, Z., Casanoves, M., & Novo, M. (2013). Building bridges between biotech and society through STSE education. The Journal of Deliberative Mechanisms in Science, 2(1), 62-74.

[24]Schunk, D. H., Pintrich, P. R. & Meece, J. L. (2008). Motivation in education: Theory, research, and application. Ohio: Pearson.

[25]Sharaabi-Naor, Y., Kesner, M. & Shwartz, Y. (2014). Enhancing students' motivation to learn chemistry, Journal of Education, 2(2), 100-123.

[26]Shibley Jr, I. A., & Zimmaro, D. M. (2002). The influence of collaborative learning on student attitudes and performance in an introductory chemistry laboratory. Journal of Chemical Education, 79(6), 745.

[27]Taylor, T. N. (2001). Using constructivism to inform tertiary chemistry pedagogy. Chemistry Education Research and Practice, 2(3), 215-226.

[28]Tran, V. D. (2019). Does Cooperative Learning Increase Students' Motivation in Learning?. International Journal of Higher Education, 8(5), 12-20.

[29]Upadhya, P., & Lynch, R. (2019). A Comparative study of student motivation and academic achievement in grade 8 science under teacher-centered and student-centered instructional methods at Triamudomsuksa Pattanakarn School, Thailand. Scholar: Human Sciences, 11(1), 108-118.

[30]Wright, G. B. (2011). Student-centered learning in higher education. International Journal of Teaching and Learning in Higher Education, 23(1), 92-97.

[31]Yoruk, N., Morgil, I. & Secken, N. (2010). The effects of science, technology, society,

environment (STSE) interactions on teaching chemistry. Natural Science, 2(17), 1417-1424.

[32]Zoller, U. (1990). Students' misunderstandings and misconceptions in college freshman chemistry (general and organic). Journal of Research in Science Teaching, 27(10), 1053-1065.