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RESEARCH ARTICLE

APPLICATION OF LEARNING MODEL SCIENCE TECHNOLOGY SOCIETY (STS) IN IMPROVING MASTERY OF CHEMISTRY LEARNING OF COLLOID SYSTEM CONCEPTS IN SECONDARY SCHOOL

***Rafiuddin and Maisara**

Chemistry Education Program, Universitas Halu Oleo, Kendari

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ABSTRACT

This research aimed to improve student mastery of chemistry learning of the colloidal system by integrating Science Technology Society (STS). A pretest-posttest control group design was used which involved three year XI secondary school classes. The students engaged with different issues using STS principles. They used different sources from the environment which linked with the Colloid concept. A concept map was used as the research instrument along with multiple-choice test items. The results show that (1) there are three fundamental concepts in the Colloidal Systems in the curricula consisting of 12,50% abstract concepts with concrete examples, 4,17% of concepts that state the nature of properties, and 70,83% concepts that describe the process; (2) the comparison of the highest mean of posttest score of 93,89 for the experimental class with the Tyndall effect concept, meanwhile, for the control class with a score of 82 in Colloid concept. The lowest score for the experimental class was 68,89 in the Liofil Sol concept while in the control class it was 24,58 in the Gel Concept; (3) the comparison of the average score of N-gain for increasing mastery of the concept by the experimental class students was higher than for the control class with an average score of N-Gain 0,78> 0,53 which entered the high category for the experimental class while the control class in the category of being; (4) The model of science learning technology communityimproved students' mastery of the concept for high ability groups with th 63> 2,91, the ability of being with th 37,15> 1,72, low ability to th 9,8> 6,3 on the subject of Colloid Systems, which was reinforced by the results of different test t 'intergroup ability of students showed no difference, with t' high ability and being t'h 0,259<1,753,high and low ability t'h0,270 <6,313 and the low-skilled and t'h0,342 <6,313; (5) the response of students qualify as well to the application of science learning model community technology with a percentage of 77,9% while the response of students qualify as sufficient to direct learning model with a percentage of 36,84%.

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INTRODUCTION

Curriculum, as a description of students’ learning, should empowered students. The curriculum should seek both meaningful learning experiences and empowering learning outcomes for students within a range of societal demands and government policies. Therefore, the curriculum is a key driver of economic, political, social and cultural questions about the aims, purposes, content and processes of education (UNESCO, 2016). In the context of science education, students should be helped to develop the understanding and habits of thinking needed to solve life’s problems Mundilarto, 2002 in Atika, 2018). Chemistry, as part of science, should help students to develop their knowledge and skills to make chemistry more relevant to their lives and society.

****Corresponding author:*** **Rafiuddin and Maisara,**
Chemistry Education Program, Universitas Halu Oleo, Kendari

The chemistry subject involves three representations of macroscopic, microscopic and symbolic representation (Treagust, 2015), therefore, chemistry learning is required to convey the concept of contextualization or the phenomenon of everyday life (Westbroek, 2005; King, 2012)in order to make learning more meaningful. The research conducted by experts, including Wiseman (1981), Nakhleh (1992), Kirkwood and Symington (1996) as cited by Rusmansyah and Yudha Irhasyuarna (2001) suggests that many students can easily learn other subjects, but have difficulty in understanding the concepts and principles of chemistry. Chemistry learning is considered difficult for students, especially the material colloidal system, therefore the process for learning chemistry should involve innovative teaching approaches. The colloidal topic is relevant to students’ daily lives, therefore, to understand the colloidal material, student mastery of concepts need to be improved (Pudjiadi, 2005). One teaching model that can be used to learn the colloidal topic is the Science

Technology Society (STS) which uses resources from the environment. Relevant research from Eady (2013) states that teachers can connect the concepts of science that have been delivered in the classroom with problems that occur in society and in the student's daily life. In addition Diana (2012) states that there is a strong relationship between education and technology. Tools and technologies, in their broadest sense, are important drivers of education, though their development is rarely driven by education. Writing, one of the most important tools in the development of human civilization, was not invented for education but for commerce. Pasnik and Hupert (2016) state that that technology can model approaches to learning, ways of interacting with peers, adults or children, and most importantly, it can use visual and audio information, enabling adults and children to engage in meaningful discourse about science and the world around them.This approach is reinforced by Yager (2009) regarding the "comparison of students in learning STS along with guided learning inquiry in class. Research into STS shows that students develop 1) understanding of basic concepts, 2) science process skills, 3) creativity, and 4) positive attitudes about their knowledge by learning through STS. In support, Sirhan (2007)states that students prefer problems that challenge real-world contexts that have clear relevance to everyday life. If the problem is interesting, meaningful, challenging, and involves students in the learning process they will be more motivated to learn.

Vygotsky's and Bandura's theories, as reportedby Eady (2013), provide teachers with guidance on how to use technology in teaching and learning. Learning occurs within a social environment – we learn by modelling and interacting with others. Technology can be used to facilitate social interaction and communication among learners in class, within a school, between schools and around the world. For this reason, the researcher applied the community technology science learning model, because the STS model can link between the material in the classroom and those in the environment, so that with this the students can improve their mastery of the concept. In the context of this research, the teacher still tends to use teaching to develop students' concept mastery. The data shows that the average score for chemistry in year XI is below the minimum passing grade (Kriteria Ketuntasan Minimal-KKM), therefore, the researcher looked at the influence of the application of the STS model on the learning of the Colloidal System. The research was not only to help achieve the KKM, but to explore different teaching approaches since students in a traditional classroom are less active because of the teaching methods such as memorizing and recording material provided by the teacher. The STS uses environmental issues so that students can develop mastery of the concepts. By learning through everyday life expereinces. Thompson, *et all*, (2001) states that the STS research has to serve society and engage students in the issues of real life situations. Therefore, this study will explore the effect of this model on student learning.

RESEARCH METHODS

The research focused on "how can the application of STS improve the mastery of concepts of the colloidal system for year XI students in secondary school?". In particular, the following research questions were stated:

1.What are the characteristics of the concept of the colloidal system?

2. How does mastery of the concept by students in the control class using a direct teaching model compare with the STS model cohort?

3. What is the difference between the effectiveness of increasing the mastery concept of students using the STS model compared with the control class using the direct teaching model?

The participants in the study consisted of three parallel year XI chemistry students at a secondary school enrolled in the 2016/2017 academic year. A *random sampling technique* (Creswell, 2012) was used which determined class XI IPA_1 as the experimental class and class XI IPA_3 as the control class. The experimental class was taught by STS while the control class was taught using a direct teaching model.

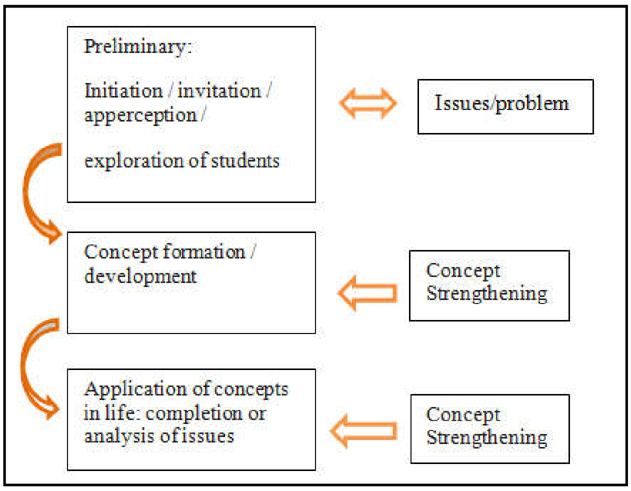


Figure 1. STS learning flow (Poedjiadi, 2005)

The posttest was given to assess student mastery of the concepts. Data analysis was performed using statistical techniques of descriptive statistics and inferential statistics.

RESULTS AND DISCUSSION

A. Characteristics of Colloid System Concepts

A curricula analysis was conducted to understand the characteristics of Colloid concept.

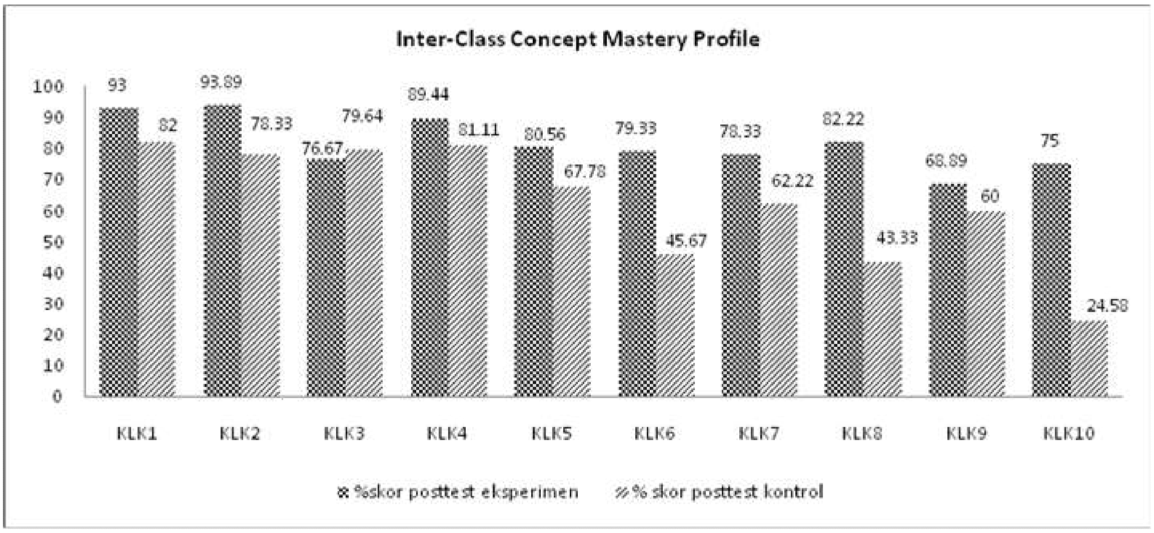
Based on Table 1 above, the concept characteristics of the subject matter of the colloidal system is more dominant in the concept that states the process with a percentage of 70.83%, thus the colloidal system material is suitable for use with the practicum method or the STS model. Fry, *et all.* (2008)states that arousing the interest of students is important to reassure them and to help them see that the material to be covered will be useful in solving problems that exist in the surrounding environment.

Concept Mastery Profile

Based on the mean score and the mean percentage of *posttest* scores for each group of the concept of each question in the experimental and control classes, it can be described the comparison concept of mastery of the concept. The description of the comparison profile of mastery of concepts between the experimental class and the control class can be seen in Figure 2

Table 1. Characteristics of Concepts in Colloidal System Material

No	Concept Type	Label Concept	Number	Percentage
1	Abstract Concept with Concrete Examples	Colloid, Tyndall Effect, Coagulation	3	12.50%
2	Concept that natures of Properties	Brown Motion	1	4.17%
4	Concept that describes the process	Electrophoresis, dispersion, condensation, aerosol, sol, emulsion, foam, gel, foam, solid emulsion, dispersion phase, dispersion medium, mechanics, peptization, transfer reaction, hydrolysis, redox reaction	17	70.83%



KLK= Kelompok Label Konsep (Label Concept Group)

Figure 2. Concept of Mastery of Concepts Between Classes

Based on Figure 2 of the results of the percentage of concept mastery profiles from the average score *posttest* between the experimental class and control class on the concept label each question can be concluded that the experimental class is higher than the control class because it can be seen from the highest percentage of Label Concept Group (KLK) in the experimental class, which is 93.89% in KLK2 (Tyndall effect), high percentage KLK2 (Tyndall Effect) that is 93.89%, because students are more likely to master the concept of Colloidal System material which is related to the sub-material of colloidal properties, especially the material of Tyndall Effect, while the highest percentage of control class is 82% in KLK1 (Colloid), the high percentage of KLK1 (Colloid) is 82% due to the sub-material understanding of colloid, the material still tends to be easy so the students can immediately understand even though the teacher uses the direct learning model while the lowest percentage of the averagescore in *posttest* the experimental class is 68.89% found in KLK9 (sol liofil), the low percentage of KLK9 (sol liofil) is 68.89% because in the liofil sol material it tends to be difficult so students still find it difficult to understand the material, while in the percentage control class that is 24.58% found in KLK10 (Gel), the low percentage of KLK10 (Gel) is 24.58% because the students' control class is not using practicum methods so students tend to find it difficult to understand gel material.

The percentage profile of KLK3 concept mastery (Colloid Type) in the control class was higher than in the experimental class due to the material being explained so that the students could understand it, therefore, the STS learning model did not significantly influence the colloid type material. The percentage of the mastery profile of the KLK4 (Gel) concept showed a significant difference between the experimental class and the control class due to the instructional methodology used.

The experimental class used a practicum method where students experienced the learning process directly while the control class used a direct, lecture style learning model where students did not understand the material. The use of active methodologies (Kirkwood *et al*. 2016), reflective exercises and writings (Burr *et al*. 2016; Constable 2010), seem to support mastery by focusing on learning from experience in conjunction with reflective practice, discussion with others and dialogue with the trainer. In this way learners are encouraged, through reflection and comparison with the contexts of their professional practice, to question the sense of 'self in practice', and to develop their own professional identity (Bruno and Bracco 2016).

Index Data *N-Gain*

Profile mastery of concepts in KLK3 (Colloid Type), based on the scores *N-Gainin* were higher in the control class compared to the experimental class, because in this sub-subject the control class students were better understood than the experimental class students, by the STS learning model is not very influential on the sub-material, it does not affect the STS model because this material can be used without practicum methods. The concept mastery profile in KLK10 (Gel) showed a significant difference between the experimental class and the control class. In the experimental class pre-test students did not know what the Gel was, nor did the control class. But after the application of each associated learning model, the experimental class found it easier to understand because it saw and experienced direct learning while the control class only heard from a teacher explanation, therefore, for the post-testthe experimental class better understood the sub-material compared to the control class. As Hulu (in Maimunah, 2017) opinioned, the process and the frequency of enjoyable learning can increase motivation for students so that the quality learning

Tabel 2. Normality Test Result

Statistics	N-Gain Experiment	N-Gain Control	Pre-test Experiment	Post-test Experiment	Pre-test Control	Post-test Controls
Average	0.785	0.535	13.60	81.45	15.85	60.40
	0.063	0.185	5.394	5,689	6,738	17,282
Asymp. Sig. (2-tailed)	0.972	0.570	0.656	0.356	0.656	0.767

Table 3. Homogeneity Test Results

Statistics	Class Experiment	Control Class
N	20	20
Mean Pretest	13.60	15.85
ScoreAverage Post-test	81.45	60.40
F_{count}	1.51	1.05
F_{table}	2.18	2.18
Conclusion	Homogeneous	Homogens

outcomes improves. Salila, and Musrin (2014) claimed that when the experimental class is given a learning treatment with SETS learning model in which there are discussion, demonstration, and practicum activities, and control class with conventional learning model in which there is also practicum activities.

Effectiveness of STS Model on Mastery of Students Concept

Hypothesis test analysis was carried out using a t-test analysis technique, before hypothesis testing with a t-test analysis prerequisite test. Prerequisite tests include a normality test to determine data distribution, and the variance homogeneity test. These prerequisite tests include:

Normality

Test Data distribution normality was carried out on the data of the experimental group and control group learning outcomes. Table 4.1 below shows the results of the analysis of the normality test of two variables. Parts that need attention and *Asymp. Sig*. (*2-tailed*). If the value of *Asymp. Sig*. (*2-tailed*) is more than or equal to 0.05, the data is normally distributed, if *Asymp. Sig*. (*2-tailed*) is less than 0.05, the data is not normally distributed. The normality test was carried out on the control class and Experimental Class as follows:

A normality test was conducted to find out whether the data obtained were from a normal distribution or not. The results of the normality test can be briefly seen in Table 2 From table 2 can be concluded that the data has a normal distribution of normality.

Homogeneity Test: Homogeneity was tested by the *One Way Anova* with significance level was 0.05. The calculation of homogeneity test results can be seen in Table 3. From Table 4.3 shows that F_{counts} <F_{table} both experimental and control classes because it can be seen from the value of 1.51 <2.18 for the experimental class, while for the control class value is 1.05 <2.18, it can be concluded that the experimental class data as well as the homogeneous control class.

Different test: After prerequisite data analysis, the data from the research sample shows a normal and homogeneous distribution, therefore, testing the data was continued by hypothesis testing.

In this study, hypothesis testing was done using the "t" test with the testing criteria: p value> alpha 5%, so Ho is accepted, $H_{1\ is}$ rejected and vice versa. In this study hypotheses were tested based on the level of student ability between the experimental class and the control class. Based on data *N-gain* from both classes, the t test was carried out. The results of the calculation of the t test were carried out using the SPSS application. The differences in the increase in mastery of concepts for each group of students' abilities between the experimental class and the control class can be seen in Table 4.4 below. In accordance with the criteria for testing the hypothesis where if t_{count}> t_{table} or p value <α 5% then $H_{0\ is}$ rejected and vice versa then by Table 4.4, the data from samples taken with a significant level of 5% can be seen that t_p = 5.72> 1.68 or p value = 0.000 <0.05 so that it can be said $H_{0\ is}$ rejected and $H_{1\ is}$ accepted, with the acceptance of H_1 there is a difference in students' concept mastery based on the index *N-gain* because the difference in the scores *pretest* to *posttest* in the experimental class is higher than the increase in scores from *pretest* to *posttest* in the control class, the increase in *pretest* to *posttest.* experimental class because the experimental class uses the STS model with the practicum method by which students experience the learning process directly while the control class uses the direct learning model using the lecture method so that students tend to be less active in the learning process, so the increase in scores pre-test to post-test does not increase. The difference in the increase in the adoption of this concept is also strengthened by research conducted by Iskandar (1997) which shows that the application of the STS approach is considered suitable for integrating dominant concepts, skills, processes, creativity, attitudes, values, applications and interrelations among the fields of study in learning and the scientific approach. In addition, Mandra (2012) also reported that there is a difference in understanding the concept of chemistry towards the application of the community technology science learning model (STS) for the better.

The difference in the increase in the adoption of this concept is strengthened also by the research, (Mandra, 2012) that in this study there were differences in understanding the concept of chemistry on the application of the community technology science learning model (STS). Bennett J, Hogarth S, Lubben F (2003) also show that the in-depth review to the five studies were included in the in-depth review has shown the following: first, there is some evidence to support the claim that context-based approaches motivate pupils in their science lessons. Second, is there is evidence to support the claim that such approaches also foster more positive attitudes to science generally, and third, there is evidence to support the claim that context-based approaches do not adversely affect pupils' understanding of scientific ideas.

Conclusion

Based on the results of the study and previous discussion, it can be concluded that the characteristics of the subject of colloid can be divided into three types of concepts including 12.50% of abstract concepts with concrete examples, 4.17% of concepts which state the nature of properties, and 70.83% of concepts that state process. The results are consistent with what has been previously reported (Akcay, 2015). The results of the study show that an ICPD program integrated with STS instruction helps students to understand the nature of science concepts and engenders and more positive attitude towards science, science class and science teachers than traditional textbook-oriented classrooms. The results are consistent with what has been reported previously (Yager, 1996; Liu, 1992; Rubba & Wiesenmayer, 1990; Lochhead & Yager, 1996 in Akcay, 2015). However, the results of this study are quite different from the Mackinnu study (Mackinnu, 1991 in Akcay, 2015) where it was reported that no statistically significant differences occurred in either pre-test or post-test scores on student understanding of the nature of science. Profile mastery of concepts from the application of community technology science learning models to students of class XI in the topic of the colloidal system has an average comparison of the scores *posttest* highest and lowest for the experimental class and control class, the comparison for the score *posttest* highest in the experimental class is 93.89 on the Tyndall Effect concept label while the control class is 82 on the label of the concept of colloid. while the score comparison *posttest* lowest in the experimental class was 68.89 on the liofil sol concept label while the control class was 24.58 on the gel concept label. Mastery of the concept of class XI studentsincreased after instruction using the community technology science learning model and the direct learning model with the average *N-Gain* experimental class being 0.78 in the high category, while the average *N-Gain* for thecontrol class was 0.53 in the medium category. The community technology science learning model effectively increased the mastery of the concept of high-ability group students with t_h 63> 2.91, moderate ability with t_h 37.15> 1.72, low ability with t_h 9.8> 6.3 on the subject of colloid systems. This is reinforced by the results of different test t 'between groups of students ability showed no difference, with t' high ability and being t_h 0.259 <1.753, high capability and low t'_h 0,270 <6.313 and the ability of low- and t_h 0.342 <6.313. In other words, the three groups have a significant increase in ability, an outcome supported by Yörük, Nuray (2010) that shows teaching science subjects through STSE links enable sstudents to understand that the topics they learn are not independent from real life and could lead them to learn about occupations related to real world fields.

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