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Integrated Traditional Learning Model (TLM) or Cooperative (CLM) with the Motivational Level towards Understanding the Concept and Scientific Reasoning Skills in Electrochemistry for Form 4 Students among 3 Schools in LMS Area

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Abstract:*This paper will discuss about the performance of 96 of 16-yrs old students in learning Electrochemistry. The samples were chosen from 3 schools around LMS area in Perak, Malaysia. Two Learning Model, Traditional and Cooperative were chosen. Three Tests were conducted Pre- and Post were Logical Thinking (LT), Scientific Reasoning Skills (SRS) and Electrochemistry Final Exam (EFE). The T&L sessions were conducted out from formal class period. The contents of the syllabus were based on Malaysia Ministry of Education. The analysis of data using One-Way ANOVA Test is valid to Learning Model (LM), Motivational Level (ML). Results showed p > 0.05 showed that Factor (F) had no significant influence on DV. One-Way Repeated ANOVA Test was conducted for evaluating Pre- and Post-Tests. Research findings showed there are improvements in LT, SRS and EFE after treatments were given.*

Keywords: *Electrochemistry Form 4; Logical Thinking (LT); Motivational Level (ML); Scientific Reasoning Skills (SRS); Traditional, Cooperative Learning Model (TLM, CLM)*

I. INTRODUCTION

Traditional Learning Model (TLM) promotes teacher just give lectures, while students hearing. There are no discussions. While Cooperative Learning Model (CLM) is different. Students will discuss, asking, answer and give their opinions. They are active learners. But, CLM need more time compared to TLM. Time management is so important during discussion due to not every members will discipline them. Sometimes, the discussion will be out of the topic, Electrochemistry. The T & L sessions in learning Electrochemistry with assimilation of Logical Thinking (LT) and Scientific Reasoning Skills (SRS). There are 12 LT and 10 SRS questions were built related to EFE. Students were trained to give scientific explanations based on Electrochemistry concepts they were learnt. While the LT function to facilitate their memory based on contextual learning, the ideas related to Electrochemistry they can see in everyday life.

II. EXPERIMENTAL

2.1 Respondents

Initially, about 150 of students were chosen from 3 schools around LMS, Perak, Malaysia to participate in this programme. But then, only 96 of 16 yrs old respondents were left. The schools involve are SMK Bukit Jana, SMK Dr. Burhanuddin, and SMK Kamunting. There are about 4-5 members in a CLM group each.

2.2 Research Hypotheses

H_1: Learning Model (LM) influences the students' performance in Post-LT, -SRS and –EFE.
H_2: Motivational Level (ML) influences the students' performance in Post-LT, -SRS and –EFE.
H_3: Pre-Tests influence the students' performance in Post-LT, -SRS and –EFE.

2.3 Learning Model (LM)

2 LM were chosen, traditional and cooperative. The TLM was conducted in large group. The respondents in CLM were divided into 4-5 small groups during T & L.

2.4 Tests

3 tests were conducted – LT, SRS and EFE as presented in Section 3.1, Table 1. Pre-Tests were given initially. Then, students involved into T & L. After finished, the Post-Tests will be given. In this study, students must have multiple intelligences, consist of mathematical logical, language, visual and space, interpersonal and intrapersonal. Another test for cooperative groups is Groups' Compatibility (GC) Test. 25 questions related to their peers were given. Students got less 75 % will be change to other groups. Motivational Level (ML) Test is also given. The Motivational Level assessed the 5 dimensions of students' motivation in learning Electrochemistry through: (1) self-efficacy, (2) scientific learning value, (3) goal, (4) epistemological beliefs

and (5) test anxiety. The 5-point Likert-type scale, from (5) strongly agree to (1) strongly disagree were used to get their opinions in 35 questions [1].

2.5 T&L Sessions

The T&L sessions were done in 4 sessions for 4 weeks. Every week, there was at least once T&L session with the presence of researchers. The activities inside this programme are: (1) lecture session about Electrochemistry overally, (2) Electrolytic and Galvanic Cells – Components and How They Works?, (3) Electrochemical Series and Games, and lastly training how to give answer with scientific explanations by using (4) Worksheet about Electrochemistry. All the T&L sessions were done for both TLM and CLM but there was an extra for CLM, which is training session for Group Instructors (GI). All the GI were prepared with Electrochemistry Manual Programmes while others not.

2.6 Data Analyzing

The data analysing is using IBM SPSS Statistics Software 20.0. The One Way ANOVA or Repeated Tests were used to analyze the data. The normality and homogeneity of regression slopes were first determined before the One Way ANOVA and ANOVA Repeated Measurements is conducted. While the significant value (p) for the Levene or Brown-Forsythe Tests also must be > 0.05 [2]. So, the data were normally distributed and homogeneity of variances has been met.

III. RESULTS AND DISCUSSION

3.1 Preparation of Tests

The components of tests questions as in Table 1.

Table 1. The Questions in LT and SRS Tests related to Electrochemistry concepts.

No.	Electrochemistry Concepts	No. of Questions in LT	No. of Questions in SRS
1	Same charges repel	1	1
2	Same magnet polar repel	2	2
3	Dissolving rate = Deposition rate	3	3
4	Stirring effect	4	4
5	Ion affinity towards electrodes	5	5
6	Effects of level differences in Electrochemical Series (ES)	6	6
7	Anion will be attracted to cathode	7	2
8	Galvanic cell do not have electrical sources	8	6
9	Electrolysis of Compounds	9	-
10	Electrical conductivity	10	9
11	Inert vs. active	11	9
12	Negative terminal for Galvanic Cell	12	9
13	Neutralisation of ions	-	7, 8
14	Oxidation number	-	10

3.1.1 The Electrochemistry Concepts: Inert vs. Active Substances/ Negative Terminal for Galvanic Cell.

The examples for LT and SRS questions as follow:

a) LT Question No. 11:

Based on Figure 1, which object can be dissolved in water?

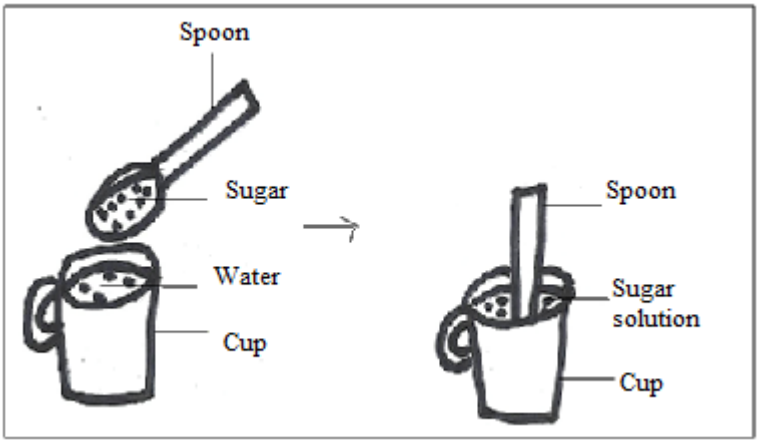

Figure 1. Sugar dissolves in water.

b) SRS Question No. 9.

100 g of sugar each in crystal or cube form were dissolved in water with uniform stirring rate as in Figure 2. At 15 s, all sugar crystal was dissolved completely in Beaker B. While all sugar cubes were dissolved completely at 35 s. Which forms of sugar dissolved completely faster?

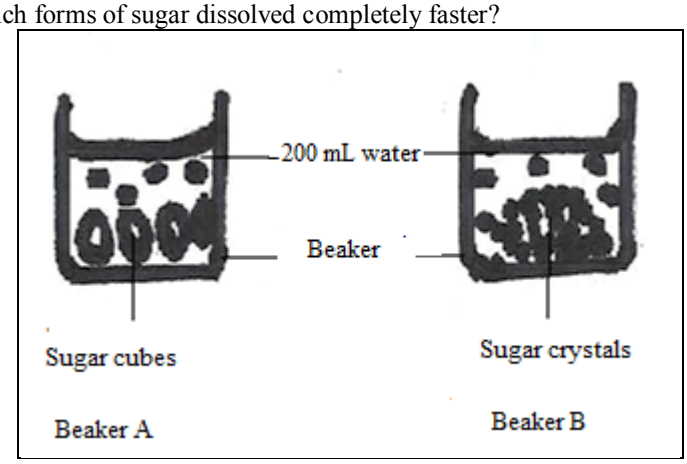

Figure 2. Sugar in crystal and cubes form dissolved in 200 mL of water each.

All the questions in EFE are in Higher Order Thinking Skills (HOTS), so need them to predict and give scientific explanations. The use of analogies based on something occurred in their everyday life which related to Electrochemistry concepts will make sense to their learning [3].

By using analogy, students need to assimilate and accommodate their existing conceptions or personal experiences into other situations in Post-EFE. They need to give scientific explanation based on SRS that were given [4, 5]. 2 from 7 strategies supposed by Cordellichio and Field (1997) in training brain are finding similarity when using analogies and analysing opinions by sharing ideas [6].

3.2 One-Way ANOVA Test

Table 2. The results for Levene and Brown-Forsythe Tests using LM as IV.

DV	Levene Test				Brown-Forsythe Test			
	Levene Statistic	df1	df2	Sig.	Brown-Forsythe Statistic	df1	df2	Sig.
Post-LT	2.111	1	94	0.150	0.245	1	70.261	0.622
Post-SRS	10.588	1	94	0.002	2.804	1	87.486	0.098
Post-EFE	2.728	1	94	0.102	0.295	1	90.473	0.588

The Levene Test for Post-SRS gave $p < 0.05$, indicated that the homogeneity of variances had been violated. While using Brown-Forsythe Test, all the $p > 0.05$ for Post-LT, -SRS and –EFE indicated that all the homogeneity of variances had been met (as can be seen in Table 2).

Table 3. Descriptive Statistics for students' scores on Post-LT, -SRS, and –EFE using TLM and CLM.

DV	TLM			CLM		
	Mean	Std. Deviation	N	Mean	Std. Deviation	N
Post-LT	17.91	3.872	43	17.57	2.576	53
Post-SRS	15.16	3.477	43	16.75	5.744	53
Post-EFE	12.74	4.243	43	13.34	6.439	53

The descriptive statistics of students' scores on Post-LT, -SRS, and –EFE as can be seen in Table 3. The mean scores become more less from Post-LT to –EFE for both TLM and CLM. This indicated that although students' LT is more, their performance in SRS and EFE are still not increased. The Electrochemistry Form 4 Manual is given only to Groups' Instructors. Students' said they did not have enough time to take note during T & L sessions. Researchers have given them Electrochemistry slides during the first T & L, but that not enough. They did not know how to elaborate the slides outside the class. So, all depend on their GI. If they were very willing to share, so each member in their groups will be success. Their opinion was I should give them a copy of manual for every member. But this will consume much money.

Table 4. The results for Levene and Brown-Forsythe Tests using ML as IV.

DV	Levene Test				Brown-Forsythe Test			
	Levene Statistic	df1	df2	Sig.	Brown-Forsythe Statistic	df1	df2	Sig.
Post-LT	0.217	1	94	0.642	1.043	1	12.975	0.326
Post-SRS	0.369	1	94	0.545	0.265	1	14.607	0.614
Post-EFE	1.409	1	94	0.238	0.125	1	18.141	0.728

From Table 4, all the $p > 0.05$, indicated that the homogeneity of variances had been met for all collected data. The Levene and Brown-Forsythe Tests are insensitive to normality, so they are right choice to determine homogeneity of variances compared to Bartlett's Test [7].

Interpersonal intelligence by Howard Gardner (1995) listed 4 good members group behavior such as: (1) listening with empathy, (2) help and built, (3) respect others time and space and (4) positive enhancements. These aspects important to guarantee social skills in that group are done effectively [6]. But in reality, this is hard to achieve. Not every member is good, sometimes they have opposite personality as borders in social skills, plus they are still youngsters. Social skills in groups also can create positive climate such as enhance ML and produce learning competition.

Table 5. Descriptive Statistics for students' scores on Post-LT, -SRS, and –EFE using different ML.

Post-Test	HML (151 – 200)			LML (101 – 150)		
	Mean	Std. Deviation	N	Mean	Std. Deviation	N
LT	17.84	3.221	11	16.82	3.093	85
SRS	15.96	5.030	11	16.64	3.931	85
EFE	13.02	5.771	11	13.45	3.475	85

The Post-SRS score mean value for LML is higher than HML, 16.64 compared to 15.96 although the difference in sample size is large 85 and 11 respectively [$F(1, 94) = 0.18$, $p > 0.05$] (can be seen in Table 5).

Table 6. One Way ANOVA results for LM as IV.

Test		Sum of Squares	df	Mean Square	F	Sig.
Post-LT	Between Groups	2.759	1	2.759	.266	.607
	Within Groups	974.647	94	10.369		
	Total	977.406	95			
Post-SRS	Between Groups	60.162	1	60.162	2.543	.114
	Within Groups	2223.672	94	23.656		
	Total	2283.833	95			
Post-EFE	Between Groups	8.417	1	8.417	.272	.603
	Within Groups	2912.073	94	30.979		
	Total	2920.490	95			

Problem aroused when some male respondents quit during half-way of this program occurred. This is due to their absence during programme because of rain and time constrain. School programme so packed during this period. Transportation is also the main factor their absence. This due to this programme can only be done in the evening, after school session finished. They need to go back home first to take lunch. This program had started with limitation budget. Lodewyk K. R. et al. [8] cited that the environment in education must be setting well to increase self-efficacy so that anxiety also will be decreased.

$F(1, 94) = 0.266$, $p = 0.607$ for Post-LT, $F(1,94) = 2.543$, $p = 0.114$ for Post-SRS, and $F(1,94) = 0.272$, $p = 0.603$ for Post-EFE (as can be seen in Table 6). All the p-value for those Post-Tests was above 0.05 showed that insignificant differences among LM towards DV scores.

Students got most scores for Post-LT when using both TLM and CLM (as can be seen in Table 3). Mostly, the $p > 0.05$, so Factor (F) had insignificant influences on Dependant Variable (DV) (as can be seen in Table 6).

Table 7. One Way ANOVA results for ML as IV.

Test		Sum of Squares	df	Mean Square	F	Sig.
Post-LT	Between Groups	10.076	1	10.076	.979	.325
	Within Groups	967.330	94	10.291		
	Total	977.406	95			
Post-SRS	Between Groups	4.394	1	4.394	.181	.671
	Within Groups	2279.440	94	24.249		
	Total	2283.833	95			
Post-EFE	Between Groups	1.809	1	1.809	.058	.810
	Within Groups	2918.680	94	31.050		
	Total	2920.490	95			

F(1, 94) = 0.979, p = 0.325 for Post-LT, F(1,94) = 0.181, p = 0.671 for Post-SRS, and F(1,94) = 0.058, p = 0.810 for Post-EFE (as can be seen in Table 7). All the p-value for those Post-Tests was above 0.05 showed that insignificant influence of ML towards those tests (as can be seen in Table 7). During this programme, students were given prize as positive enhancements to encourage their ML. In CLM groups, there must be at least one High Motivational Level (HML) member to create positive climate during discussions.

3.3 One-Way Repeated ANOVA Test

Table 8. Descriptive Statistics Pre- and Post-Tests for LT, SRS and EFE using One Way ANOVA Repeated.

Test	Mean	Std. Deviation	N
Pre-LT	17.35	2.186	96
Post-LT	17.72	3.208	96
Pre-SRS	14.95	4.125	96
Post-SRS	16.04	4.903	96
Pre-EFE	8.72	4.192	96
Post-EFE	13.07	5.545	96

Table 8 shows the descriptive statistics for Pre- or Post- LT, -SRS and –EFE gave meaning that the students' LT, and SRS is higher than –EFE gave impact that their SRS is higher than conceptual understanding. The –SRS Tests is to evaluate students' SRS while EFE function to examine their conceptual understanding about Electrochemistry. But their mean differences were little. Electrochemistry Form 4 is a complicated topic to be learnt, because many topics in this chapter including in the future topics, such as Oxidation and Reduction, Chapter 3 Form 5 Syllabus. Students still cannot memorize well how to write ionic equations. Also, electrolyte that can be used such as Acids and Bases in Chapter 7 and 8, Form 4 Syllabus. In order to answer well in Electrochemistry, they must understand very well in those topics first [9].

Table 9. Mauchly's Test of Sphericity for measuring LT, SRS and EFE.

Within Subjects Effect	Measure	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
						Greenhouse-Geisser	Huynh-Feldt	Lower-bound
PrePost	LT	1.000	0.000	0	.	1.000	1.000	1.000
	SRS	1.000	0.000	0	.	1.000	1.000	1.000
	EFE	1.000	0.000	0	.	1.000	1.000	1.000
Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.[a]								
a. Design: Intercept Within Subjects Design: PrePost								
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.								

Table 10. Univariate Tests for measuring LT, SRS and EFE.

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.
PrePost	LT	Sphericity Assumed	6.380	1	6.380	1.131	0.290
		Greenhouse-Geisser	6.380	1.000	6.380	1.131	0.290
		Huynh-Feldt	6.380	1.000	6.380	1.131	0.290
		Lower-bound	6.380	1.000	6.380	1.131	0.290
	SRS	Sphericity Assumed	57.422	1	57.422	5.606	.020
		Greenhouse-Geisser	57.422	1.000	57.422	5.606	.020
		Huynh-Feldt	57.422	1.000	57.422	5.606	.020
		Lower-bound	57.422	1.000	57.422	5.606	.020
	EFE	Sphericity Assumed	910.021	1	910.021	35.992	.000
		Greenhouse-Geisser	910.021	1.000	910.021	35.992	.000
		Huynh-Feldt	910.021	1.000	910.021	35.992	.000
		Lower-bound	910.021	1.000	910.021	35.992	.000
Error (PrePost)	LT	Sphericity Assumed	536.120	95	5.643		
		Greenhouse-Geisser	536.120	95.000	5.643		
		Huynh-Feldt	536.120	95.000	5.643		
		Lower-bound	536.120	95.000	5.643		
	SRS	Sphericity Assumed	973.078	95	10.243		
		Greenhouse-Geisser	973.078	95.000	10.243		
		Huynh-Feldt	973.078	95.000	10.243		
		Lower-bound	973.078	95.000	10.243		
	EFE	Sphericity Assumed	2401.979	95	25.284		
		Greenhouse-Geisser	2401.979	95.000	25.284		
		Huynh-Feldt	2401.979	95.000	25.284		
		Lower-bound	2401.979	95.000	25.284		

There are differences of SRS among pre- and post- groups [$F(1.00, 95.00) = 5.61$, $p < 0.05$]. New df1 = 1.00, New df2 = 95.00. Pre- and post-EFE [$F(1.00, 95.00) = 35.99$, $p < 0.05$] also show there were increased in scores after treatments were given (as can be seen in Table 10 and 11, Figure 3, 4 and 5).

Table 11. Tests of Within-Subjects Contrasts for measuring LT, SRS and EFE.

Source	Measure	PrePost	Type III Sum of Squares	df	Mean Square	F	Sig.
PrePost	LT	Level 1 vs. Level 2	12.760	1	12.760	1.131	0.290
	SRS	Level 1 vs. Level 2	114.844	1	114.844	5.606	.020
	EFE	Level 1 vs. Level 2	1820.042	1	1820.042	35.992	.000
Error (PrePost)	LT	Level 1 vs. Level 2	1072.240	95	11.287		
	SRS	Level 1 vs. Level 2	1946.156	95	20.486		
	EFE	Level 1 vs. Level 2	4803.958	95	50.568		

Abraham et al. (1992), Skelly and Hall (1993), Baker and Piburn (1997), and Sanger and Greenbowe (1999) discovered that the environment, language, classroom materials, textbooks, students' attitudes to the subject matter, incompatibility of teaching approaches with students' learning styles caused alternative conceptions [10]. Some abstract Electrochemistry concepts are presented into concrete form in Post-SRS and Post-LT Tests to make them sense for learning. This also can be done with the help of diagrams.

The profile plots for pre- and post-LT, -SRS and –EFE as can be seen in Figure 3, 4 and 5.

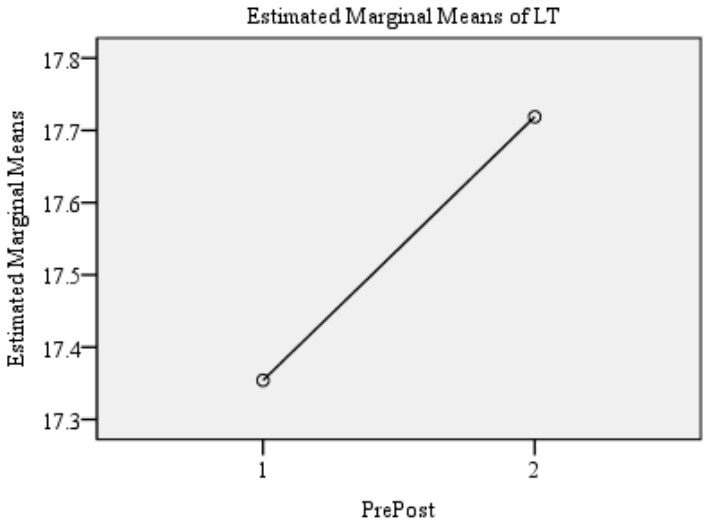

Figure 3. Estimated Marginal Means (EMS) for Pre- and Post-LT.

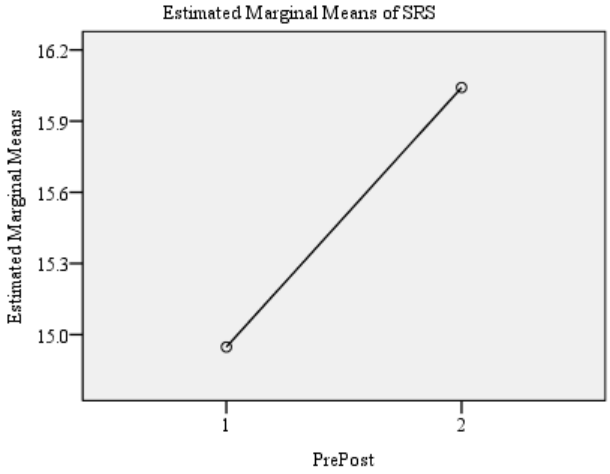

Figure 4. Estimated Marginal Means (EMS) for Pre- and Post-SRS.

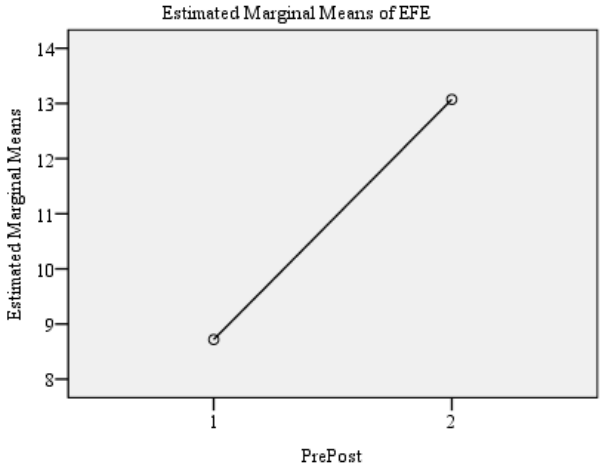

Figure 5. EMS for Pre- and Post-EFE.

IV. Conclusion

Mostly, LM and ML did not give significant influence on Post-LT, -SRS, and –EFE. But, there are increasing in Post-LT, -SRS and –EFE scores compared to their Pre-Tests showing higher performances after treatments were given. LM and ML have no significant influence to Post-LT, -SRS and –EFE. For the next research, the focus is to facilitate the contents of Electrochemistry Form 4 Manual through diagrams or languages with adding more exercise. Each student will be provided with this manual to let them study alone (T & L Aids centered) freely with no time constraints. The answers for each exercise will be spread through email. By using this way, hopefully all the limitations in this study will be solved.

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