

Innovation in Lewis Structure Learning through Lesson Study: Teacher Learning/Collaboration and Student Engagement

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Abstract –

There are twenty-two STPM Chemistry students in Pusat Tingkatan 6 Victoria Institution, Kuala Lumpur. In their first chemistry test on 22 September 2021, these students only achieved an average grade of 2.47, which is lower than the targeted grade 3.00. It is found that these students could not apply the chemistry concepts in answering the test questions, especially questions related to Lewis Structure in chemical bonding. Lewis structure is a representation showing the sharing of valence shell electrons between atoms in a molecule or ion. This study was carried out to increase students' ability to draw Lewis structure by making the invisible electrons visible to them. A total of twenty students from S1BM, S1BFM and S1FM and three chemistry teachers were involved. The students were divided in groups of 2 to 3 students per group. Each group was given 100 pieces of 10¢ coins and cards with symbol of elements in Periodic Table. In the group activity, each 10¢ coin representing an electron. Students arranged the 10¢ coins around the symbol of elements to build "Duit Structure" of selected molecules/ions. Preliminary survey was done through pre-test before the intervention. The students were exposed to the "Duit Structure" for a week and the results showed that 90% students have improved significantly in their ability to draw Lewis Structure. By collaborating in this study, teachers found that they have created new knowledge in teaching practice and an increase in students' engagement.

Keywords: Lesson Study, Chemistry, Lewis Structure, STPM, Victoria Institution

1 Introduction

A ²Lewis Structure is a very simplified representation of the valence shell electrons in a molecule. It is used to show how the electrons are arranged around individual atoms in a molecule. Electrons are shown as "dots" or as a line between the two atoms in a single covalent bond. The goal is to obtain the "best" electron configuration, *i.e.* the octet rule and formal charges need to be satisfied.

Electrons are minute sub atomic particles which cannot be seen with our naked eyes or even under a microscope. Therefore it is invisible to human eyes. As a result, chemistry teachers are facing great challenge to teach the topic of Lewis Structure and other related sub topics.

In this study, chemistry teachers are to make the invisible, visible. The most unique teaching aids selected was the 10¢ coins, the most common item a student use in their daily life. These 10¢ coins are used to represent electrons to construct “Duit Structure” under the constructionist learning environment created in the chemistry classroom.

Constructionist learning involves students drawing their own conclusions through creative experimentation and the making of social objects. The constructionist teacher takes on a mediational role rather than adopting an instructional role. Teaching "at" students is replaced by assisting them to understand—and help one another to understand—problems in a hands-on way. The teacher's role is not to be a lecturer but a facilitator who coaches students to attaining their own goals. Further, constructionism suggested that learning can happen most effectively when people are active in making tangible objects in the real world.

In conjunction with that, an analysis of ³STPM 2013 - 2021 Chemistry (Paper 1) was carried out to find out if Lewis Structure is a popular sub-topic. It was found that Lewis Structure related questions carries 4 to 12 marks out of 60 marks in STPM Chemistry (Paper 1). Understanding and mastering the skill to draw Lewis Structure is therefore very important to ensure a student to excel in STPM Chemistry Paper 1.

1.1 Reflection and Problem Statement

There are twenty-two lower six Chemistry students in Pusat Tingkatan Enam (PTE) Victoria Institution, Kuala Lumpur. These students have been attending the online classes since the start of Semester 1 in Week 23 (26 July 2021) due to the Covid-19 pandemic. The performance of the students in their first chemistry test (22 September 2021) only achieved an average grade of 2.47, which is very much lower than the targeted grade (3.00). It is found that the students could not apply the chemistry concepts in

answering the test questions. They were also not aware of the strategies that may help them in the learning of chemistry. It was a challenge for the chemistry teachers to remedy their performance.

When the students were allowed to attend lesson in school in Week 36, we, chemistry teachers decided to incorporate constructionist learning technique using suitable teaching aids into the teaching of Lewis Structure and critical thinking skills in the instruction design. Thus, this study was conducted to investigate the following question:

“Does application of constructionist learning using 10¢ coins in building “Duit Structure” enhance the ability of students in drawing Lewis Structure?”

1.2 Focus Of The Study

The focus of this study is to introduce an active learning style because students must do more than just listen in order to learn effectively. In our observation, this group of students were being locked down for too long. They were following their Form 5 studies through pdpr since March 2020 at home until SPM examination in March 2021. They then continue Form 6 (Semester 1) in July 2021.

Many of these students have difficulty in finding main ideas from informative text and using these main ideas to organize the information to be learned so that a useful memory is constructed – one that guides flexible recall for answering questions or explaining ideas.

The activity of building “Duit Structure” can be easily implemented by the students in group during the chemistry lesson to develop their thinking skills and metacognition. It helps to engage the students in higher-order thinking tasks like analysis, synthesis, and evaluation. More importantly, it makes the invisible visible to students during the group activity.

1.3 Objectives of The Study

1.3.1 General Objective

This study attempts to investigate whether the constructionist learning method using suitable teaching aids can improve the achievements of the students in STPM chemistry (Paper 1) 2022.

1.3.2 Specific Objectives

To increase students' ability to draw Lewis Structures for 25 molecules/ions which were found in the 2013 – 2021 STPM Chemistry (Paper 1).

2 Methodology

The research design uses lesson study model as shown in **Fig. 1**.

Fig. 1 : Lesson study Model

The Chemistry Team teachers had several meetings to investigate the current situation and problems before setting of the goal. The ultimate goal is to achieve grade point average (GPA) of 3.00 for Chemistry STPM 2022. Hence, few discussions were conducted between group members and decision was made that we need to increase the ability of students in drawing Lewis Structure. To achieve this, the implementation of an action study “Learning Lewis Structure through Duit structure” was introduced.

2.1 Target Group

A total of 20 students from S1BM, S1FM and S1BFM in PTE Victoria Institution, Kuala Lumpur were selected as the target group for the study. The targeted group consist of 8 male students and 12 female students.

2.2 Instrument

The instrument used was a printed list of chemical formula for twenty-five (25) molecules / ions which were found in the 2013 – 2021 STPM Chemistry (Paper 1) as shown in **Fig 2**. It was used as pre-test and post-test instrument to measure achievement of the targeted students.

Year	Question	Molecules/ Ions	Mark	Remark
2013	Q2	HF, H ₂ O, NH ₃	1	
2013	Q18	O ₃ , I ₃ ⁻	9	VSEPR, shapes
2014	Q6	CO ₃ ²⁻ , NO ₃ ⁻	1	
2014	Q19(a)(ii)	ClF ₂ ⁺ , SF ₄	6	VSEPR, shapes
2015	Q16(a)	HCN	4	Hybridisation of C, σ and π bonds
2016	Q5	BeCl ₂ , BF ₃ , CO ₃ ²⁻ , SO ₄ ²⁻	1	

2016	Q19(a)	CONH, CN ⁻	5	Compare C-N bond length
2017	Q18	NH ₄ ⁺ , NH ₂ ⁻	8	VSEPR, shapes
2018	Q5	NO ₃ ⁻ , ClO ₄ ⁻ , I ₃ ⁻	1	
2018	Q16	NH ₄ ⁺ , NO ₃ ⁻	4	Shape
2019	Q18	SO ₂ , SO ₃ , SO ₃ ²⁻	12	VSEPR, shapes
2020	Q4	CHCl ₃ , NOCl, PCl ₅ , SO ₂	1	
2020	Q18	NH ₄ ⁺ , NO ₃ ⁻	8	Hybridisation, geometry Bond angle,
2021	Q17	H ₂ SO ₄	8	Orbital diagram of O and S, hybridisation

Fig 2 : The Instrument

2.3 Procedure

The procedure of action study can be summarized as a flow chart below:



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2.4 The Intervention

The instructions applied to incorporate “Duit Structure” into the classroom practice was shown in the in **Fig. 3** .

Step	Instruction
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1	Students form group of 2 or 3 students and a group leader is selected. Group leader to get the following items for group activity : · 100 pieces of 10¢ coins · 10 cards · One Mahjong paper · Markers · Masking tape
2	Teacher shared a list of 25 molecules/ions.
3	Students to construct “Duit Structure” that conform to the octet rule and formal charges using: · Each 10¢ coin to represent one electron · Card with symbol of elements
4	Each group to take picture of “Duit Structure” and draw Lewis structure of the molecules/ions on mahjong paper.
5	Step 3 and 4 is repeated until Lewis Structure of all(25) molecules/ions are done.

Fig. 3 : Group activity in classroom

2.5 Data Collection

A pre-test was conducted to the target group to identify the ability of the targeted students to draw Lewis structures. The items for the pre-test were taken from STPM Chemistry Paper 1 examination questions.

The pretest consists of a list of 25 molecules/ions. Students were given 20 minutes to draw as many structures as possible from the list. Each correct structure drawn by student was given one mark. Total full mark for the test was 25 marks.

Within the same week, an 80-minute lesson was conducted to implement the intervention. A posttest was then conducted in the following week using the same items as the pre-test.

3 Findings/Results and Discussion

3.1 Analysis of The Pre-test and Post-test Result

Table 1 shows the comparison of the pre-test and post-test results in cycle 1.

No	Students	Score (/25)		Effect (+ / - / No effect)
		Pre test	Post test	
1	Student 1	5	19	14

2	Student 2	7	19	12
3	Student 3	4	15	11
4	Student 4	8	19	11
5	Student 5	11	22	11
6	Student 6	6	16	10
7	Student 7	12	21	9
8	Student 8	15	24	9
9	Student 9	0	8	8
1 0	Student 10	9	17	8
1 1	Student 11	7	14	7
1 2	Student 12	14	20	6
1 3	Student 13	3	8	5
1 4	Student 14	8	13	5
1 5	Student 15	11	15	4

1 6	Student 16	3	5	2
1 7	Student 17	11	12	1
1 8	Student 18	10	11	1
1 9	Student 19	10	10	0
2 0	Student 20	6	4	-2
	Average mean	8	15	

Table 1 : Pre-test and Post-test scores

The average mean score increases from 8/25 to 15/25 after first intervention within one week. The result of study revealed that mean achievement score of students using “Duit Structure” was almost doubled. The results of pretest and posttest also shows eighteen students (90%) have positive effect and achieved higher score after the intervention. However, there is a student showing no effect and another student showing negative effect.

The effect of the intervention on individual student can be observed clearly through a histogram in **Fig. 4** below.

Fig. 4 Effect of Intervention

4 Conclusion

Based on results collected in lesson study cycle 1, teachers are confident that application of constructionist learning using 10¢ coins in building “Duit Structure” has significantly enhance the ability of students in drawing Lewis Structure.

In conclusion, the constructionist learning which emphasizing active learning is an excellent way to improve learning experience in any classroom because it stimulates their minds and students will be better equipped to make curricular connections and develop in-depth knowledge and understanding of chemistry concepts.

At the moment this report was written, the targeted group of students has shown in their STPM 2022 (Semester 1) result with 90% of passing rate and GPA 2.70. The two students who did not passed the Semester 1 examination was the also the two students who did not show positive effect of the intervention. However, there are 8 students (40%) who have achieved GPA above 3.00. There is still a gap of 0.30 to work on the 12 students who scored below 3.00 in Semester 1.

The result of this study has motivated the teachers to conduct lesson study cycle 2, 3, 4 and more on which may be based on many other chemistry sub topics. Another thought of the team is to work on the two students who are still weak in drawing Lewis structure.

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