UNIVERSITI PUTRA MALAYSIA

EFFECTS OF BLENDED LEARNING THROUGH LAB-ROTATION AND FLIPPED CLASSROOM MODEL ON ACADEMIC PERFORMANCE AND SELF-REGULATED LEARNING AMONG FORM FOUR CHEMISTRY STUDENTS

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By

MOHD ARIFFUDDIN BIN ABDUL AZIZ

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

January 2022

DEDICATION

This dissertation is dedicated to my mum, Rosmini Bt Marjuki and my dad, Abdul Aziz Bin Mohamed Thani. My siblings, Azrini Hanim and Azrini Hanani with love and gratitude. Thank you for always listening, giving me the best advice and brightening each day throughout my PhD journey with your smiles.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Blended learning is known as combination between the online learning and face-to-face learning. In this study, there were two blended learning models had been tested namely as lab-rotation and flipped classroom. Blended learning through lab-rotation (BLLR) model required the students to learn by rotation between the computer laboratory for online learning session and classroom for face-to-face learning. For the blended learning through flipped classroom (BLFC) model, the students are required to learn earlier at home using the online learning platform then, discuss the teaching task during the face-to-face learning session at the school. The failure of Malaysian students to achieve a minimum average score in PISA and TIMSS for four consecutive years causes them to have difficulty in learning chemistry, especially for electrochemistry topics, when they are in form four level (students at the age of 16). Students have several misconceptions about electrochemistry, which they must understand at the three different levels of modes as stated by Johnstone's Chemistry Triangle (1993) model. The researcher implements the BLLR model and BLFC model to overcome the problems.

The study aimed to investigate the effects of blended learning through lab-rotation model and flipped classroom model on the academic performance and self-regulated learning (SRL) among the form four chemistry students. The research design used in this study is mix-method explanatory design with a quantitative (ANOVA and ANCOVA) followed by qualitative (semi-structured interview) to give comprehensive understanding of the findings. For the quantitative part, quasi-experimental featuring a non-randomized control group with pre-test and post-test which included a retention test was used in this study. At the end of the treatment, the researcher had conducted a semi-structured interviews for collecting qualitative data. The total respondents involved in this study were 92 Form Four chemistry students. The respondents were random assigned into three groups, namely as the BLLR model group (Experimental 1), BLFC group (Experimental 2) and F2F traditional learning method group (Control). The online

learning platform chosen in this study is Google Classroom. The instruments used in this study were academic performance test, which based on Electrochemistry's topic in 'Sijil Pelajaran Malaysia' (SPM), SRL questionnaires and a semi-structured interview questions to explore students' perceptions on BLLR model, BLFC model and F2F traditional learning method.

The findings of the study revealed that BLLR model, BLFC model and F2F traditional learning method had improved students' academic performance and SRL among the respondents. There was significant difference at the post-test level for academic performance among the three groups ($F(2, 88) = 118.979$ and a significant level of .000 ($p < .05$), BLLR model showed the highest scores followed by BLFC model and F2F traditional learning method. For the SRL, there was significant difference at the post-test level among the three groups ($F(2, 88) = 48.648$ and a significant level of .000 ($p < .05$), BLFC model showed the highest scores followed by BLLR model and F2F traditional learning. At the retention test level, for academic performance test there was significant different among the three groups ($F(2, 88) = 294.797$ and a significant level of .000 ($p < .05$), BLFC model showed the highest scores followed by BLLR model and F2F traditional learning. For SRL at the retention test level, there was significant different among the three groups ($F(2, 88) = 29.083$ and a significant level of .000 ($p < .05$), BLFC model showed the highest scores followed by BLLR model and F2F traditional learning method. The findings in qualitative part through the semi-structured interviews showed that the respondents in the BLLR model and BLFC model agreed that these methods were effective, interesting and convenient to improve their academic performance and SRL.

The findings revealed that the BLLR model had a potential to improve academic performance at the post-test level while the BLFC model at the retention level. BLFC model showed the effective method of instruction in enhancing SRL and retained it as well. These findings suggest that BLFC model is the most effective instruction to improve academic performance and SRL compared to BLLR and F2F traditional learning method. This instructional method provides an alternative way in teaching and learning by implementing constructivism theory through the Google Classroom online learning platform to enhance the academic performance and SRL among the secondary school students. Moreover, during the global pandemic COVID-19, policymakers and school principals should implement the BLLR and BLFC models to support students in teaching and learning, as well as in continuing the Science Technology Engineering and Mathematics (STEM) program at the tertiary level.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN PEMBELAJARAN TERADUN SECARA MODEL PUTARAN MAKMAL DAN KELAS BERBALIK KE ATAS PENCAPAIAN AKADEMIK DAN PEMBELAJARAN ATURAN KENDIRI DALAM KALANGAN PELAJAR KIMIA TINGKATAN EMPAT

Oleh

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Pembelajaran teradun dikenali sebagai kombinasi antara pembelajaran di atas talian dan pembelajaran secara sua-muka. Dalam kajian ini, terdapat dua model pembelajaran teradun yang diuji iaitu putaran makmal dan kelas berbalik. Pembelajaran teradun melalui model putaran makmal (BLLR) memerlukan murid untuk belajar secara putaran antara makmal komputer untuk pembelajaran di atas talian dan di kelas untuk pembelajaran secara sua-muka. Pembelajaran teradun melalui model kelas berbalik (BLFC) pula, murid belajar secara sendiri lebih awal di rumah menggunakan pelantar pembelajaran di atas talian, kemudian berbincang tugasan yang diberi semasa sesi pembelajaran secara sua-muka di sekolah. Kegagalan pelajar Malaysia mencapai markah purata minimum di dalam PISA dan TIMSS selama empat tahun berturut-turut menyebabkan mereka menghadapi kesukaran untuk mempelajari mata pelajaran Kimia terutamanya bagi topik Elektrokimia apabila berada di tingkatan empat (pelajar yang berumur 16 tahun). Pelajar mengalami beberapa miskonsepsi bagi topik elektrokimia apabila mereka perlu memahami tiga tahap penguasaan yang berbeza seperti yang dinyatakan di dalam model Segitiga Kimia Johnstone (1993). Pengkaji melaksanakan model pembelajaran teradun putaran makmal dan kelas berbalik bagi menangani permasalahan ini.

Kajian ini bertujuan menyiasat kesan pembelajaran teradun bagi model putaran makmal dan kelas berbalik ke atas pencapaian akademik dan Pembelajaran Aturan Kendiri (SRL) dalam kalangan murid Kimia tingkatan empat. Reka bentuk kajian yang digunakan adalah kaedah campuran penjelasan dengan kuantitatif (ANOVA dan ANCOVA) diikuti kualitatif (temu bual separa berstruktur) bagi mendapatkan kefahaman yang komprehensif. Pada bahagian kuantitatif, kuasi experimental yang melibatkan satu kumpulan kawalan bukan rawak yang melibatkan ujian pra-pasca serta ujian ketekalan

digunakan. Pada akhir rawatan, penyelidik telah melakukan temubual separa berstruktur untuk mengumpulkan data kualitatif. Jumlah responden yang terlibat dalam kajian ini adalah 92 orang murid Kimia tingkatan empat. Responden dipilih kepada tiga kumpulan secara rawak, iaitu kumpulan BLLR (Eksperimental 1), BLFC (Eksperimen 2) dan kumpulan kaedah pembelajaran tradisional secara sua-muka (Kawalan). Platform pembelajaran di atas talian yang dipilih dalam kajian ini ialah Google Classroom. Instrumen yang digunakan dalam kajian ini adalah ujian pencapaian akademik berdasarkan kepada soalan Topik Elektrokimia di dalam Sijil Pelajaran Malaysia (SPM), soal selidik SRL dan soalan temu bual untuk meneroka persepsi pelajar mengenai model BLLR, model BLFC dan kaedah pembelajaran tradisional sua-muka.

Hasil dapatan kajian menunjukkan model BLLR, model BLFC dan kaedah pembelajaran tradisional sua-muka telah meningkatkan pencapaian akademik dan SRL dalam kalangan responden. Terdapat perbezaan yang signifikan pada tahap ujian pasca untuk pencapaian akademik di antara ketiga-tiga kumpulan ($F (2, 88) = 118.979$ dan tahap signifikan .000 ($p < .05$), model BLLR menunjukkan skor yang tertinggi diikuti dengan model BLFC dan kaedah pembelajaran tradisional secara sua-muka. Bagi SRL, terdapat perbezaan yang signifikan pada tahap ujian pasca antara ketiga-tiga kumpulan ($F (2, 88) = 48.648$ dan tahap signifikan .000 ($p < .05$), model BLFC menunjukkan skor tertinggi diikuti dengan model BLLR dan pembelajaran tradisional sua-muka. Pada tahap ujian ketekalan, untuk ujian pencapaian akademik terdapat perbezaan yang signifikan antara ketiga-tiga kumpulan ($F (2, 88) = 294.797$ dan tahap signifikan .000 ($p < .05$), model BLFC menunjukkan skor tertinggi diikuti model BLLR dan pembelajaran tradisional sua-muka. Bagi SRL pada tahap ujian ketekalan, terdapat perbezaan yang signifikan antara ketiga-tiga kumpulan ($F (2, 88) = 29.083$ dan tahap signifikan .000 ($p < .05$), model BLFC menunjukkan skor tertinggi diikuti model BLLR dan kaedah pembelajaran tradisional sua-muka. Dapatan kualitatif melalui temu bual separa berstruktur menunjukkan bahawa responden dalam pembelajaran teradun model putaran makmal dan kelas berbalik bersetuju kaedah ini adalah efektif, menarik dan memudahkan untuk meningkatkan pencapaian akademik dan SRL mereka.

Hasil kajian menunjukkan model BLLR berpotensi untuk meningkatkan pencapaian akademik pada tahap ujian pasca manakala model BLFC pada tahap ujian ketekalan. Model BLFC menunjukkan kaedah pengajaran yang efektif untuk meningkatkan SRL dan pengekalannya. Dapatan ini mencadangkan model BLFC merupakan kaedah pengajaran yang paling efektif untuk meningkatkan pencapaian akademik dan SRL berbanding model BLLR dan kaedah pembelajaran tradisional secara sua-muka. Kaedah pengajaran ini menyediakan kaedah alternatif dalam pengajaran dan pembelajaran dengan menerapkan teori konstruktivisme melalui platform pembelajaran di atas talian Google Classroom untuk meningkatkan prestasi akademik dan pembelajaran aturan kendiri (SRL) dalam kalangan murid sekolah menengah. Selain itu, semasa pandemik global COVID-19, penggubal dasar dan pengetua sekolah harus melaksanakan model BLLR dan BLFC untuk menyokong pelajar dalam pengajaran dan pembelajaran, serta meneruskan program Sains Teknologi Kejuruteraan dan Matematik (STEM) di peringkat pengajian tinggi kelak.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation, Evaluation
BLFC	Blended Learning Through Flipped Classroom
BLLR	Blended Learning Through Lab-Rotation
CMI	Computer Mediated Instruction
CMS	Course Management Systems
EDA	Exploratory Data Analysis
F2F	Face-to-Face
GC	Google Classroom
GPS	Gred Purata Sekolah (Schools' Average Grade)
ICT	Information and Communication Technology
KBSM	Kurikulum Bersepadu Sekolah Menengah (Secondary School Integrated Curriculum)
KR-20	Kuder-Richardson 20
KSSM	Kurikulum Standard Sekolah Menengah (Secondary School Standard Curriculum)
LCMS	Learning Content Management Systems
LMS	Learning Management System
M	Mean
MOE	Ministry of Education
MOF	Ministry of Finance
OECD	Organization for Economic Co-operation and Development
PCM	Percentage Calculation Method
PISA	Programme for International Student Assessment
PT 3	Pentaksiran Tingkatan 3 (Form Three Assessment)

SD	Standard of Deviation
SPM	Sijil Pelajaran Malaysia (Malaysia Certificate of Education)
SPSS	Statistical Package for the Social Sciences
SRL	Self-Regulated Learning
TIMSS	Trends in International Mathematics and Science Study
USA	United States of America
VLE	Virtual Learning Environment

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter discusses the background of this study. It presents the problem statement, research objectives, research questions, research hypotheses, research significance, the scope and limitations of the study, and the operational definitions of terms used in this study.

1.2 Research Background

The education in Malaysia is ongoing with many efforts being put forward to developing the potential of individuals in a holistic and integrated manner. The Malaysian education aims to produce individuals who are physically balanced and harmonious based on their belief in God (Curriculum Development Division, MOE, 2018). Hence, the Malaysian Ministry of Education has developed Secondary School Integrated Curriculum (KBSM) and the latest is Secondary School Standard Curriculum (KSSM) based on the National Philosophy of Education to produce individuals with the values of intellectual, spiritual, emotional, and obedience to God. According to the National Science Education Philosophy, the science education in Malaysia aims to produce individuals who are competitive, dynamic, resilient, and able to master scientific knowledge and technological competency by nurturing science and technology into science subjects. In Malaysian secondary schools, there are three major science subjects offered to form four students, namely chemistry, physics, and biology. For these subjects, the curriculum was designed and developed by the Curriculum Development Division at the Malaysian Ministry of Education.

The chemistry curriculum for the secondary school level was designed to provide chances to students to acquire science knowledge and skills and develop thinking skills and thinking strategies to be applied in the real-life as well as cultivating students with noble values and patriotism. Furthermore, this curriculum can produce well-balanced citizens who would contribute to the harmony and prosperity of the nation. For the teaching and learning process of chemistry, the learning process is through thoughtful learning (Curriculum Development Division, MOE, 2018). Several learning approaches can be chosen through the thoughtful learning process, which encompasses inquiry, constructivism, contextual learning, and mastery learning.

The learning activities in science, especially for the chemistry subject, should be implemented with the elements that to promote higher-order thinking skills. Students

will be challenged with higher-order questions and problems during the instructional process. In addition, these skills are required by students when answering questions in Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) because the instruments of both tests required students to think analytically besides being a component tested in the chemistry subject (Lavonen & Laaksonen, 2009; Chong, 2019).

According to the Trends in International Mathematics and Science Study (TIMSS) reported in 2007, approximately 20% of Malaysian students failed to achieve a minimum level of achievement in science and mathematics compared with other subjects such as 5% in science and 7% in mathematics in 2003 (Ministry of Education, 2012). The achievement of TIMSS in Malaysia revealed that the average score for Malaysian students dropped drastically from 471 in 2007 to 426 in 2011. In 2015, the average score of Malaysian students in TIMSS increased drastically to 471 compared to 426 in 2011. In addition, the result in 2019 revealed a deterioration trend from 471 in 2015 to 460 (MOE, 2020). The average score for TIMSS is 500. Therefore, these results showed that the achievement of Malaysian students were less than 500 scores, which were considered as below the minimum score. Table 1.1 shows the achievement of science in TIMSS in Malaysia from 2007 until 2019.

Table 1.1: Result in Science in TIMSS in Malaysia from 2007 to 2019

TIMSS	Scores
2007	471
2011	426
2015	471
2019	460

According to the Programme for International Student's Assessment (PISA) in 2015, the Malaysian students' average score in science in 2009 was 422, 2012 was 420, and 2018 was 438, and these scores were below the OECD's average score (MOE, 2019). The average score for PISA is 500. The result revealed that the achievements of Malaysian students in the science subject were lower than the minimum average score set by TIMMS and PISA organisation. Table 1.2shows the result in science in PISA for Malaysian students from 2009 to 2018.

Table 1.2: Results in Science in PISA in Malaysia from 2009 to 2018

PISA	Scores
2009	422
2012	420
2015	-
2018	438

Chemistry is one of the branches of the science subject which requires students to think analytically. Hence, the academic performance of students for this subject should be highlighted to produce quality students as stated in the Malaysian Educational Philosophy. To achieve a good grade in chemistry, the instructions should be conducted by teachers who are technology savvy that can make the lessons more effective and interesting. According to Fung (2017), the role of technology is to facilitate students during the teaching and learning process. The technology can enhance students' performance by providing features that could ease students' understanding during the lesson.

The academic performance of students in chemistry is important to produce learners with exposure to innovation and creativity. These elements could be achieved by the effective instructions at the school through the support of educational technologies. To improve students' performance in chemistry, the misconception in this subject needs to be solved to ensure students can comprehend the subject. Electrochemistry is a difficult-to-score topic in the form four chemistry subject. Educators also ranked electrochemistry as one of the most difficult subjects to learn and teach (Akram, Surif, & Ali, 2014; lhan et al., 2016). According to Rokhim, Widarti, and Fajaroh (2020), electrochemistry is the study of the transformations between chemical energy and electricity and is divided into two main areas: electrolysis and the simple cell. The researcher focused on Form Four chemistry students as respondents in his study because the students will be taught an Electrochemistry topic at the beginning of the second term of school. Electrochemistry is the sixth chapter in the chemistry subject for Form Four chemistry students. Form 4 refers to secondary students at the age of 15 to 16 years old. In this study, all the respondents were Form 4 students with the age of 16 years old.

According to SMKPI (2019), in the annual report for chemistry's subject in the school understudy, the results of chemistry students' passed electrochemistry topics' tests in the year 2016 were 13%, 2017 was 11%, and 2018 was 12%. The result showed that the majority of students were unable to master the electrochemistry topic for three consecutive years. Table 1.3 shows the result in Electrochemistry Test for SMKPI.

Table 1.3: Result in Electrochemistry Test for SMKPI

Electrochemistry Test	Scores
2016	13%
2017	11%
2018	12%

Besides the academic performance in Electrochemistry, students are required to be responsible in their studies to achieve the target at the end of the examination. Students need to plan their learning strategies by choosing the best learning method, the best place to have their revision, time management, and questioning technique when facing difficulties. These elements are considered as students' self-regulated learning (SRL). Students are required to self-regulate their learning by studying electrochemistry topics because other topics in chemistry require them to do so. Electrochemistry can enhance

the SRL among the students due to the topic's requiring the students to plan their learning strategies to master the topic (Hermanns & Schmidt, 2019). As a result, the effects of studying the electrochemistry topic can enhance the SRL of students for further chemistry topics such as redox reactions, acids, and bases.

According to Zimmerman (2008), SRL comprises students who are equipped with metacognitive skills and able to plan their study, set goals, organize, self-monitor, self-evaluate, self-efficacy, and self-attributions besides actively participating in the learning processes. Self-regulated learning students can study effectively and independently as well as selecting suitable learning strategies to monitor their learning growth (Ambreen et al., 2016). Therefore, to achieve good achievement in academic performance, students should practice SRL. Previous studies showed that SRL is a vital component of students' academic performance, and the studies revealed the positive relationship between academic performance and using technology in learning (El-Senousy & Alquda, 2017; Hermanns & Schmidt, 2019; Permatasari & Laksono, 2019). Hence, the usage of technology in education could have positive effects on academic performance and SRL among students.

Recently, the developments of information communication and technology (ICT) had influenced the uses of technology in the education system. Technology can be used to support the instructional process conducted by the educator to learners. According to Feng et al. (2019), the usage of the internet in education is continuously expanding from time to time and has grown significantly for academic purposes. According to Malaysia Educational Blueprint 2013-2025 in the 7th shift, the Ministry of Education will leverage ICT to scale up the quality of learning in Malaysia by providing internet access and virtual learning environment. In response to this effort, teachers are urged to use technology during their lessons to enhance the teaching quality (MOE, 2012). Moreover, the usage of technology such as the internet, video, and computer in the science subject is a powerful tool that has great potential in enhancing the learning of science through animations and simulations (Curriculum Development Division, 2018).

Learning management system (LMS) is a platform for students and teachers to implement virtual learning environment (VLE) by combining the instructions with internet technology. Canul (2011) defined LMS as a web-based software that expands the teaching and learning process beyond the four walls of a classroom. As a result, the learning process could be conducted outside the classroom when the teacher provides teaching materials such as homework or notes using the VLE platform. LMS is also known as a web-based learning technology that needs internet access so that the learning process can be conducted anytime and anyplace conveniently. According to Thomas and Graham (2019), web-based learning or e-learning refers to the learning process that involves ICT where the learning process incorporates electronic media to enhance academic performance. Meanwhile, e-learning is one of the tools that can deliver and promote the interactive and independent learning experience for students at their own convenient time and places (Khan, 1997; Michailidou & Economides, 2003; Moore, & Kearsley, 1996; Raes et al., 2020). Hence, virtual learning provides independent learning, and students are required to practice self-regulated learning in the lesson provided by the teacher. As a result, the technology can be used as a joining force for

other institutions and societies to improve the education system (Bhasin, 2012; Alves, Miranda, & Morais, 2017).

The combination of online learning and face-to-face teaching process is known as blended learning. Blended learning is defined as a combination of computer-mediated instruction and face-to-face instructions (Graham, 2013; Cronje, 2020). Meanwhile, the process of teaching and learning which involved online technology learning and conventional face-to-face instructions is called blended learning that can enhance the academic performance among the learners (Rasheed, Kamsin, & Abdullah, 2020). Blended learning can provide more choices in instructions such as enhancing the learning process more effectively, extending the learning beyond the scope, economical in cost and time, transferring the knowledge faster, motivating students, realizing the learning objectives, and improving academic performance in chemistry. Previous studies have shown blended learning has the potential to improve academic performance in the chemistry subject among secondary school students (Hodges et al., 2018; Suleiman et al., 2017). Moreover, an instructional process that is conducted using blended learning focuses on student-centred learning. Students are required to learn by themselves through the online learning platform, and students can practice independent learning. According to Amanda et al. (2019), students become self-regulate when they access the online platform for learning purposes in blended learning, and they have to be engaged with the teaching materials provided by the teacher. Previous studies have revealed that blended learning has the potential to enhance self-regulated learning among chemistry students (Permatasari & Laksono, 2019; Hermanns & Schmidt, 2019; Sinaga, 2018). Therefore, students who are involved in blended learning are exposed to SRL skills during the teaching and learning process.

The effects of using technologies such as online learning and blended learning on SRL among students have been investigated by several authors (Lynch & Dembo, 2004; Dettori et al., 2014; Uz & Uzun, 2018). From these studies, it was revealed that blended learning is suited to practising SRL and even fostering its development due to collaborative activities and the fact that in such subjects or courses, metacognitive skills are often explicit or implicit objectives in the learning process. Uz and Uzun (2018) suggested that blended learning is essentially based on textual interaction, and this results in deeper reflection and involvement since the messages exchanged are recorded in the environment and students can access them at their convenience. Finally, in blended learning, students are usually free to choose where and when to study their subject. This gives the students a perception of freedom of choice, which is reported to develop self-regulation among them (Rais et al., 2019). Previous studies have revealed that blended learning has the potential to enhance SRL among chemistry students (Permatasari & Laksono, 2019; Hermanns & Schmidt, 2019; Sinaga, 2018).

There are several blended learning models which had been practiced in education such as rotation, flex, a la carte, and enriched virtual model (Michael & Heather, 2015). In this study, the researcher focused on the rotation model which encompasses lab rotation and flipped classroom as the sub-model. In lab rotation, students are required to rotate between attending the computer laboratory where students learn through online learning and the classroom where students are exposed to face-to-face learning with the teacher

and other students. For the flipped classroom model, students are required to learn using the online platform at home where the teacher has provided the teaching materials such as videos, notes, online quizzes, and online discussion earlier in the platform. Students will discuss the topic in detail during the face-to-face learning after completing the online learning part. The researcher chose the blended learning through lab-rotation (BLLR) model and the blended learning through flipped classroom (BLFC) model in his study because both of these models are more feasible among secondary school students compared to the other models (Hodges et al., 2018; Suleiman et al., 2017).

The BLLR model provides students with online learning and face-to-face learning in a rotational way. As a consequence, students are given a precious opportunity to experience by gaining the benefits of both online learning and face-to-face learning with several collaborative learning activities provided by the teacher (Christensen, Horn & Staker, 2013). In the BLLR model, students will rotate across differentiated learning stations on a fixed schedule or based on the teachers' discretion. Students' performance and achievement are closely monitored by the teacher in the classroom and through the online learning platform. McKnight (2016) revealed that the BLLR model has several benefits: i) Individualized learning, ii) Focused in a small group instruction, iii) Differentiated lessons to meet students' needs, iv) student choice and control (agency), v) Engaging, novelty, and peer interaction, and vi) Building life skills such as communication and supporting others.

The teaching methods that meet the quality of learning for students can achieve the goals and visions of the country. Therefore, teachers need to diversify their teaching methods because teachers act as agents of change in conveying information. For the flipped classroom approaches through the blended learning method, the teacher will provide the teaching materials such as video, notes, and quizzes in the online learning platform earlier to ensure students can study and revise by themselves at home before continuing with the discussion with their peers in the classroom. According to Hwang (2016), flipped classroom or inverted classroom is one of the student-centred learning where the teacher provides the teaching materials earlier before beginning the lesson in the classroom. When the students had learned the lesson at home earlier, there will be an active discussion in the classroom with the students' presentation and feedback from the teacher and students. The flipped classroom approach creates an active learning environment (Siegle, 2013; Fung, 2017). This method began to gain attention after being popularized by two school teachers, Bergmann and Samms (2009), through the use of video and online learning activities. The advantage of flipped classroom method is that it has two phases that allow students to learn independently and acquire knowledge through experience or guidance from teachers and friends (Lowell et al., 2013; Gilyazeva, Evgrafova, Sharypova, & Akhunzianova, 2020). The usage of technology in the implementation of flipped classroom methods does not only help teachers in teaching but also improve students' understanding of difficult subjects if used appropriately and systematically (Abu Bakar, 2013; Sojayapan & Khlaisang, 2020). Previous studies also revealed that the BLLR model and BLFC model had the potential to improve students' performance in academic (Tekane et al., 2020; Alsalhi, Eltahir, & Al-Qatawneh, 2019; Hinampas, Murillo, Tan, & Layosa, 2018). Moreover, previous studies claimed that the BLLR model and the BLFC model were effective for enhancing self-regulated learning

among students (Hewitt, Journell & Zilonka, 2014; El-Senousy & Alquda, 2017; Jdaitawi, 2019).

A technology such as an online learning platform in blended learning has features to enhance SRL among secondary school students learning electrochemistry topics. In the BLLR model, students learn electrochemistry using the online learning platform at the school's laboratory, followed by classroom learning. However, in the BLFC model, students will learn the electrochemistry topic using the online learning platform at home, followed by classroom learning at school. The online learning platform enables the students to learn independently through watching videos, answering online quizzes, completing online tasks, and participating in online learning discussions (Permatasari & Laksono, 2019). As stated in SRL, these elements can enhance the metacognitive skills, time management, persistence, help-seeking and environmental structuring among the students. The BLLR and BLFC models' combination of online and face-to-face learning allows students to easily comprehend and improve their academic performance in the Electrochemistry topic.

Regardless of the overview about the influence of BLLR model and BLFC model on academic performance and SRL, the evidence of its effectiveness in chemistry is still scarce. Therefore, this study investigated the effects of BLLR model and BLFC model on academic performance and SRL among the form four students in chemistry.

1.3 Problem Statement

The result of Malaysian students in Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) had caused some concerns on Malaysian educators. The scores of Malaysian students in both tests were below the average scores (500). According to MOE (2020) and TIMSS's Report 2019, the Malaysian students' achievements in TIMMS were below the average level for four consecutive years. Meanwhile in PISA, the Malaysian students' achievements were also below the minimum score (500) set by OECD for three consecutive years: 2009 (422), 2012 (420), and 2018 (438) (MOE, 2019). Hence, the Ministry of Education had taken action and implement strategies to improve our education system by focusing on mathematics and science through the reformation of the school curriculum. The skills and elements tested in PISA and TIMMS examination are related to problem-solving and high order thinking. Chemistry is one of the branches in the science subject which produced students with problem-solving and high order thinking skills. In the Malaysian context, chemistry is an elective subject for students in the science stream. This subject needs the students to think analytically to solve problems in the science process skills. The skills that students learned in chemistry is needed to become innovators for the future.

The students' achievements in chemistry are still below the average of passing marks, and most students can only achieve passing scores rather than excellent grades; some

students always failed for every chemistry's examination (Suleiman, Salaudeen, & Falode, 2017). According to Chu and Hong (2010), chemistry is one of the most difficult subjects among Malaysian students. The textbooks and public perceptions such as misunderstandings from friends and family members about the chemistry subject from various media caused misconception (Ratamun & Osman 2018). Electrochemistry is one of the titles in the form four chemistry subject, which is difficult to score among students. Form four chemistry students were chosen as respondents for the study because they will be introduced to electrochemistry at the beginning of the second school term. Electrochemistry is the sixth chapter in the chemistry curriculum for students in form four. Rokhim, Widarti, and Fajaroh (2020) stated that electrochemistry is a study of the changes between chemical energy and electricity, and it is divided into two main areas, namely electrolysis and simple cell. Electrochemistry was also considered one of the toughest topics to learn and teach by educators (Akram, Surif, & Ali 2014; İlhan et al., 2016). According to SMKPI (2020), in the annual report for chemistry subjects in the school understudy, the results of chemistry students' passed electrochemistry topics' tests in the year 2017 were 13%, in 2018 it was 11% and in 2019 it was 12%. The result showed that the majority of students were unable to master the topic. This indicates that the topic said should be focused in this study.

In understanding the concept of electrochemistry, students need to understand the three levels proposed by Johnstone (1993). At the macroscopic level, they need to understand the changes that occurred in electrolysis cells or chemical cells when the oxidation and reduction processes occurred in electrodes. The students also observe the changes like electrolyte color, the presence of air bubbles or precipitation, and the change in size or mass of the electrode. At the microscopic level, they need to imagine how the electron flow in the external circuit, the flow of ions in the electrolyte, and what happened to each electrode during the redox process in the cell. At the symbolic level, they should write and express the changes that occurred in the form of chemical equations. The findings by Bong and Lee (2016) showed that Malaysian students faced difficulties in understanding the electrochemistry concept in the three levels. Moreover, electrochemistry is considered one of the toughest chapters in the chemistry syllabus for secondary school students, and students usually find it difficult to master this chapter (Lee & Osman, 2012; Lee, 2013; Bong & Lee, 2016).

Previous studies have shown the frequent misconception in learning electrochemistry among students when they failed to differentiate the electrical conduction in the metal conductor and electrolytes (Garnett et al., 1995; Karsli & Çalik, 2012; Özkaya et al., 2003; Sanger & Greenbowe, 1997). Besides that, most students assumed that electrons flow in the electrolyte to complete the circuit, but the electrons only flow through the wires of the electrical circuit (Karsli & Çalik 2012; Lee & Mohamad Yusof 2009; Lee 2008). According to Bong and Lee (2016), students had problems in identifying the reaction that occurred in the anode and cathode because they cannot identify the ions which are assembled in both electrodes.

Virtual learning environment (VLE) is one of the flexible ways for students to learn at their own pace via web-based learning. According to Khlaisang and Songkram (2017), VLE is an essential learning tool to allow students to simultaneously collaborate with

other students and teachers. It also facilitates learning to construct knowledge without time and place constraints to enhance academic performance. Although the development of online learning is increasing rapidly, research on what influences students' achievements using technology is not fully understood (Tabak & Nguyen, 2013) and little is known about the effect of academic performance and self-regulated learning when using VLE (Melissa Ng Lee Yen, 2020). As indicated by Ashikin, Ibrahim, and Osman (2013), the study of VLE on the performance of school students is still lacking for chemistry. Since the launch of the school-level adoption in 2012, teachers are still using it at a moderate level. For this reason, other researchers perceived that studies about VLE courses on students' academic performance need to be identified (Waheed et al., 2020).

In light of the global COVID-19 pandemic, the implementation of virtual learning has accelerated globally. According to the World Health Organization (2020), coronavirus has had a significant impact on the economies of every nation on earth, including the education sector. To break the chain of the virus's spread, the majority of educational institutions around the world have ceased instruction and learning (Dhawan, 2020). According to Izhar et al. (2021), the closure of educational institutions, particularly secondary schools, has disrupted students' educational opportunities. The closure of educational institutions has affected approximately 1.58 billion students worldwide, from pre-school to higher education (United Nations, 2020). The phenomenon of the abrupt closure of secondary schools has transformed traditional classrooms into VLE. However, realistic implementation scenarios for large-scale virtual learning are lacking (Izhar et al., 2021; Zhou et al., 2020).

As VLE becomes more individualized and involved in student-centered learning, students need to master their learning strategies and processes to achieve their goals in their academic achievement; hence, students are required to become self-regulated learners (Delen, Liew & Willson, 2014; Motiwalla, 2007; Schunk & Zimmerman, 1998). Self-regulated learning (SRL) refers to the students' skills of regulating their learning process effectively to achieve goals in learning. However, the high level of autonomy and demand of SRL skills could pose problems for the students in learning (Sletten, 2015; Butzler, 2016). Boev´e et al. (2017) stated that although students realized the different study behavior, they might not change their learning method due to the direct instructions which make them passive. Moreover, students' knowledge in cognitive learning strategies is still lacking which hindered their metacognition during self-study, and they do not use the optimal learning strategies (Dirkx et al., 2019). Chen and Liu (2020) mentioned that student-centered learning is important and effective in learning chemistry to improve learning outcomes.

The combination of online learning and face-to-face instructional method is known as blended learning. The approach might enhance the understanding of electrochemistry due to the combination of different approaches. According to Hinampas, Murillo, Tan, and Layosa (2018), the combination of online learning and face-to-face instructional method makes the students practiced the theoretical knowledge in their real life. In addition, students will be responsible for their learning through the integration of online learning (Graham, 2006). However, the integration of online learning and face-to-face

instructional method is still less practiced in secondary schools (Nurkhamimi & Muhammad Sabri, 2015; Irma Martiny et al., 2016). According to the MOF (2013), the integration of online learning in the teaching and learning in Malaysian schools is less based on the number of teachers who log into the online learning platform provided by the government.

Besides that, the flipped classroom can improve the performance of students and communication skills and cultivate teamwork among students (Herreid & Schiller, 2013). The flipped classroom of the instructional model is a new teaching strategy that can improve students' achievements and the SRL outside the classroom. Students are required to learn at home through videos, notes, and online discussions prepared by the teacher. Students will discuss the lesson at school after learning at home, and this teaching strategy can promote the effective teaching and learning process at school. According to Mukherjee and Pillai (2013), studies about the flipped classroom model are limited in Malaysia. In addition, there are only a few studies that discussed the benefit of the flipped classroom on chemistry (Bergmann & Sams, 2012; Arnaud, 2013).

The blended learning through lab rotation (BLLR) and blended learning through flipped classroom (BLFC) models were chosen by the researcher because they are both more viable among secondary school students than the other models. Previous research has shown that the BLLR and BLFC models have the ability to improve students' academic performance (Tekane et al., 2020; Alsalhi, Eltahir, & Al-Qatawneh, 2019; Hinampas, Murillo, Tan, & Layosa, 2018). Furthermore, earlier studies stated that the BLLR and BLFC models were beneficial in improving students' self-regulated learning (Hewitt, Journell & Zilonka, 2014; El-Senousy & Alquda, 2017; Jdaitawi, 2019).

Based on the literature review about blended learning in Malaysia, most studies focused on the different perspectives of students and educators on the implementation of blended learning (Noh, Abdullah, Teck, & Hamzah, 2019; Masrom, Alwi, & Asshidin, 2019; Karimi & Ahmad, 2020) and there was hardly any studies regarding the implementation of blended learning on the academic performance in electrochemistry and SRL of form four chemistry students in Malaysia. Therefore, this study could contribute to studying the effects of BLLR model and BLFC model on the academic performance and SRL of form four chemistry students.

1.4 Purpose of the Study

The purpose of this study is to investigate the effect of three different learning approaches namely as blended learning through lab-rotation (BLLR) model, blended learning through flipped classroom (BLFC) model and face-to-face (F2F) traditional learning method among the form four chemistry students. These three different learning approaches will affect the academic performance and self-regulated learning (SRL) among the form four chemistry students.

1.5 Research Objectives

Research objectives in this study are:

1. To determine the effect of blended learning through lab-rotation (BLLR) model, blended learning through flipped classroom (BLFC) model, and face-to-face (F2F) traditional learning method on the academic performance of form four chemistry students.

2. To determine the effect of BLLR model, BLFC model, and F2F traditional learning method on the self-regulated learning (SRL) of form four chemistry students.

3. To explore students' perceptions of the implementation of BLLR model, BLFC model, and F2F traditional learning method effective in improving the academic performance and SRL of form four chemistry students.

1.6 Research Questions and Hypothesises

The research questions and hypotheses in this study are as follows:

1. Do the BLLR model, BLFC model, and F2F traditional learning method have any effect on form four students' academic performance?

    Ho1: There is no significant difference in the mean scores of students' academic performance on the pre-test of BLLR model group, BLFC model group, and F2F traditional learning method group.

    Ho2: There is no significant difference in the mean scores of students' academic performance on the pre-test, post-test, and retention test in the BLLR model group.

    Ho3: There is no significant difference in the mean scores of students' academic performance on the pre-test, post-test, and retention test in the BLFC model group.

    Ho4: There is no significant difference in the mean scores of students' academic performance on the pre-test, post-test, and retention test in the F2F traditional learning method group.

    Ho5: There is no significant difference in the mean scores of students' academic performance on the post-test among BLLR model group, BLFC model group, and F2F traditional learning method group while controlling their scores in the pre-test.

Ho6: There is no significant difference in the mean scores of students' academic performance on the retention test among BLLR model group, BLFC model group, and F2F traditional learning method group while controlling their scores in the pre-test.

2. Do the BLLR model, BLFC model, and F2F traditional learning method have any effect on form four students' self-regulated learning (SRL)?

Ho7: There is no significant difference in the mean scores of students' SRL on the pre-test in the BLLR model group, BLFC model group, and F2F traditional learning method group.

Ho8: There is no significant difference in the mean scores of students' SRL on the pre-test, post-test, and retention test in the BLLR model group.

Ho9: There is no significant difference in the mean scores of students' SRL on the pre-test, post-test, and retention test in the BLFC model group.

Ho10: There is no significant difference in the mean scores of students' SRL on the pre-test, post-test, and retention test in the F2F traditional learning method group.

Ho11: There is no significant difference in the mean scores of students' SRL on the post-test among BLLR model group, BLFC model group, and F2F traditional learning method group while controlling their scores in the pre-test.

Ho12: There is no significant difference in the mean scores of students' SRL on the retention test among BLLR model, BLFC model group, and F2F traditional learning method group while controlling their scores in the pre-test.

3. What are students' perceptions of the implementation of BLLR model, BLFC model, and F2F traditional learning method effective in improving the academic performance and SRL of form four chemistry students?

1.7 Definitions of Terms

Some key terms are defined operationally and conceptually to understand how these terms are used in this study. The following are the definitions of terms used in this study:

1.7.1 Blended Learning through Lab-rotation (BLLR) Model

Blended learning refers to a combination of traditional classroom meetings and online components of learning (Picciano, 2014). According to Picciano, Dziuban, and Graham

(2013), blended learning course is a hybrid instructional process that encompasses face-to-face instruction and technology-based learning to drive a significant educational change in the teaching and learning process. Besides that, blended learning is also defined as a hybrid of classroom and online learning which includes convenient courses that have face-to-face contact between the teacher and students (Rovai & Jordan, 2004). According to Michael and Heather (2015), BLLR model is the integration between online learning which occurred in the school's computer laboratory and classroom learning in a rotation way to create a seamless instructional method.

In this study, BLLR model is a combination between online learning and face-to-face learning which occurred in a rotation way to enhance students' academic performance and self-regulated learning in chemistry. Students were given a schedule to attend the online learning session in the computer laboratory and classroom learning sessions in the chemistry laboratory.

1.7.2 Blended Learning through Flipped Classroom (BLFC) Model

Flipped classroom is a paradigm shift that involves internet technology to leverage the instructional process so that teachers can spend more time interacting with students in the classroom instead of teaching by telling (Bergmann & Sams, 2012). According to Eunice (2016), flipped classroom is a new teaching strategy model of instruction to improve students' achievements and convey a positive attitude towards learning by moving teaching outside the classroom via technology and moving homework and exercise inside the classroom through learning activities. According to Michael and Heather (2015), BLFC model is defined as an integration of online learning where students consume the lesson at home independently, and the classroom learning sessions for activities and discussion are given by the teacher.

In this study, BLFC model is an instruction with a combination of online learning which occurred at home earlier using the google classroom application that is incorporated with videos, notes, online quizzes, online discussion, and exercises, and the classroom learning session will be taught through the learning activities such as discussing the exercises given by the teacher to enhance the self-regulated learning and academic performance for the electrochemistry topic.

1.7.3 Electrochemistry

Brady (1990) defined electrochemistry as a study of the relationship between chemical reactions and the flow of electricity, which included the electrolysis reactions in non-spontaneous changes that are forced by the passage of electricity through chemical systems and resulted in redox reactions.

In this study, electrochemistry is defined as the chemical reactions which occurred in electrolysis and voltaic cells reactions. This chemical reaction is influenced by the concentrations of electrolyte, the position of anion and cation in electrochemistry series, and the types of electrodes used in the reactions. Electrochemistry is the sixth chapter in the form four chemistry textbook. This chapter encompasses six subtopics such as electrolytes and non-electrolytes, electrolysis of molten compounds, electrolysis of aqueous solutions, electrolysis in industries, voltaic cells, and electrochemical series. This title was chosen by the researcher to teach the respondents using three different teaching methods.

1.7.4 Self-Regulated Learning (SRL)

Barnard-Brak et al. (2010) stated that SRL skills include goal setting, time management, task strategies, and environment structuring. SRL is defined as the extent to which students are motivationally, metacognitively, and cognitively engaged in their learning processes (Corno & Mandinach, 1983; Zimmerman, 1989).

In this study, SRL refers to metacognitive skills, help-seeking, time management, persistence, and environmental structuring which are affected by BLLR model and BLFC model towards the form four chemistry students.

1.7.5 Academic Performance

Naghmeh (2016) claimed that academic performance is the outcome of education for the extent to which students, teachers, or institutions has achieved their educational goals. According to Najiba (2014), performance is a way to evaluate the learners' achievement at the end of the learning activities based on the feedback by learners on what they have learned. In this study, academic performance refers to the outcome of form four chemistry students' results in the post-test and post-retention test for the electrochemistry topic.

1.8 Research Significance

The integration of technologies in teaching and learning could enhance the quality of the pedagogical methods in certain subjects. The implementation of internet technologies like online learning may help instructors to deliver their lessons interestingly using interactive elements such as videos, forums, notes, and quizzes. Online learning is web-based learning where instructors can upload their teaching materials anytime and anywhere using internet access. This technology can improve the pedagogical process among the teachers and make the learning process easier than the conventional method.

Students nowadays tend to use internet technologies in their daily life. The combination of online learning and classroom learning or known as blended learning could attract students to learn more effectively as internet technologies can make teaching and learning more interesting. The multimedia features in the online learning platform such as videos, texts, and animations can make the lesson easier and more interactive for students. The implementation of BLLR model in the teaching and learning process could engage the students in self-regulated learning. This learning style is more on the students to learn by themselves without any guidance from any parties as online learning is one of the tools that can assist students' learning through the computer and internet access. The combination of online learning and face-to-face classroom learning could improve the understanding of students as well as their academic performance.

The BLFC model is an instructional process that can be implemented at students' homes and classrooms. This teaching strategy requires students to learn at home through the teaching materials provided by the teacher such as videos, digital books, and online discussions before coming to the school. As a result, it promotes independent learning among students. The BLFC model can promote active learning through discussions among peers in the classroom after learning about the topic at home. This teaching method can shorten the duration of the lesson compared to traditional teaching methods as a part of the teaching has been covered at the students' home.

The implementation of BLLR model and BLFC model at the secondary and primary school levels are still new in Malaysia. This study could be used as a guide to the Malaysian educational ministry to implement technologies in all the schools in Malaysia to boost Malaysian students' academic performance as well as self-regulated learning. It is hoped that it can improve the ranking of Malaysian students in TIMSS in the future.

1.9 Research Scope and Limitation

This study was conducted at a school located in Ampang. The data were collected at only one school so that it would not be generalized to represent all the schools in Malaysia. In addition, the respondents in this study were selected among the form four chemistry students who are studying at an ordinary school. Hence, the data could not be used to represent students from the boarding schools who have excellent results from their PT3 examination.

Moreover, the respondents in this study were among students who use the face-to-face traditional learning method at their school. Therefore, the findings of this study cannot represent students who used blended learning or flipped classroom approaches at their school. Besides that, the online learning platform that is used in this study is Google Classroom. Hence, the result of this research could not represent other online learning platforms such as Moodle or any online learning platform developed by any parties.

1.10 Summary

This chapter discussed the research background, the problem of statement, research objectives, research questions, research hypotheses, research significance, the scope and limitations of the study, and the operational definitions of the key terms used in this study. The next chapter will discuss the literature review that provides further explanation.

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