THE EFFECT OF FLIPPED CLASSROOM ON INTRINSIC MOTIVATION AND ACHIEVEMENT IN CHEMICAL EQUILIBIRUM AMONG YEAR 11 PUPILS

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ABSTRACT

Nowadays, lack of motivation has been quoted as one of the leading challenges in chemistry education. In science education, low academic achievement in chemistry is another major problem encountered in secondary school. Therefore, the purpose of this study was to investigate the effect of flipped classroom on intrinsic motivation and achievement in chemical equilibrium among Year 11 pupils. This study employed a quasi-experimental non-equivalent pretest-posttest design. Sixty (60) Year 11 secondary school chemistry pupils from two intact classes were assigned to an experimental group (n = 30) and a control group (n = 30). The experimental group students were exposed with flipped classroom approach and the control group pupils were exposed with the traditional classroom approach. The research was conducted for six weeks in a secondary chemistry education international school setting. Research instruments used in this study were the modified version of Intrinsic Motivation Inventory (IMI) to evaluate the pupils' intrinsic motivation based on the indicators of autonomy, competence, relatedness, interest and value; Chemical Equilibrium Achievement Test (CEAT) to measure students' achievement scores. Reliability and validity of the instruments were assessed in the pilot study. The reliability obtained for IMI, Cronbach's α is 0.88 and for CEAT, test-retest r is 0.89. The validity coefficients for IMI are acceptable and exceed the acceptable factor loading criterion of 0.35. The analysis of CEAT was validated by three experienced teachers from Cambridge Assessment Specialist Team. Quantitative data were analyzed using Analysis of covariance (ANCOVA) and Pearson Correlation test. The major findings of this study revealed that there was a significant difference between experimental group and control group on pupils' post intrinsic motivation scores with pretest as a covariate ($F(1, 57) = 64.41$,

$p < .05$) Also, it showed that there was a significant difference between experimental group and control group on pupils post chemical equilibrium achievement scores with pretest as a covariate (F (1, 57) = 37.38, $p < .05$). The Pearson Correlation test results revealed that the relationship between pupils' intrinsic motivation and chemical equilibrium achievement scores in experimental group after intervention was significant: $r = .39$, $p < .05$. For intrinsic motivation scores, the experimental group with an average mean of 70.63 scored significantly higher than the control group with an average mean of 61.00. For chemical equilibrium achievement scores, the experimental group with an average mean of 15.3 scored significantly higher than the control group with an average mean of 9.83. The results showed that the flipped classroom approach enhances pupils' intrinsic motivation as well as achievement in chemical equilibrium. The findings of this study have theoretical significance as well as pedagogical implications. In addition, the findings of this study suggested the importance of flipped classroom approach to improve secondary school pupils' intrinsic motivation and achievement in chemical equilibrium. This study also helps to inform a better chemistry education learning strategy for pupils and provide suggestions for future research using flipped classroom approach. Therefore, the study recommended that flipped classroom approach should be added to the teaching strategies of chemistry teachers at the secondary school level.

KESAN BILIK DARJAH BERBALIK TERHADAP MOTIVASI INTRINSIK DAN PENCAPAIAN DALAM KESEIMBANGAN KIMIA BAGI MURID TAHUN 11

ABSTRAK

Pada masa kini, kekurangan motivasi telah dipetik sebagai salah satu cabaran utama dalam pendidkan kimia. Dalam pendidikan sains, pencapaian akademik yang rendah dalam kimia merupakan satu lagi masalah utama yang dihadapi di sekolah menengah. Justeru, kajian ini menyelidik kesan penggunaan kelas terbalik terhadap motivasi intrinsik dan pencapaian keseimbangan kimia dalam kalangan pelajar Tahun 11. Kajian ini menggunakan reka bentuk kuasi eksperimen dengan ujian pra dan pasca. Seramai 60 orang murid Tahun 11 dari dua buah kelas utuh sekolah menengah telah dipilih sebagai kumpulan eksperimen (n = 30) dan kumpulan kawalan (n = 30). Kumpulan eksperimen melibatkan penggunaan pendekatan kelas terbalik sementara kumpulan kawalan melibatkan penggunaan pendekatan kelas tradisional. Kajian ini dijalankan selama enam minggu di sebuah sekolah menengah antarabangsa Selangor. Instrumen dalam kajian ini adalah versi ubahsuaian Skala Motivasi Intrinsik (IMI) dan Ujian Prestasi Keseimbangan Kimia (CEAT). IMI telah digunakan untuk menilai motivasi intrinsik pelajar berdasarkan petunjuk autonomi, kecekapan, keterkaitan, minat dan nilai. Selain itu, CEAT telah digunakan untuk menilai skor pencapaian pelajar. Kebolehpercayaan dan kesahan instrumen telah dinilai dalam kajian perintis. Kebolehpercayann yang diperolehi untuk IMI, Cronbach's α adalah 0.88 dan untuk CEAT, uji ujian semula adalah 0.89. Kesahan untuk IMI boleh diterima dan melebihi kriteria pemuat factor yang boleh diterima pada 0.35. Analisis CEAT telah disahkan oleh tiga guru berpengalaman dari

Pasukan Pakar Penilaian Cambridge. Data kuantitatif dianalisis dengan menggunakan Analisis Kovarians (ANCOVA) dan ujian Korelasi Pearson. Penemuan utama kajian ini menunjukkan bahawa terdapat perbezaan yang signifikan antara kumpulan eksperimen dan kumpulan kawalan pada catatan skor motivasi intrinsik pasca pelajar dengan praujian sebagai kovarian ($F\ (1, 57) = 64.41$, $p < .05$). Selain itu, ia menunjukkan bahawa terdapat perbezaan yang signifikan antara kumpulan eksperimen dan kumpulan kawalan pada catatan skor pencapaian keseimbangan kimia pasca dengan praujian sebagai kovarian ($F\ (1, 57) = 37.38$, $p < .05$). Keputusan ujian Korelasi Pearson menunjukkan bahawa hubungan antara motivasi intrinsik dan skor pencapaian keseimbangan kimia untuk kumpulan eksperimen selepas rawatan adalah signifikan, $r = .39$, $p < .05$. Bagi skor motivasi intrinsik, kumpulan eksperimen dengan purata 70.63 menunjukkan skor yang signifikan tinggi daripada kumpulan kawalan dengan purata 61.00. Bagi skor pencapaian keseimbangan kimia, kumpulan eksperimen dengan purata 15.3 menunjukkan skor yang signifikan tinggi daripada kumpulan kawanlan dengan min purata 9.83. Hasil kajian menunjukkan bahawa pendekatan kelas terbalik meningkatkan motivasi intrinsik pelajar serta pencapaian dalam keseimbangan kimia. Hasil kajian ini mempunyai kepentingan teori serta implikasi pedagogi. Di samping itu, hasil kajian ini menunjukkan kepentingan pendekatan kelas terbalik untuk meningkatkan motivasi intrinsik pelajar sekolah menengah dan pencapaian dalam keseimbangan kimia. Kajian ini juga memaklumkan strategi pembelajaran pendidikan kimia yang lebih baik untuk pelajar sekolah menengah dan menyediakan cadangan untuk kajian lanjut menggunakan pendekatan kelas terbalik. Oleh itu, kajian ini mencadangkan bahawa pendekatan kelas terbalik harus ditambah kepada strategi pengajaran guru kimia di peringkat sekolah menengah.

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List of Symbols and Abbreviations

CEAT : Chemical Equilibrium Achievement Test

IMI : Intrinsic Motivation Inventory

SDT : Self-determination Theory

IGCSE : International General Certificate of Secondary Education

ICT : Information and Communications Technology

GLM : General Linear Model

STEM : Science, Technology, Engineering and Mathematics

SD : Standard deviation

M : Mean

AMOS : Analysis of A Moment Structure

SPSS : Statistical Package for the Social Science

ANCOVA: Analysis of Covariance

EFA : Exploratory Factor Analysis

CFA : Confirmatory Factor Analysis

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Recent studies in science education have shown that the latest instructional strategy of 21st century highlights on the technology application in teaching and student-centered active learning (Ng, 2014; Rahman et al., 2014; Turiman et al., 2012). Flipped classroom instruction is one of the most recent instructional methods that emphasize on active learning by using technology innovation as a medium in learning and teaching (Rahman et al., 2014). The selection of the instructional strategies is vital as provide flexibility for the instructor to satisfy the student needs to enhance achievement and to maximize the class contact time (Bergmann & Sams, 2012). The flipped classroom basically flips what is generally done as homework and what is generally done in class. The activities that are completed at home and at school are inverted in the flipped classroom, which means homework is to watch an educational videos or instructional videos of the lecture, and class contact time is utilized for students' centered active learning activities with instructor support" (DeMaio & Oakes, 2014, p.340).

In the chemistry traditional classroom, learners view the educational or instructional videos during class time and solve chemistry problems in the rest of the time at school and complete it at home. Whereas in chemistry flipped learning environment, learners watch instructional lecture videos during out-of-class learning and practice chemistry problems during class time. Hence, it is vital to have flipped classroom as it could offer a better solution for educators who want to optimize the contact time in class as to enhance student motivation and thus lead to achievement

(DeMaio & Oakes, 2014). Besides, in the flipped classroom students learn by doing and with that, students are never again at home alone and being unsupervised while they having obstacles in their learning (Fulton, 2012). When students view instructional lecture videos outside of class time, they are more participative in class and most vital part is it can be used to optimize the contact time in class (Tucker, 2012) especially in chemistry education with insufficient time allocation problem for the intensive chemistry curriculum (Kaptan & Timurlenk, 2012). According to Tucker (2012), teachers credit flipped classroom with “increase level of interaction, improved student engagement and stimulate higher intrinsic motivation”. A model of flipped classroom is proposed as shown below (Lo & Hew, 2017). In flipped classroom, students learn content knowledge outside classroom. Learners can view instructional videos; complete guided notes to learn content at home, and then apply the content during class with guidance of the instructor. Class time is devoted to ‘minilectures, small group activities, or individual practices designed to increase pupils’ skills of competency followed by conclusion and preview (Davies, Dean, & Balls, 2013).

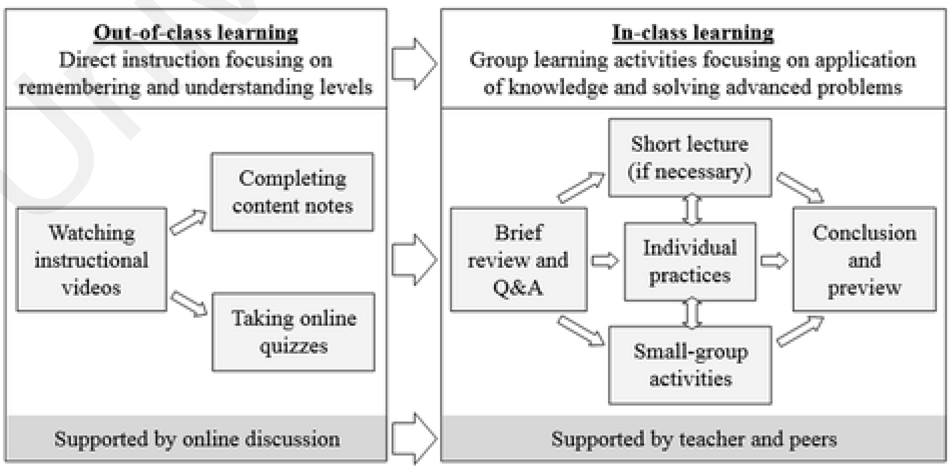

Figure 1.1. Proposed model of flipped classroom (Lo & Hew, 2017).

Technology plays a vital role in flipped classroom design and delivery. Flipped classroom is feasible due to the affordance of innovation in technologies that supports science resources acquirement nowadays (Kim & Hannafin, 2011; Ng, 2014). Also, digital technologies supports learners with better engagement, provides them immediate feedback and create interactive learning environment (Ng, 2014; Webb, 2005). Besides, digital technologies intrinsically motivate young adults who are familiar and comfortable of using these technological innovations (His, 2007; Ito et al., 2008; Ng, 2014). Therefore, it can be mentioned that this FC instructional strategy is able to present remarkable opportunities to transform our classroom in ways that promote student learning in chemistry education (Atkins, 2015). Despite the popularity of this FC instructional strategy in the press, online Google searches, and many indirect studies such as learner and teacher satisfaction surveys promoting this strategy (Gilboy et al., 2015). However, little statistical evidence is available on the effect and impact in knowing what a flipped learning instructional model is (Abeysekera & Dawson, 2015). Most importantly, in the aspects of educational outcome, there has been little research on whether the flipped classroom increases students' intrinsic motivation and achievement in chemistry education (Schultz et al., 2014). In order to enhance academic achievement of students, it is vital to study the relationship between intrinsic motivation and achievement (Eymur & Geban, 2011; Sikhwari, 2014). According to Deci and Ryan (2000), there are two different forms of motivation, which can be divided into extrinsic motivation and intrinsic motivation. In this research, the focus of the type of motivation will be on intrinsic motivation because it reflects the greatest level of motivation as it originates inside of the individual (Grolnick, 2002). Therefore, a hypothetical claim that flipped classroom may enhance students' intrinsic motivation and thus assist enhance in academic achievement will be examined.

Motivation is an important affective variable in education, which is essential for the advancement of science teaching and learning (Velayutham & Aldridge, 2013). Deci and Ryan (2000) reported that there are two different forms of motivation, which included extrinsic motivation and intrinsic motivation. Learners that are extrinsically motivated refer to someone's behavior that is led by the external factors such as awards and punishments (Sansone, 2000). In this study, the focus of the type of motivation will be on intrinsic motivation because it is a true motivation that comes from within that is long lasting and self-sustaining (Grolnick, 2002). Intrinsic motivation refers to the drives that causes individuals to perform certain behavior for their own internal satisfaction derived from participation (Deci, 1975; Vallerand & Ratelle, 2002). Therefore, this research is to investigate if manipulating the educational instruction in a secondary chemistry classroom with flipped learning, could lead to enhanced intrinsic motivation in chemistry topic simultaneously also determining whether the achievement is affected.

1.2 Statement of the problem

Decreased motivation of students towards science learning over time has been the center of attention in many studies related to education (Sharaabi-Naor et al., 2014). Lack of motivation in science education has been quoted as one of the leading challenges in science (chemistry) teaching and learning (Kaptan & Timurlenk, 2012). Similarly, Malaysia is facing the same issue of lack of proper motivation among upper secondary students towards STEM (Science, Technology, Engineering, Mathematics) subjects (Hossain & Robinson, 2012; Luan, 2009; Talib et al., 2009). Also, many studies revealed that decreased students' motivation towards science learning, especially during secondary school years (Chan & Norlizah, 2017). According to Deci and Ryan (2000), there are two main forms of motivation, which are intrinsic motivation and extrinsic motivation. In this study, the focus of the type of motivation will be on intrinsic motivation due to it is reflected the highest level of motivation as the behavior is driven by internal rewards (Grolnick, 2002) and influences the learners' focus and level of engagement on a given learning activities (Black & Deci, 2000).

Nowadays, students were demotivated being passive learners due to lack of peer interaction and engagement in their learning (Hurst et al., 2013; Kinde, 2007; Liu, 2014). This is due to students nowadays; known as Millennials, have unique learning preferences that prefer collaboration and teamwork (Li, 2019). According to Anderson (2000), technology integration in education has the tendency to increase student motivation by allowing the learners to work collaboratively with their peers and incorporate technology in their learning activities (Demissie et al., 2013). Millennial learners, also known as " digital generation" (Prensky, 2001), were subjected to information technology since they were very young. As a consequence, Millennials demonstrate decreased tolerance in traditional classroom for lecture-style delivery of course information (Roehl et al., 2013). Since flipped classroom instructional strategy employs readily accessible technology and allows various kind of interactive learning activities during lesson time (Rahman, 2014; Robert et al., 2016). This gives chances for more teacher- to –student coaching and collaboration among peers occur in class (Roehl et al., 2013). This instructional strategy encourages active participation from the learners and this deep learning approach in classroom can be considered to motivate students' learning (Aziz et al., 2012; Ryan, 2015).

However, several research studies reported that lack of accessibility on the digital resources in schools might affect the effectiveness of teaching and learning pedagogical practices in the classroom (Afshari & Amla, 2012; Ghavifekr et al., 2016; Barak, 2007). Insufficient use of digital resources in teaching and learning may lead to lack of digital differentiated tasks among pupils with different abilities (Sletten, 2017; Touchton, 2015). Lack of differentiated tasks in science learning might not be able to evaluate the learners' competency level and develop their skills (Kusurkar et al., 2011; Thaman et al., 2013). Therefore, the integration of technology in science education should be further examined as to enable chemistry learning to be more motivating for their learners with flipped classroom instruction (Kinde, 2007).

Another major problem is the decline in academic achievement prevalent in high schools today (Alderman, 2013; Wang & Sheikh –Khalil, 2014; Rocha et al., 2016). In science education, low academic achievement in chemistry due to the intensive curriculum in chemistry education with insufficient time allocation is another major problem encountered in secondary school (Cheung, 2012; Kaptan & Timurlenk, 2012). Most of the time, learners listen to a lesson in the traditional classroom and then finish the necessary homework after the lesson. This passive classroom may lead to learner's come to class ill-prepared (Young, 2002) and insufficient teaching time for students (Chen & Wei, 2015). This existing gap could be possibly be tackled with a typical flipped classroom approach which students learn new knowledge before class by assessing the Google classroom that can save teaching hours (Chen & Wei, 2012). In addition, in the flipped classroom, active learning activities improve student accountability for class preparing. This is because in- class home- based pre-assignment activities encourage learners to finish tasks and attend classes to further understand the topic (McLaughlin, 2013). However, little literature has been reviewed on the effect of flipped classroom towards pupils' intrinsic motivation and achievement in a secondary chemistry classroom in comparison with traditional classroom (Jayawardena et al., 2017 Peng, 2012; Sletten, 2017, Robert et al., 2016).

In this study, chemical equilibrium is chosen to be the topic of study because it is fundamentally important for understanding many basic chemistry concepts (Yildirim & Yilmaz, 2016). This topic is representative of the specific nature of chemistry since it requires the conceptualization of macroscopic events, explanation of sub microscopic nature and application of symbolic language and mathematics (Demissie et al., 2013). Chemical equilibrium has a long tradition in learning difficulties and misconceptions that have persisted until nowadays (Kousathana & Tsaparlis, 2002; Piquette & Heikkinen, 2005). Therefore, a theoretical argument that flipped classroom that can enhance pupils' intrinsic motivation and achievement on chemical equilibrium in high school need to be examined.

1.3 Purpose of the study

This purpose of this study is to examine the effects of flipped classroom on learners compared to traditional classroom instruction. Particularly, the aim of this research is to investigate the effect of flipped classroom instructional strategy on pupils' intrinsic motivation and achievement. In relation to the aim of the study, the following objectives are proposed as shown below.

1.4 Objectives of the study

The objectives of this study are:

1. To investigate the effect of flipped classroom in intrinsic motivation scores compared to traditional classroom in chemical equilibrium.

2. To investigate the effect of flipped classroom in achievement scores compared to traditional classroom in chemical equilibrium.

3. To investigate the correlation between the pupils' intrinsic motivation and achievement scores in experimental group before and after flipped classroom intervention.

1.5 Research questions

1. Is there any significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate?

2. Is there any significant difference on post achievement scores in chemical equilibrium between experimental group and control group with pretest as a covariate?

3. Is there any significant correlation between pupils' intrinsic motivation and chemical equilibrium achievement scores in experimental group before and after flipped classroom intervention?

1.6 Hypothesis of the study

Null hypothesis (Ho):

1. There is no significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate in the population.

2. There is no significant difference on post achievement scores in chemical equilibrium between experimental group and control group with pretest as a covariate in the population.

3. There is no significant correlation between pupils' intrinsic motivation scores and achievement scores in experimental group before and after flipped classroom intervention in the population.

Alternative Hypothesis (H_1):

1. There is a significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate in the population.

2. There is a significant difference on post achievement scores in chemical equilibrium between experimental group and control group with pretest as a covariate in the population.

3. There is a significant correlation between pupils' intrinsic motivation scores and achievement scores in experimental group before and after flipped classroom intervention in the population.

1.7 Definitions of terms

In this study, the key terms used are most appropriate for the content of this study only. These are as follows:

(i) Flipped classroom (FC)

Flipped classroom is an instructional strategy used as treatment for the experimental group in this study. According to Touchton (2015), it is a blended learning model that mixes traditional face-to-face methods and information and communication technology (ICT) tools. In flipped classroom, students learn the prior knowledge outside of class time by viewing the instructional videos posted online in Google classroom or Learnerscloud prior attend the lessons. Class contact time is devoted as face-to face interaction on "practice assignments (Kerboodle quizzes), personalized coaching and peer discussions, and interactive classroom activities (Kahoot game-based learning). In this study, a six week lesson plan based on flipped classroom lesson plan was conducted by the researcher in a secondary international school Selangor. As to increase the accessibility of the technology tools during class lessons, Chromebooks or Macbooks will be provided to the learners in school.

(ii) Traditional classroom (TC)

Traditional classroom is an instruction that used in control group and learners will not receive treatment in this study. It represents the teacher – centered model of learning and instructors deliver the lesson content in the classroom and pupils solve the homework at home (Kates et al., 2015). Whole class instruction happens more frequently than small group interaction. Class contact time for interaction will be lesser as the instructors use most of the teaching time for delivering the contents in the classroom. In this study, class contact time in traditional classroom is devoted to content delivery such as lectures and presentation and lack of peer discussion and interactive classroom activities using ICT tools.

(iii) Intrinsic Motivation

In this study, pupils' intrinsic motivation is a dependent variable and will be assessed by the modified Intrinsic Motivation Inventory (IMI) pretest and posttest scores. The subscales to be measured are autonomy, competence, relatedness, interest and value based on the learning activities given. The more individuals' psychological needs of the above subscales are fulfilled, the more their behavior is intrinsically motivated (Riley, 2016).

The level of measurement for this variable is interval and the pretest and posttest scores will be evaluated by using online Google form with 5-point Likert scale.

(iv) Achievement

The pupil's achievement is a dependent variable and is assessed by the Chemistry Equilibrium Assessment Test (CEAT) pre- test and post-test scores. The measurement of this variable is ratio as the pretest and post-test scores are measured as scores from 0 to 20 marks and the ratio statements are permitted (Coladarci et al., 2011). The pretest and posttest scores are produced from the online test system.

1.8 Significance of the study

To date, there is little statistical proof that shows pupils' intrinsic motivation and achievement by using flipped classroom in secondary science education (Gonzalez – Gomez et al., 2016; Moos & Bonde, 2015; Robert et al., 2016) and unclear direction of the relationship between intrinsic motivation and achievement remains (Arreepattamannil et al., 2011; Garon-Carrier et al., 2016). Therefore, a quantitative research on the flipped classroom instructional strategy is crucial.

The findings from this study may give an insight on the effect of flipped classroom on intrinsic motivation and achievement score in comparisons between experimental group and control group. It may serve as a guiding framework to educational practitioners and academic community for planning flipped classroom instruction that may lead to positive change in science education by focusing on in class activities that could stimulate intrinsic motivation among learners. Besides, the findings in this study provide research-based foundations of flipped classroom which drawn from the groundwork of literature on flipped education in science and add value to the literature of flipped classroom instructions for the academic community.

Furthermore, the findings also may provide information about the correlation between the level of intrinsic motivation and pupils' achievement in a secondary school setting, It will help the researchers in the effort of attempting to understand the complexity of motivation in young adults and it allow the further discussion for the development of flipped classroom instructional strategy that focus on fostering intrinsic motivation, which may then lead to increased academic achievement. This is a crucial part in education field because pupil achievement is also linked to the growth of society (Amrai et al., 2011).

Also, the study may examine how the flipped classroom approach can be used to cater learners' psychological needs of intrinsic motivation with the components of competency, autonomy, and relatedness in chemistry education. This is vital as in secondary school chemistry education, educators are facing the difficulties on how to design and implement class activities that can promote secondary pupils' intrinsic motivation based on their autonomy, competency and relatedness as reported by previous studies (Kusurkar et al., 2011; Thaman et al., 2013). Therefore, it is possible to reveal methods to enhance the components of intrinsic motivation fulfillment for secondary science education in teaching chemistry if the implementation of flipped classroom strategy is successful in this study. Such finding is essential in flipped lessons implementation to teach students with different learning abilities. Thus, the outcomes of this study will be beneficial to chemistry teachers and social scientists to plan the use flipped classroom strategy to meet student requirements on intrinsic motivation in scheduling their lesson. As a consequence, the findings of this study is possible to give recommendations to the school administrators and education instructional designers to direct their focus towards the elements of motivation in a secondary chemistry classroom setting.

The research results also gave an insight into how the flipped classroom approach brought differences in the aspects of students' classroom interaction, students' competence level in differentiated tasks and students' freedom of content learning in chemistry lessons. Effective application of educational pedagogical strategy in chemistry learning such as flipped classroom can significantly improve student' achievement as indicated by past studies (Loukomies et al., 2013; Moos & Bonde, 2015; Robert et al., 2016). The study meets the expectations of 21st century curriculum development trends, which emphasized on the necessity of innovation in teaching and active learning for learners (Ng, 2014; Rahman et al., 2014). The results of this research outlined the application of technology tools for flipped classes such as Learnerscloud, Kerboodle and Kahoot online resources during chemistry flipped lessons.

This research also has a significant impact on the theoretical input in chemistry education by using the flipped classroom approach. It enhances students' intrinsic motivation under the self-determination theory in science education. The objective of the study is to develop pupils' intrinsic motivation using self-determination theory with the flipped classroom approach (Cortright et al., 2013; Niemiec & Ryan, 2009). It will be a new discovery in Malaysia's secondary chemistry education context.

In line with Malaysia's aspiration to be a global education hub in 2020, the Ministry emphasized on the effort to enhance ICT integration in education (Hassan, 2009). About 4000 schools have been rated and 89% have shown to be practice various level of ICT integration in Malaysia. Therefore, this study will have practical application in the chemistry education settings for research design and evaluation. This is vital in education policy planning process, curriculum development for educators as the study provides information on students' intrinsic motivation and achievement in secondary chemistry education class that are the major concern in the recent years.

1.9 Limitations of the Study

A threat to external validity may occur merely because learners are conscious of being involved in a study. This limitation and potential threat to external validity is known as the Hawthorne Effect in which participants alter their behavior because they take part in a research or an experiment (McCambridge et al., 2014). Students knew about the research as a consequence of the pre-study information session with learners. Students' intrinsic motivation and achievement may therefore have been affected by the novelty of participating in a research study and not by the application of flipped classroom instruction.

Besides, the diffusion of experimental treatment is a limitation due to control group might know regarding the implementation of treatment to the experimental group and might have been disseminated subconsciously by the respondents and educators (Rovai et al., 2013). To reduce this risk of internal validity, only experimental group participants registered in the flipped classroom had access to the contents on the websites such as Google Classroom and Learnerscloud ® by providing the class codes or personal login details to the experimental group students by the flipped classroom instructor.

Furthermore, history poses a threat to this study's internal validity and could be one of the limitations in the study, as learners were not divided by level of achievement. Students with prior knowledge may have had a benefit over learners who did not expose to the same content knowledge before attending class. However, Gall et al. (2007) stated that this limitation can be statistically controlled by using the pretest-posttest design for nonequivalent groups to reduce the threats for internal validity.

Moreover, student participants with high percentage of absenteeism may have affected by the absence of learning material and the failure to engage in classroom activities. This is one of the limitations and potential internal validity threats in research because this is beyond researcher's control to track students' participation in class activities or rate of attendance. As a consequence, it will reduce the amount of the class contact time gained by the learners. Students who were present in the class daily had the chance to acquire the instructors' learning subject material, and participate in the associated activities. In contrast, learners failed to receive an equal amount of instructional time that related to its content design and delivery if they were absent during the lesson. This might have altered the outcomes of the IMI and CEAT posttest scores. In addition to that, this study was only involved respondents who are predominantly Chinese and male students. As such, the findings can only be generalized to similar population.

1.10 Summary

This chapter described the study justification and the need for flipped classroom approach studies. This chapter starts with a background in the worldwide research of chemistry education. After that, the current gaps in the studies and the objective of the study are identified. This chapter also addressed the research gap and how this research can provide learners, teachers and curriculum designers with understanding and practical application to flipped classroom teaching and learning pedagogy in chemistry education. Finally, the chapter examines the advantages and importance of the research to learners and educators of secondary chemistry education as well as policy makers and stakeholders in Malaysia for science education.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter includes evaluation of substantial findings and review of knowledge status on technology integration in chemistry education, comparisons between flipped classroom and traditional classroom instructional strategy, challenging topics in chemistry education, related literature regarding intrinsic motivation and achievement. Also, this section provides the description of the conceptual framework that connects the variables and the underlying theoretical framework to guide the research.

2.1.1 Technology integration in chemistry education

There has been some interest in applying the use of information and communication technology (ICT) in latest years. When educational technology instruments are properly and efficiently used in science classrooms, learners will be actively participated in constructing knowledge and enhancing their capacity to think and solve issues (Trowbridge, Bybee & Powell, 2008). According to Barron et al. (2003), technology integration offers an outstanding avenue for motivating, exploring and promoting active learning in education.

In particular, Barrron et al. (2001) revealed the following advantages of integrating technology in science education: (i) emphasizes cooperative learning and increases teacher- student interaction, (ii) offers differentiated activities and self-paced learning, (iii) enhances communication skills, (iv) provides information to support learners with different learning styles through multi-sensory channels, (v) provides flexibility for learners with special needs, and (vi) motivates and empowers students by making learning interesting and meaningful.

There are number of quantitative studies that investigated the effect of technological on student learning. Some of the tools are game based learning (Stansfield & Boyle, 2011; Yilmaz-Soylu et al., 2009), computer –based interactive multimedia program (Chang& Lehman, 2002), prerecorded video tutorials (Luyen & Warden, 2009; Shaffer, 2011), and blogs (Hsu & Wang, 2011; Yang & Chang, 2011). Overall, the results from these studies reported that students were able to learn equally well using a given technology compared to traditional classroom approach. However, there are only a few studies that used an experimental design to study the effect of technology on student motivation (Papastergiou, 2009). For example, the effect of an educational game on student intrinsic and extrinsic motivation (Tuzun et al., 2009), the effect of an educational game accompanied by conceptual scaffolding on student motivation (Charsky & Ressler, 2011), the effect of computer-based interactive multimedia program on students' perception of motivation (Chang & Lehman, 2002), the effect of blogging on learning motivation (Hsu & Wang, 2011). Interestingly, some of studies found there was no statistically difference in motivation between experimental and control groups (Charsky & Ressler, 2011; Hsu & Wang, 2011; Yang & Chang, 2011). In contrasts, the results from most of the studies on educational games and computer based interactive multimedia program that were designed with enhance relevance of the topic reported there were statistically significant increase in motivation.

In the past few years, there has been some interest in the use of technology such as the games in education (McGonigal, 2011; Pede, 2017; Wang, 2015), using cloud-based technology for collaboration (Sultan, 2010) in flipped classroom. These areas have been chosen due to there are some of the present and cutting-edge uses of technology in education. Wang (2015) suggests that playing video games such as Kahoot or Quizizz is intrinsically motivating. The author suggested that gamers were motivated to create sense of the information they received during game play and even after they failed to create sense of the data. Besides, Watson et al. (2011) reported a case study of high school sophomores (who aged between 15 to 18) using the video game Making History to learn about the Second World War, it was discovered that the classroom environment has changed to a more student-centered model from a traditional teacher-centered model. This allows more active interaction and participation in student centered learning model. In combination with journals entries, authentic documents, maps, text, and other classroom activities, this video game was used to provide learners with a thorough review of the Second World War events and results. This is a research example that shows that video games are a positive part of the motivation of a student. In summary, while further study on the effect of video games in the classroom is still needed, the reviewed literature outlined the potential that video games helped learners learn (Gee, 2005; Watson et al., 2011). According to Ares et al. (2018), the utilization of Kahoot in the learning process has resulted to a significant increase in students' academic performance and it can be argued that the application of Kahoot as a gamification instrument for tertiary chemistry education had improved students' learning and performances. In addition to that, research studies in have indicated that integrated technology in secondary science education may have a positive impact on students' motivation and engagement in science learning and enhance learning through gamification tool such as Kahoot (Khazanchi, 2019).

Besides that, collaboration using cloud-computing technologies is another application for current classroom computers. Google Apps is one of the collaborative tools frequently referred to in the school literature (Sultan, 2010). These tools are designed primarily to enable people to work together on Internet documents such as Google slides, Google docs, etc. When using these tools, whether the partner is in the same space or nationwide, writing an assignment with a partner can occur in real time (Wang, 2017). Most importantly, as learners edit their task, the other respondents can immediately see the modifications being made. This enabled users to write their work with others, enabling them to edit, communicate and retrieve ideas and experience different styles of writing (González-Martínez et al., 2015). The 'cloud computing' is comparable to collaboration. The ' cloud' is a center where anywhere information is stored and accessed. The primary benefit of using the cloud is that from any internet-connected computer in the globe you can access your files. It also enables people to share their documents with others or to read and edit the documents. This trend of ongoing connectivity and sharing of thoughts continues to develop, particularly in scholarly successes (Al-Emran & Malik, 2016; Sultan, 2010). Since the above technologies have the biggest potential to improve communication among all-important educational communities, such as educators, peers, professionals around the globe and their parents (González-Martínez, 2015). Therefore, it should be used widely as teaching and learning instructional approaching in chemistry education.

2.1.2 Traditional Classroom

Traditional classroom instructions usually depend on techniques that perceived to be teacher-centered rather than student –centered and also known as direct instruction (Clark, 2014). Instructors involved in this instructional strategy usually use material dissemination and presentation, lectures, attempt practice questions as techniques for learning of new content and questions and answers sessions (Martin, 2012). In a traditional classroom setting, the following features are often found (Steinmatz, 2013): (i) teacher-centered learning and instructor speaks and gives lecture teaching most of the time, (ii) lack of differentiation in learning activities for high and low achievers and usually provides whole class instruction, (iii) instructor makes the decision on how to allocate class contact time and (iv) textbook is used as primary resources to develop instructional content materials.

With direct whole class instruction taking place, lecturing to learners is a way to distribute massive information to a large number of learners. This method is helpful when fundamental knowledge is needed but does not allow learners to gain conceptual understanding, particularly in chemistry education (Steinmatz, 2013). This lecture mode only gives learners the response with hopes that they are the passive learners (Steinmatz, 2013). The instruction and environment is constantly evolving in education, like the group of learners in the school and thus the educators also need to change their teaching strategy as to cater the learners' learning requirements. With this, a different teaching approach requires to be developed and applied in order to transform learners from easy fact memorization to deeper conceptual understanding and the use of technology and active learning practices (González-Gómez et al., 2016). To do this, educators must switch to a student-centred classroom from a teacher-centred classroom (Roehl et al., 2013).

2.1.3 Flipped Classroom

The flipped classroom is an educational approach that has transformed the teaching and learning paradigm into a student-centered one (Ritchhart et al., 2011). The concept of flipping the classroom is not recent (Pardo et al., 2012), but due to technological improvements and increased access to computers and other mobile devices, the idea has recently achieved prominence (Schneider et al., 2014; Seery, 2015). Flipped classroom is always compared to online learning because of the videos components and associated online resources. However, there are distinct differences. For online learning, it transpires from a distant place but between educators and learners there is no face-to face session (Oblinger, 2005). In fact, flipped learning fall under the larger taxonomy of blended learning (Staker & Horn, 2012). Blended learning is the act of teaching, assessment and feedback that can be complemented by what we do in the online component of our teaching (Seery & Conner, 2015). Flipped classroom is a type of blended learning that utilizes both face-to- face and online learning (Ng, 2014). With the advances in technology, flipped classroom allows instructor to access various Cambridge IGCSE based online resources such as Learnerscloud, Kerboodle, Twinkl, Quizlets, Google classroom, Kahoot video game, etc. Previous study on flipped learning reported that this instruction has positive effects on students' performance and attitude towards learning (Rahman, 2014). Most importantly, the change from teacher-centered to student-centered learning takes place (Sletten, 2017).

In a flipped classroom, lectures are assigned in the form of videos are viewed before attending the classroom, and assignments traditionally assigned as homework are performed as learning activities in the classroom (Ryan, 2015). By shifting the content delivery portion of a class out of the classroom, educators have more time to devote to student-centered, effective teaching strategies where learners can integrate their understanding and apply it. According to Hamdan et al (2013), the flipped learning network, which comprises of a group of teachers devoted to promote the flipped learning system has developed the following four components of flipped learning. These are flexible environment, learning culture, intentional content and professional educator.

Flipped learning enables a range of learning modes in a flexible setting; teachers often rearrange their room physically to support a lesson or unit to promote either group or independent study (Hamdan et al., 2013). They provide flexible spaces for learners to choose when and where to study. In addition, teachers who flip their lessons are flexible in the expectations of their learner timeline and the evaluation of learners. Furthermore, the teaching pace and evaluation in flipped classroom is flexible, reflecting the learners' learning abilities. It allows the utilization of some differentiated content materials in this matter such as core worksheets for weaker learners or extended worksheets for high competent learners. Weaker pupils are facilitated in meeting compulsory goals while pupils with higher level of competence are challenged with more inclusive, inquiry-based and problem solving assignments (Ng, 2014).

The educator is the main source of information in terms of learning culture in the traditional teacher-centered model. On the other hand, the flipped learning model intentionally move direct instruction to learner centered instruction, which class contact time is devoted to more comprehensive exploration of subject matter and rich learning opportunities is provided. By focusing in learners, teachers can foster student interest, which translates into increased student motivation for learning (Heafner, 2004). This is due to flipping the classroom does provide a personalized education that tailored to their individual requirements through differentiation activities in class. As a consequence, learners engage actively in building of their knowledge and assess their learning in a meaningful way (Schultz et al., 2014).

Furthermore, educators are constantly considering on how to implement the flipped learning model to assist learners gain understanding of concepts and procedural learning through task performance (Ryan, 2015). They decide on what content they should deliver and what resources they need to use to explore learners. Instructors utilize content intentionally to optimize student learning time in class by adopting active learning strategies, student-centered learning activities grade-based level and subject matter. The examples of active learning activities may include small group presentation, peer-led discussion, peer marking or autonomous research. Continuous thinking on how to improve the conceptual knowledge of learners is emphasized (Hamdan et al., 2013).

According to past studies, in flipped learning, the role of an educator is specifically more crucial and challenging compared to traditional classroom (Gojak, 2012; Hamdan et al., 2013). Teachers constantly observe their learners during class time and evaluate their class work. In doing so, it is the teacher's decision to decide and manipulate the transformation of the direct instruction into an individualized coaching practice to maximize face-to- face class time (Gojak, 2012). In their practice, professional teachers are reflective, connecting with each other to enhance their training, tolerating controlled chaos in their class and accepting constructive criticism. While in a flipped classroom, professional instructors play less clearly prominent roles, they stay the vital component that allows flipped learning to take place. Learners in the formal classroom would concentrate on and participate in tasks that foster deeper understanding and high-order thinking through group discussion, practical practices, and problem solving assignments, which they performed as individual work or as small group collaboration (Lo & Hew, 2017).

Table 1.1 below demonstrates an overview of how class contact hour is maximized in comparisons between flipped classroom and traditional classroom in secondary school environment (Bergman & Sams, 2012).

Table 1.1

Comparisons of Class Time In Flipped Versus Traditional Classroom (Bergman & Sams, 2012).

	Activity	Time (min)
Flipped Classroom	• Start-up activity (starter)/ Review activities	10 mins
	• Guided /Independent Practice/ Interactive Activities	40-50 mins
Traditional Classroom	• Start-up activity (starter) /Q & A session on homework from previous lesson	10 mins
	• Guided / Independent Practice	10-20 mins
	• Lecture	30 -40 mins

Although the empirical research or extensive quantitative research on flipped learning is limited, the primary mechanisms of the strategy are supported by a body of research (Hamdan et al., 2013). As mentioned in the past literature, the benefits of using the flipped classroom include personalized coaching to students, enhanced student engagement, active learning and frequent class discussions while ensuring standardized curriculum adherence (Millard, 2012). Enfield (2013) examined the effect of the flipped classroom on learners in a multimedia undergraduate course. The results revealed that this new instructional strategy has benefitted the learners, increasing the rate of participation in class and promoting student engagement (Enfield, 2013). Besides that, learners discovered video lecture in a flipped classroom to be main motivators and they gain more competency in learning a new topic (Enfield, 2013). In Malaysia, there was a study done by Zainuddin and Attaran

(2016) on flipped classroom in University of Malaya. Their research focused on the theory of mastery learning as their theoretical framework for flipped classroom, which conducted among the postgraduate students. The findings reported that at least 80 % of students stated that flipped learning is found to provide more student participation and engagement than traditional lecturer classroom environment. According to Steinmatz's (2013), even though there was no definite findings to reveal how the flipped classroom operated, the findings revealed that 80 percent of the 453 instructors who implement flipped classroom strategy had an improvement in terms of attitudes of the students and 67 percent had an increase in performance through standardized test scores. However, there is little scientific evidence on its effect on learners' motivation and attainment in the aspects of educational outcome (Abeysekera & Dawson, 2015). It is therefore suggested that the application of the flipped classroom with its technology incorporation should be examined in order to enhance motivation and achievement among the learners (Abeysekera & Dawson, 2015). The desired of increased motivation and achievement in flipped classroom is aligned with the self-determination theory that describes how Deci and Ryan's (2000) view of human learning and motivation.

2.1.4 Chemical Equilibrium

Chemical equilibrium is one of the most challenging and difficult topics in chemistry education (Davenport et al., 2014; Rogers et al., 2000; Yildirim et al., 2016). This topic is representative of the specific nature of chemistry since it requires the conceptualization of macroscopic events, explanation of sub microscopic nature and application of symbolic language and mathematics (Demissie et al., 2013). Chemical equilibrium has a long tradition in learning difficulties and misconceptions that have persisted until nowadays (Kousathana &

Tsaparlis, 2002; Piquette & Heikkinen, 2005). The previous research on chemical equilibrium concentrated on different teaching instructional strategies to clear up the misconceptions related to chemical equilibrium such as using conceptual change model (Yildirim & Yilmaz, 2016), using jigsaw technique (Doymus, 2008), using modelling-based teaching instructions (Maia & Justi, 2009) and using ICT technologies as learning tools (Rau et al., 2017). According to Demissie et al., (2013), chemical equilibrium is commonly identified as a topic suitable for the pedagogical use of Information and Communication Technologies (ICT). By using ICT in teaching of chemical equilibrium, it is easier for the students to reach the abstraction level in order to understand chemical equilibrium concepts because the abstraction level is the major source of difficulties to students (Demissie et al., 2013). With the aid of digital technologies such as videos integrated with student-centered learning in flipped classroom, students are able to visualize complex and abstract concepts in chemical equilibrium (Demissie et al., 2013). Therefore, more empirical research on instructional strategy that using technology in teaching chemistry such as flipped classroom in chemical equilibrium is essential (JeetKaur & Sharma, 2013; Rau et al., 2008).

2.1.5 Intrinsic Motivation and Achievement

One of the most important factors leading to one's goals is the drive (Singh, 2011). This drive is referred to as motivation. Motivation could certainly be perceived as one of the most important concepts of education in psychology (Eymur & Geban, 2011). One of the useful theories developed for understanding of motivation in an individual is self-determination theory (Niemiec & Ryan, 2009). Self-determination theory proposes that the impetus motivated conduct has the experience of choice (autonomy) and excitement of efficacy in actions (competence), along with the interactions of others in an environment (relatedness). According to Deci and Ryan (2000), there are two main types of motivation, which are extrinsic motivation and intrinsic motivation. Extrinsic motivated learners position their behavioral control location outside themselves and are influenced by external components such as rewards and penalties. (Luan, 2009). In this study, the focus of the type of motivation will be on intrinsic motivation because it is reflected as the greatest level of motivation since the place of behavior is entirely internal (Grolnick, 2002). Intrinsic motivation is to engage in learning activities for itself and gain satisfaction from active involvement (Cortright et al., 2013; Gilboy et al., 2015). According to self-determination theory, conditions supporting the individual experience of autonomy, competence, relatedness, interest and value are argued for supporting the highest quality motivation forms called intrinsic motivation (Garon-Carrier et al., 2016) and most importantly the effort to support intrinsic motivation were commonly recognized as a desirable instructional practice (Khoshnam et al., 2013). According to Carlisle (2010), students enrolled in a flipped classroom seemed better autonomous learning skills and they wanted to take more ownership for their learning and more persisted on tasks given. One of the instructional strategies to achieve greater student engagement, higher intrinsic motivation and achievements refers to "doing the activity itself for the intrinsic satisfaction of the activity" (Deci & Ryan, 2000). Therefore, active learning pedagogies such as flipped classroom is implemented in order to increase student engagement in the classroom and keep them motivated and persisted on task to achieve higher attainment.

Previous research suggests a positive correlation between intrinsic motivation and achievement (Aunola et al., 2006; Denissen et al., 2007) but to date the direction of this developmental relationship remains unclear (Garon-Carrier et al., 2016). According to Koller et al. (2001), educational interventions strive to increase intrinsic motivation, and ideally achievement by promoting autonomy, relatedness and competency among learners. According to self-determination theory, past literature have reported that intrinsic motivation predicts achievement but some studies did not (Areepattamannil et al., 2011; Bouffard et al., 2003; Garron-carrier, 2016). According to Garon-carrier (2016), the research demonstrates that intrinsic motivation does not result "naturally" in greater achievement, but intrinsic motivation can be improved through interventions.

2.1.6 Related Literature

According to previous research, in an introductory science course, studies have been done on the intrinsic motivation of adolescents' aged 14 to 16 to learn science. This study found that the learners were intrinsically motivated when they participate in small group collaboration and practical activities based on the findings in questionnaire data and interviews (Bryan et al., 2011). Based on previous studies, the overwhelming amount of contextual information and educators depend mainly on PowerPoint presentations demotivated students (Bryan et al., 2011). Alternatively, in their science lessons, the learners strived to increase autonomy, research-based activities and social interaction with peers (Nolen, 2003; Potvin & Hasni, 2014).

Williams (2011) reported on the learners' motivation and the possibilities to even enhance intrinsic motivation by identifying the psychological needs and interest of learners. This was done by implementation of science education instructions that allow high school learners to improve their intrinsic motivation. A total of 54 Finnish and Greek graders used the questionnaire based a psychometric inventory based instrument to assess the science inquiry activities (Trenshaw et al., 2016). According to Vaino et al. (2012), a multidimensional psychometric instrument, which also known as Intrinsic Motivation Inventory, can be used to assess learners' experiences in given to measure the psychometric properties such as competency, autonomy, interest, etc. Based on self-determination theory, the study discovered that the aspects that can be included to evaluate learners' intrinsic motivation were valued differently (Li, 2019). Jewell (2011) stated that learners are keen to know what teachers expect if adequate resources and the implementation of relevant teaching strategies are employed. In addition, students who participate in fun learning activities, are able to fulfill personal satisfaction and then more likely to adopt positive attitudes and further increase their intrinsic motivation towards science learning, which resulted in higher achievement (Koballa & Glynn, 2010). According to previous study done in Malaysia, Chan and Norlizah (2017) reported that the students' motivation towards science learning has a significant correlation with students' science achievement. In addition to that, the finding indicated that there is a significant difference between in students' motivation between male and female students. However, this study did not reveal on the correlation between the intrinsic motivation and chemical equilibrium achievement among the secondary school learners.

2.2 Conceptual Framework

The conceptual framework is based on the independent variables, which comprises of the traditional classroom instructional strategy and flipped classroom instructional strategy. There are two dependent variables in the study that consists of intrinsic motivation scores and achievement scores respectively. This is to investigate the effects on Year 11 pupils' intrinsic motivation and achievement scores in chemical equilibrium by manipulating the instructional strategy used in this study. Pupils' intrinsic motivation scores will be evaluated by using a modified Intrinsic Motivation Inventory (Vaino et al., 2012). This instrument was used to measure the students' intrinsic motivation with the subscales of competency, autonomy and relatedness, interest and value before and after the intervention for both control and experimental group. By using the Likert-rating scale, the intrinsic motivation scores are recorded.

The second dependent variable is pupil' achievement scores, which was measured by the chemical equilibrium assessment test (CEAT). This instrument measured the students' chemical equilibrium achievement scores, which covered the subtopics of 9.1 energy changes, 9.2 exothermic and endothermic reactions, 9.3 energy diagrams, 9.4 energetics in terms of bonding, and 9.5 bond energy. This instrument was used before and after the intervention for both control and experimental group in this study.

Figure 2.1 below presents the conceptual framework of the study. This framework gives an overview idea of the present study and finally to investigate the correlation between pupils' intrinsic motivation and achievement in chemical equilibrium.

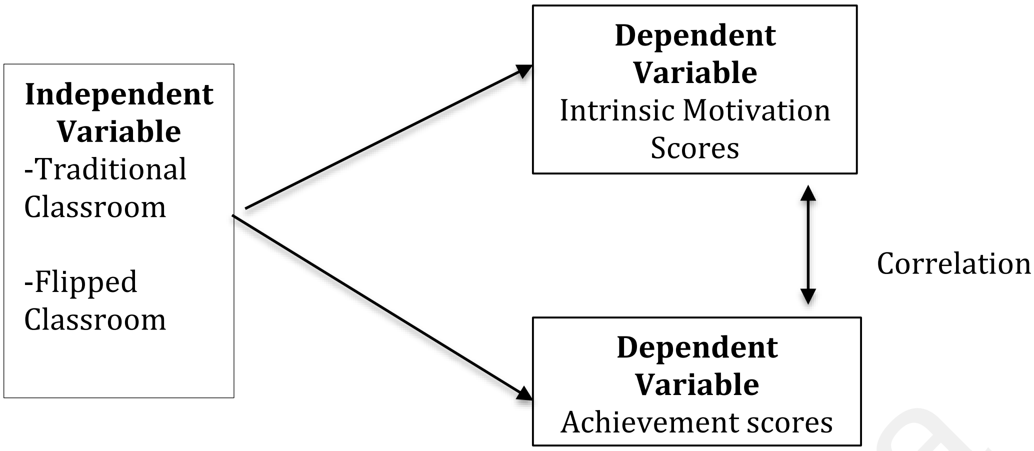

Figure 2.1. Conceptual Framework of the Study.

2.3 Theoretical framework

One of the most empirically and comprehensive supported theories of motivation nowadays is self-determination theory (SDT) (Riley, 2016). The theory of self-determination is unique in comparison with other motivational theories, as it highlights the educational task of improving the internal motivational resources of learners as the essential element in achieving high quality participation (Reeve & Halusic, 2009). SDT differentiates between two primary forms of motivation: intrinsic and extrinsic. Intrinsic motivation relates to those activities that learners participate in as they are naturally exciting and pleasant, while extrinsic motivation relates to learners involved in activities as they result in distinct results (e.g., reward and punishment) (Ryan & Deci, 2000). According to Reeve et al. (2003), intrinsic motivation is spontaneous motivating force in all individuals that emerges naturally from the needs for self-determination and it empowers essential growth-fostering conducts such as to persuade on one’s interest. Over the previous four decades, SDT-led experimental and field research has been intrinsically motivated to predict improved learning, efficiency, creativity, optimal growth and psychological well-being (Domenico & Ryan, 2017).

In this research, SDT was selected as its implementation in education is one of the domains because motivation is regarded as a key factor in students' achievement and engagement (Ryan & Niemiec, 2009). According to previous studies, SDT offers a framework to understand why students engage in activities and how contextual variables and regulatory processes may interfere with interactions or task features (Boiché et al., 2008). As SDT research has advanced, basic needs theory (BST) is one of the mini theories emerged to describe these different motivational occurrences in intrinsic motivation. According to BST, the conditions that fulfill the sense of autonomy, competence, and relatedness are claimed to contribute to greater quality forms of motivation are called intrinsic motivation (Ryan & Deci, 2000). Therefore, in order to evaluate intrinsic motivation, all three psychological needs of autonomy, competence and relatedness are essential (Orsini et al., 2015). Besides that, the subscale interest is the most direct measure of intrinsic motivation and it evaluates the inherent enjoyment when carrying out specific activities (Monteiro et al., 2015). In addition, the subscale usefulness is included as to internalize and become more self-regulated with the activities that they experience as useful for students and to improve the level of intrinsic motivation (Vaino et al., 2012). Hence, evaluation of the approach in this study focused on indicators of autonomy, competence and relatedness, but also including items of students' interest and value (Vaino et al., 2012). According to the past literature, the IMI was used to study the intrinsic motivation in education (Filak & Sheldon, 2003; Vaino et al., 2012; Monteiro et al., 2015). As a result, an instrument known as Intrinsic Motivation Inventory –IMI (SDT, n.d.) is used in this study to determine the levels of intrinsic motivation that measured by a set of subscales: competence, autonomy, relatedness, interest and usefulness as the outcome of flipped classroom intervention.

2.3.1 Autonomy

Studies found that when teacher offer student's choices, the choices will increase self-determination and motivation intrinsically (Reeve, 2012). By treating learners as active participants, the flipped classroom approach is to fulfill the need for autonomy of learners and thus affect their learning attitude through integrated regulation, which will then lead to increased intrinsic motivation (Abeysekara & Dawson, 2015). For example, in this study, when learners voluntarily choose to invest time and energy to learn the basic chemistry content knowledge, they are considered autonomous and intrinsically driven (Niemiec & Ryan, 2009) via the educational videos in the Google classroom before attend the in-class lesson. Being an active learner requires time and space to take ownership of the learning process. As a result, when learners are in control of their conduct, they feel relaxed and comfortable. Autonomy can also be referred to independent learning after class or home study (Zainuddin & Pererra, 2017). In the flipped classroom, teachers can improve this by providing alternatives of learning methods during out-of –class-learning session such as utilizing various types of videos (educational videos like Khan Academy, FuseSchool or instructional videos, etc) and online exercises (Google Quiz, Quizlet, etc), leading to intrinsic motivation (Bengtsson & Ohlsson, 2010; Kusurkar et al., 2011).

2.3.2 Competence

To what extend to which learning activities pupils are intrinsically motivated, also depends on the competency fulfillment (Vaino et al., 2012). The focus of the flipped classroom approach is to create learning environments that support students' centered learning activities. For instance, students have the chance to build knowledge and scientific understanding by participating actively during in class activities. Students feel more competent when they are engaged in activities that building knowledge and sharing of information compared to traditional instruction strategy which most of the time they are passive knowledge recipient governed by an educator (Lord et al., 2012; Thaman et al., 2013). In flipped classroom, in class activities such as Kahoot game based technology learning tool can be used as low risk formative assessment to enable learners to respond actively and receive instant feedback. This can provide constructive feedback to students on the progress of their learning and this benefits their competence level (Legault et al., 2006). Besides that, in -class learning activities such as differentiated task (core and extended) is needed to ensure the assigned tasks are in line with the learners' level of understanding and skill. In fact, activities should not be too difficult, but not too simple to evaluate and develop students' skills. All the above activities could be used to make the students feel competent in their learning tasks when they can meet challenges during the activities (Brohy, 2004; Legault et al., 2006). Hence, it is important to offer optimal challenges for students who feel competent and then reinforce their intrinsic motivation (Cortright et al., 2013; Khoshman et al., 2013).

2.3.3 Relatedness

Relatedness refers to a sense of community, belonging, and shared purpose in the efforts of an individual (Trenshaw et al., 2016). According to SDT, there are two aspects to support learners' psychological requirement for this component, which consists of interaction between teachers-students and also interaction between students-students. Therefore, the level to which the learning environment used in flipped classroom chemistry learning fulfills students' need for relatedness is essential to determine the level of intrinsic motivation (Beachboard et al., 2011). Through flipped classroom instructional strategy, it is likely to have a learning environment that supports small learning groups (peer led team) to increase their level of interaction among peers. Also, moving direct instruction outside of class time enables more time for educators to interact with learners individually or in a small group of students. Thus, it can be used to enhance the student experience of relatedness to teacher. As such, the flipped classroom environment is likely to fulfill students' need for relatedness, thus, increasing the level of intrinsic motivation. Overall, it can be postulated that learning environments generated by the flipped classroom strategy are expected to meet the students' needs for competence, autonomy and relatedness and therefore, contribute to a greater level of intrinsic motivation based on SDT (Zainuddin & Halili, 2016).

The SDT theory that connects the flipped classroom (independent variable), intrinsic motivation and achievement (dependent variable) in the theoretical framework is shown in Figure 2.2. Flipped classroom is able to create an environment that enables students to be more self-determined by increasing the level of motivation through fulfillment of three psychological needs, which comprised of sense of competence, autonomy and relatedness (Deci & Ryan, 2000).

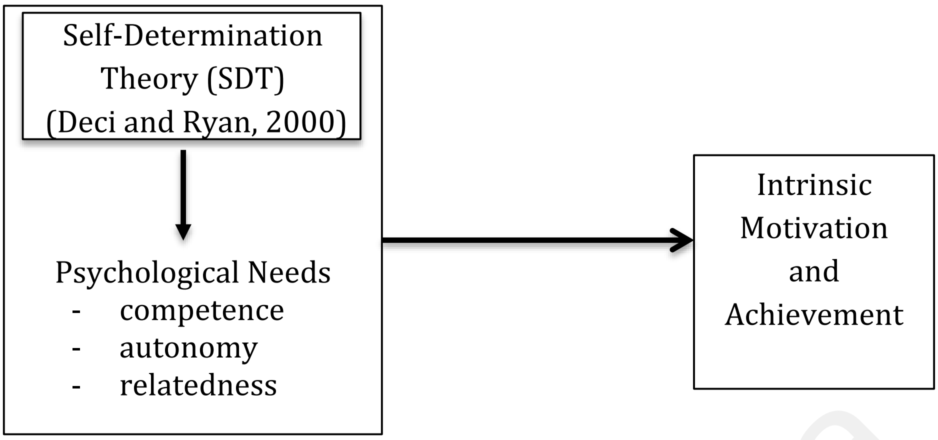

Figure 2.2. Theoretical framework of the study

2.4 Summary

The discussions of theoretical framework, study of the status of knowledge and review of the latest substantial findings on the flipped classroom are outlined in this chapter. This section began with the discussions of technology integration in education, studies on traditional and flipped classroom, problems relate to the topic chemical equilibrium, relationship between the two dependent variables, and related literature in this study. In Malaysia, there is a research studies that contribute to the body of knowledge of flipped classroom by Zainuddin and Attaran (2016). However, in their research only focused on postgraduate students in tertiary education. As a result, the current study intends to use a quantitative methodology to investigate the implementation of flipped strategy in improving pupils' intrinsic motivation and whether it may lead to better achievement in secondary education.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The research design, subject of the study, instruments and the procedure of the study were discussed in detail in this section. The validity and reliability of instruments were reported. An ANCOVA was computed to test if the post intrinsic motivation and post achievement scores of control group is significant different from the experiment group with pretest as covariate.

3.2 Research design

The research design used in this study is a quasi-experimental non-equivalent pretest- posttest design as shown in Table 3.1 below. The researcher assigned intact groups, experimental and control groups, conducted a pretest to both groups, conducted experimental treatment (flipped classroom) activities with the experimental group only, and then conducted a posttest to evaluate the differences between the two groups (Creswell, 2015). A pretest and posttest were utilized in this study as to increase the internal validity. This design was selected due to the inability to perform randomization when sampling. This inability to perform random assignment on two groups that consists of control group and experimental group is the main weakness of the research design in this study. However, this weakness can be overcome by using ANCOVA analysis through the adjusted mean in pretest scores (Schneider et al., 2015). Besides, a control group was used as a result of lack of randomization due to the education environment in this study (Baker & Ponton, 2013). Furthermore, a pretest was conducted as a control for the differences in intrinsic motivation and achievement scores. One of the main advantages of using this quasi-experimental design is to increase the research's ecological validity attributed to same environment for both of the experimental and control group (Schmucker, 2001). Therefore, the external validity of the study can be improved (Gall et al, 2007).

Table 3.1

Pretest and Posttest Quasi- Experimental Design

Group	Pretest	Treatment	Posttest
Control	O1 (pretest)		O2 (posttest)
Experimental	O1 (pretest)	X1	O2 (posttest)

Note. X1 = Treatment of flipped classroom approach.

3.3 Research sample

In this study, convenient sampling method was used to identify the effect of flipped classroom on pupils' learning intrinsic motivation and chemical equilibrium achievement among the Year 11 students, who are ranged between 16-17 years old. The participants consisted of both males and females. Convenient sampling was chosen, as the population is readily accessible to the researcher. The sample of this study consists of 60 students, attending two sets of students (TC3 and TC4) at private international school, located in Selangor. 30 students from TC3 set was assigned to the treatment group, and the other 30 students from TC4 was assigned as the control group. Students with different learning abilities are in each group. Both experimental and control groups was taught by the researcher and another experienced chemistry teacher. This study focused on Year 11 students as they are a notable group due to the turning point on which they stand in to determine their future options in tertiary education (Raved & Assaraf, 2011).

3.3.1 Flipped Classroom Setting

Pupils that participate in flipped classroom gained subject knowledge through instructional or educational videos such as LearnersCloud, Kerboodle, Google classroom and Kahoot. In this study, LearnersCloud, an online IGCSE e-learning resource was chosen as the coverage of this resource is tailored and relevant to IGCSE curriculum syllabus. This resource was developed by real UK IGCSE teachers to ensure that each clip covers a specific topic or unit within the UK's leading exam board specifications. Thus, it can be used as a revision tool or as a complimentary teaching resource in class. It incorporates classroom learning with a variety of online videos and test and learn questions (refer to Appendix L).

Besides, Kerboodle was chosen as it works alongside with the course textbooks packed with customisable learning content and a range of assessment materials such as auto-marked quizzes and self-assessment checklists (refer to Appendix K). It allows integration of quality digital resources such as digital book, activities to develop exam skills and assessment practice papers into flipped classroom. Overall, Cambridge IGCSE ® Kerboodle is an integrated online evaluation and feasible option for the recent scientific syllabuses in Cambridge IGCSE.

Kahoot, interactive game-based quizzes conducted with the ICT gadgets in the classroom with the learners. In using Kahoot tools, learners click the correct response key to a question displayed on the smartboard with the application of ICT gadgets such as tablet, laptop, mobile phone, etc. For each correct response provided, students earn marks for that. It was chosen due to its systematic assessment that provides immediate feedback after completion of the game. It shows four aspects in the analysis: fun, learning effectiveness, learning recommendations and types of feelings accompanying the game. Most importantly, Kahoot cultivates an environment with a sense of autonomy and better chance to enhance interactions (Zarzycka-Piskorz, 2016). This can relate to intrinsic motivation that is the main concern of this study as games could be an intrinsic motivation booster (Zarzycka-Piskorz, 2016).

For educational websites such as LearnersCloud, IGCSE Kerboodle and Google Classroom, students will be provided with username and password. This login details allows the students to access to the course materials (eg: videos, assignments, progress). These educational websites allow students to collaborate to take place outside the teaching and physical school setting. Kahoot is an online game that tests that requires a multimedia tool to participate by joining with a given game pin number (Siegle, 2015). All of these technology tools allow students access outside the school in the form of laptop, cell phones, or tablets. Besides, learners have the right to use ICT gadgets in school library to access the technology tools mentioned above.

The lesson for experiment group began with 10 minutes of review activities as preparation for the lesson (Appendix P). The lessons continued with facilitate session the teacher. The facilitate session continued with students' centered active learning activities such as peer discussion, Google slides presentation and Kahoot interactive learning games for 40 mins. This session aims to improve the sense of relatedness through class interactions between students and students or teachers to students. Activities like peer discussion, small group presentation, small group assignments using Google apps allow students interact with their peers and lead to intrinsically driven to perform the tasks. At the same time, personalized coaching from the instructors allows more interactions take place during the facilitate session.

Overall, the level of relatedness can be improved through increased level of interactions. After that, this continued with the solidify session by students' self-evaluation for 10 mins by using Kahoot or Kerboodle quizzes. In these websites, there are differentiated level of activities such as beginner, intermediate and higher level. This allows students to complete the tasks based on their competency. If the learners are able to achieve at certain level, they are allow to proceed to a more challenging level based on their competency.

Lastly, for homework session, students are provided with multiple resources such as educational videos in Google classroom, presentation slides, and Learnerscloud websites and they are provided the freedom to choose. This will give them the autonomy to learn the content knowledge before attending the class lesson. The implementation of the flipped classroom activities which promote the main elements of self-determination theory (autonomy, competency, relatedness) are demonstrated with the asterisks remark (*) in the lesson plan below. A brief description of the six weeks experimental group lesson plan is summarized in Table 3.2 below.

Table 3.2

Summary of Six Week Lesson Plan for Flipped Classroom Instructional Strategy

Week	Subtopic	Learning Intention	*Component
1	9.1Energy Changes	PREPARE: Review using Kahoot game-based learning. FACILITATE: Mini-lectures by instructor; peer discussion on " glossary matching activity" and personalized coaching. SOLIDIFY: Complete Kerboodle quizzes as self-evaluation. HOMEWORK: View educational videos/ presentation slides posted in Google classroom.	Competency Relatedness Competency Autonomy
2	9.2 Exothermic and Endothermic Reaction	PREPARE: Complete Oxford Cambridge Assessment Worksheet. FACILITATE: Interactive small group presentation using Google slides. SOLIDIFY: Complete Kerboodle quizzes as self-evaluation. HOMEWORK: View videos posted on Google classroom or Learnerscloud to complete the guided notes given.	Relatedness Competency Autonomy
3	9.3 Energy diagrams	PREPARE: Complete Kerboodle quizzes. FACILITATE: Peer-led or personalized coaching is given when doing past year questions. SOLIDIFY: Complete Kahoot interactive quizzes. HOMEWORK: View the instructional videos from Learnerscloud, Kerboodle or Google classroom to complete the guided notes given. Complete Learnerscloud online assessment.	Relatedness Competency Autonomy
4	9.4 Energetics in terms of bonding	PREPARE: Question and answer (Q&A) session based on the online assessment results. FACILITATE: Ten minutes minilectures is given. In pairs or small group, complete the past year questions. Personalized coaching is provided. SOLIDIFY: Peer marking and discussion. HOMEWORK: Using Google classroom to complete the assignment given.	Relatedness Autonomy
5	9.5 Bond Energy	PREPARE: Question and answer (Q&A) session for the previous questions on Google classroom. FACILITATE: Peer discussion to complete the booklet created by researcher. Differentiated tasks (core or extended) is given based on the students' competency. SOLIDIFY: self evaluation by checklist HOMEWORK: Nil	Competency
6	Revision session (9.1 to 9.5)	PREPARE: Review overall lesson objectives. FACILITATE: Using Google slides small group presentation on summary of the topic and Kahoot revision quizzes. SOLIDIFY: Complete Kerboodle Quizzes as self-assessment. HOMEWORK: Nil	Relatedness and competency

In addition to that, flipped classroom approach used in the study is possible to increase the teaching contact time in comparison with traditional classroom. This is attributed to the long lecturer sessions in traditional classroom that is one of the major issues of insufficient time allocation in secondary science education due to its intensive curriculum especially in chemistry subject. Therefore, flipped classroom will replace the long lecture session, which takes around 20 to 30 minutes with content knowledge delivery by providing the homework for the learners to acquire knowledge before attending the lesson. In this way, learners will have the opportunity to acquire the prior knowledge for the specific subtopic during the class lesson. During the class contact time for facilitate session, which takes around 20 to 30 minutes, learners are able to engage in group activities like peer-led discussion and personalized coaching from instructors. As a result, this can save the insufficient teaching hours due to extensive chemistry curriculum and at the same time students can have more class contact time to interact with their peers and teachers. A brief description of the comparisons between flipped classroom and traditional classroom instructional strategy is presented in Table 3.3 below.

Table 3.3

Comparisons between flipped classroom and traditional classroom

Flipped Classroom	Traditional Classroom
In Class: (PART 9.3 ENERGY DIAGRAMS)	In Class: (PART 9.3 ENERGY DIAGRAMS)
Group Discussion (30-40 mins): Students need to complete two structured questions extracted from past year questions (May/June 2016 and 2017-paper 4) on exothermic and endothermic energy diagrams. Peer-led discussion and instructor may provide personalized coaching by group if learners require further clarification.	Lecture (30-40 minutes): Students will watch the instructional videos on energy diagrams for exo and endothermic reactions (Learnerscloud) in class. Instructor will provide lecture on the new content based on the videos shown.
Previous Homework Assignment 1: Using LearnerCloud ®, watch instructional videos on energy diagram (https://player.learnerscloud.com/player/course/64 running time 6:00) on the energy diagram of chemical reactions (part 9.3). Assignment 2: Using Kerboodle ®, complete the assigned online quizzes to identify the exothermic and endothermic energy diagrams (Part 1 and Part 2).	Homework: Complete two structured questions extracted from past year questions (May/June 2016 and 2017 paper 4) on exothermic and endothermic energy diagrams.

3.3.2 Traditional Classroom Setting

In traditional classroom environment, students in the control group receive content delivery, which is face –to face. The main difference is the pupils in this group will not be given login details for accessibility to the educational websites such as LearnersCloud, Kerboodle and Google Classroom. Students in traditional classroom were given guided notes and new materials. They would not use the educational websites above during the study. Also, the pupils in control group were not exposed or awared of the technology platform that pupils in the flipped classroom used. Barak (2007) claimed that it is crucial to make sure the participants are not aware of the treatment used in the study as to reduce the resentful demoralization. A resentful demoralization can be a threat to the internal validity of the study and Onghena (2014) reported that any treatment groups in quasi-experimental design usually are vulnerable to resentful demoralization. Further description of the control group lesson plan can refer to Appendix O.

3.4 Research instruments

3.4.1 Chemistry Equilibrium Assessment Test (CEAT)

The Chemistry Equilibrium Assessment Test (CEAT) (refer Appendix A) was chosen to examine the dependent variable academic achievement in chemical equilibrium. The instrument used to create the chemical equilibrium assessment test is Kerboodle® Oxford Complete Chemistry for Cambridge IGCSE Assessment Tool. Assessment tool is part of Kerboodle® collection of digital book, exam skills and assessment products.

The test bank was extracted from the Assessment Tool of Oxford Cambridge IGCSE Kerboodle® and was used to create the assessment test in this study. Also, it was comprised of forty past year questions that used to evaluate the mastery level for the concepts that covered on the unit of chemical equilibrium. All questions are governed by the Cambridge Assessment International Education and are aligned with the curriculum standards. In this study, this test was given to test the participants using online Google Forms during class time. Participants for both experimental and control group were provided approximately 25 minutes to complete the online test.

Besides, the validity analysis of CEAT was conducted. The researcher extracted 20 questions from Kerboodle IGCSE ® for CEAT by taken in considerations of opinions of CIE Chemistry Examiner from Cambridge Assessment Specialist Team who comprised of three teaching staffs from the science department with chemistry education background and more than 7 years of experience (refer Appendix F). Opinions of specialists were consulted to determine the suitability of question types for students which covered five subtopics of chemical equilibrium, including energy changes, exothermic and endothermic reactions, energy diagram, energetics in bonding and bond energy. From twenty questions extracted from the question bank, 10 questions are from core questions for lower competence level and another 10 questions are extended questions for higher competence level. This is to ensure the questions have no bias in terms of testing the level of competency among the participants. Sample questions are shown in Appendix A below.

The 20-item CEAT was administered on a sample of thirty students in order to test the reliability of the instrument. These participants are not part of the study but their demographics are similar to the students involved in the main study in terms of age and class level. Based on the students' responses in this pilot study, the correlation value, r = 0.89 was obtained by using SPSS with test-retest reliability method. In this method, the same test was given for the second time after a month (January and February 2018). Since the r value is bigger than .65, this instrument was reported to be suitable for obtaining reliable data from respondents in the same research location (Raz et al., 2013).

In terms of scoring procedure for chemical equilibrium achievement test (CEAT), there were 20 multiple choice questions (MCQs), one mark is given for each right answer. There were 20 MCQs with four choices. Thus, the maximum score would be 20 marks whereas minimum score will be 0 marks.

3.4.2 Intrinsic Motivation Inventory (IMI)

A modified version of Intrinsic Motivation Inventory (Vaino et al., 2012) was used to evaluate the flipped classroom approach by using pretest and posttest method. The final validated version based on the indicators of competence, autonomy and relatedness, value and interest subscales with 21 statements (refer Appendix B) which has the overall reliabilities (internal consistency) with $\alpha= 0.888$. Specifically, the internal reliability, assessed by Cronbach alphas, measurement of the subscales were as follows: competence (0.82), autonomy (0.91), relatedness (0.62), interest (0.67), and value (0.74). According Vaz et al. (2013), if a coefficient is above 0.80 means “very good”, between 0.70 to 0.80 means “respectable”, between 0.60 to 0.69 means ‘undesirable to minimally acceptable,” and any values below 0.60 means “unacceptable”.

The modified version of Intrinsic Motivation Inventory (Vaino et al., 2012) was used to examine students’ perceived choice (autonomy), competence, relatedness level in their traditional classroom and in the flipped classroom in a five Likert scale from ‘strongly disagree’ (1) to ‘strongly agree’ (5). This questionnaire is suitable to measure intrinsic motivation in this study because the perceived choice (autonomy), perceived competence and relatedness subscales are postulated to be positively correlated with intrinsic motivation behavioral measures (Martens & Kirschner, 2004).

The original subscales validity was determined across a variety of learning activities, settings and environments (Atkinson et al., 2011; Nielson et al., 2016). The factors in the model corresponded to the sets of related items (refer Appendix

G), identified with the explorative factor analysis (EFA) by Vaino et al. (2012). Since explorative factor analysis has been done, therefore, confirmatory factor analysis (CFA) was conducted to recheck the internal validity of this inventory in this research. The pilot study used to validate the above inventory was carried out with similar study population by using CFA.

Table 3.4

Factor loadings with corresponding estimated correlations (validity coefficients) based on CFA analysis

Factor			Estimate
interest	<---	IMI	.651
autonomy	<---	IMI	.640
competence	<---	IMI	.760
value	<---	IMI	.627
relatedness	<---	IMI	.544

Based on the values obtained from confirmatory factor analysis (CFA) using AMOS software, the validity coefficients are estimated correlations, which defines how well a particular item measures its respective factor. Validity coefficients in CFA can be referred as factor loadings (Atkinson et al., 2011) and the loadings in the study above shows the range from high to moderate. Based on the CFA analysis, the factor loading 0.54 is the lowest coefficient in the study. It is acceptable as it exceeds the acceptable factor-loading criterion of 0.35 (Kim et al., 2016) (refer Appendix D).

Table 3.5 shows some sample questions found in the IMI (Vaino et al., 2012) that used to measure students' intrinsic motivation in chemistry. Likert scale used in this study is a 5-point agreement scale and each answer response of IMI was ranged from 1 to 5 which 1 = strongly disagree, 2= disagree, 3= neutral, 4= agree, and 5= strongly agree. (refer Appendix B).

Table 3.5

The components found in the modified version of IMI

Component	1	2	3	4	5
Question 11(Competence): I am pleased with my achievement at the tasks given in the lessons. Question 21(Autonomy): I believe I had some options when doing these activities. Question 17 (Relatedness): I received feedback from my classmates when participating in the lesson activities.					

In terms of scoring procedure for Intrinsic Motivation Inventory (IMI), out of 21 items, five items (10, 12, 15, 19, 20) were reversed phrases and thus they were negative scores. This indicates the Likert scale with strongly agree that gives five marks will be counted as one mark. In contrast, the Likert scale with strongly disagree will be counted as five marks instead of one mark. Meanwhile, the rest of the items are positive scores.

The summary of the measurement variables, formats of the assessment and instrument reliability used in the study are presented in Table 3.6.

Table 3.6

Descriptions of Instruments

	Modified Intrinsic Motivation Inventory (IMI)	Chemical Equilibrium Assessment Test (CEAT)
Variable measured	Intrinsic Motivation	Achievement
Assessment Format	Five-point Likert scale questionnaire	20 multiple-choice questions
Reliability	Cronbach's $\alpha = 0.88$	Test retest $r = 0.89$

3.5 Procedure

The duration of this study was six weeks. Participants were assigned to pre-existing classes to either experimental or control group. Each group received similar content materials in every class instruction. In order to differentiate these two groups, the experimental group was given mini lectures (10 to 15 mins), view videos and presentations for content knowledge delivery before attending actual lessons, complete in class activities, and some formative assessments using the Cambridge IGCSE Learnercloud ®, Kerboodle ®, Kahoot ® website and Google classroom outside of the classroom and regularly in the classroom during the instructional period. For ethical concern, the script that requested the students' permission will be announced first before intervention starts (refer Appendix E).

In contrast, in a traditional classroom setting, the participants were introduced to the subtopic content knowledge lecture based session that was conducted around 30 to 40 minutes during class time. During the lecture session, participants in the control group have to view the selected videos, slides, and activities during class contact time. Meanwhile, questions were given as homework. In this type of instructional strategy, the class contact time was mainly devoted to deliver the content knowledge rather than student-centered activities. The comparison between traditional classroom and flipped classroom approach within six weeks of the study is shown in the appendices (refer Appendix C). The Chemical Equilibrium Assessment Test (Oxford Kerboodle, 2018) and modified version of Intrinsic Motivation Inventory (Vaino et al., 2012) was administrated to all the students as pretests and posttests, and afterwards the findings was evaluated and recorded statistically. In this study, inferential statistical analysis of variance (ANCOVA) was utilized to test the null hypotheses. The research design of this study is presented in Table 3.7.

Table 3.7
Research Design of the Study

Group	Pre-test	Implementation	Post-test
Experimental Group YEAR 11 TC3 (N= 30)	*CEAT *IMI	Flipped strategy	*CEAT *IMI
Control Group Experimental Group YEAR 11 TC4 (N=30)	*CEAT *IMI	Traditional (Non-Flipped Strategy)	*CEAT *IMI
	Time (6 weeks, 18 course hours)		

*CEAT- Chemical Equilibrium Assessment Test;

* IMI – Intrinsic Motivation Inventory

The head of department of science was participating in traditional classroom due to her expertise and experiences in chemistry education. She has more than 10 years of teaching experiences in this field. Due to the time constraint, the researcher was conducting the flipped classroom due to the familiarization of the flipped classroom's planning and as to make sure the materials learned and circulated to learners is accurate based on the application of Learnerscloud, Kerboodles and Kahoot websites. According to Creswell (2015), instruction for pre- and post-test administration was provided for both classes by the instructors and the similar activities material were provided to both classes for six weeks as to ensure the fidelity of the intervention. The main difference of the activities implemented between experimental and control groups were the digital resources used and instructional approach used during the study.

3.5.1 Pilot Study

A pilot study is a preliminary study conducted in small scale to assess the feasibility of the research and examine the areas for improvement before the intended research (Rennie et al., 2001). Under the same setting, pilot study was performed by using the same instruments, which consists of chemical equilibrium achievement test and modified intrinsic motivation inventory. This can be done on a similar population of Year 11 pupils with the same background but from other classes of the actual study.

For the pilot study in this research, a private school in one of the districts in Selangor state was selected and it was the same school in the actual study. One of the classes of Year 11 chemistry that consists of 30 participants (other than the control and experimental group) was chosen as an intact group for the study. The intact group was chosen because the classes are scheduled according to the school timetable system. During the pilot study, the CEAT items were analyzed using one-month test-retest reliability and a value of 0.89 was obtained. For each intrinsic motivation subscales, Cronbach's alpha was used to evaluate the intrinsic motivation inventory for the internal consistency and reliability. The total reliability score for the instrument was 0.88.

3.6 Data Analysis

In this research, ANCOVA (two separate one-way analysis of covariance) was chosen to investigate the null hypotheses in this study. The quantitative method of ANCOVA is used, as it is more suitable if one or more covariates occur. Besides, it is used when there is any variation in pretest scores (Leppink, 2018; Clifton, 2019). Furthermore, Farrokhi and Mahmoudi (2012) reported that ANOCVA is used when random assignment of the participants is not possible. This is feasible when convenience sampling is used in this quasi-experimental study. The independent variable used in this study is the type of instructional strategy implemented (flipped versus traditional). The dependent variables will be intrinsic motivation and academic achievement on chemistry equilibrium. On the other hand, the CEAT pretests and IMI pretests are the control variables in this study. Previous literature suggests the use of ANOVA by Schneider (2015). In this study, however, due to the limited number of research that generated empirical findings on the flipped classroom instructional strategy, an analysis of variance was used. ANCOVA test is also the suitable analytical test, depending on the adjusted mean pretest scores using posttest measurements. ANCOVA can also test the substantial differences between final experimental data means. It also reduces the effects of any environmental sources such as variations that might affect the environmental error (Schneider et al., 2015). Therefore, the researcher in this study used ANCOVA statistical analysis can make sure that the findings are not influenced by other teaching instructional strategies during the experimental study.

According to Gall et al. (2007), it is suggested that at least 50 respondents be chosen for a study using a quasi-experimental pretest-posttest research design with appropriate sample size and sufficient sample size for statistical analysis. A statistical significance level of $\alpha = 0.05$ with a sample size of $N = 60$ ($n = 30$) per group, a moderate effect size and statistical power of 0.80 was used in this specific study (Lakens, 2013). The significance level used is $p < 0.05$. To examine the effect size, ANCOVA partial eta squared (η^2) statistic was used in this study (Lakens, 2013). The assumptions can be evaluated through conducting different analytical assessments such as test for normal distribution, test for outliers, test for homogeneity of variance, test for linearity, and test for homoscedasticity. All the assumption tests for ANCOVA were checked by SPSS statistical analysis tool. The details of the assumption tests were further explained in Chapter 4.

3.7 Summary

This section described the methodology of the research using quasi-experimental design. The research used the non-equivalent pretest-posttest data collection design. The research sample was obtained based on the convenient sampling method used in this study. In order to ensure the construct validity and reliability of the instruments used, pilot studies were performed for both modified intrinsic motivation inventory (IMI) and chemistry equilibrium achievement test (CEAT). By using SPSS analysis tool, analysis of covariance (ANCOVA) and Pearson Correlation Test were performed to evaluate the hypotheses in this study.

CHAPTER 4

FINDINGS

4.1 Overview

This section reveals the findings of this study. The results described on the effect of flipped learning on intrinsic motivation and chemical equilibrium achievement among Year 11 pupils. Firstly, the results of the study reported the statistical significance for intrinsic motivation mean scores between groups. Secondly, the study revealed the statistical significance for chemical equilibrium achievement mean scores between groups. In addition to that, the finding also showed the correlation between intrinsic motivation and chemical equilibrium achievement before and after the treatment in an experimental group. In addition to that, all the assumption tests were checked before computing the quantitative statistical analysis using ANCOVA and Pearson Correlation test. Overall, this chapter summarizes the results of the data collected during the research study based on the research questions and research hypotheses mentioned in previous chapter.

Below are the research questions and how the data was analyzed:

Research question 1. Is there any significant difference in post intrinsic motivation scores of chemical equilibrium between experimental group and control group with pretest as a covariate?

Research question 2. Is there any significant difference in post achievement scores of chemical equilibrium between experimental group and control group with pretest as a covariate?

Research question 3. Are there any significant relationship between students' intrinsic motivation and achievement scores in experimental group before and after flipped classroom intervention?

Research question 1. Is there any significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate?

To answer the research question 1, the means and standard deviation for intrinsic motivation scores need to be computed for all the variables in both control and experimental group. Therefore, descriptive statistical analysis was conducted to determine the means and standard deviation of the intrinsic motivation scores.

Table 4.1

Mean Score and Standard Deviation for Overall Intrinsic Motivation Scores

Dependent Variable		Control (n = 30)		Experimental (n = 30)	
		Mean	*SD*	*Mean*	*SD*
Intrinsic	Pretest	60.87	13.52	65.60	9.69
Motivation	Posttest	61.00	13.02	70.63	8.02
	Gain	0.13		5.03	

The mean scores (*M*) and standard deviation (SD) for both of the experimental group and the control group for dependent variable intrinsic motivation scores (IMI) are shown in Table 4.1. In terms of intrinsic motivation variable, the pretest mean score of IMI for control group is *M* = 60.87 with *SD* = 13.52 whereas for experimental group is *M* = 65.6 with *SD* = 9.69. For posttest mean score of IMI for control group is *M* = 61.00 with *SD* = 13.02 whereas for experimental group is *M* = 70.63 with *SD* = 8.02. This indicated that the mean score shows an increase for both of the control and experimental group in the IMI posttest, where the difference is 5.03 in flipped classroom and 0.13 in traditional classroom compared to IMI pretest scores respectively. Based on this data, the experimental group obtained a higher mean score gain of 4.9 in comparison with the control group. In response to the extent to which the flipped classroom approach improved on the pupils' intrinsic motivation, the details of the descriptive analysis were conducted on the intrinsic motivation subscales that including competence, autonomy, relatedness, interest and value. Table 4.2 presents the details of the descriptive analysis results on the intrinsic motivation subscales.

Table 4.2

Mean Score and Standard Deviation of the Intrinsic Motivation Subscales

Subscale		Control n = 30		Experimental n = 30	
		Mean	*SD*	*Mean*	*SD*
Competence	Pretest	2.33	.29	2.37	.30
	Posttest	2.74	.39	3.69	.40
	Gain	0.41		1.32	
Autonomy	Pretest	2.48	.43	2.60	.34
	Posttest	2.63	.46	3.83	.44
	Gain	0.15		1.23	
Relatedness	Pretest	2.60	.35	2.69	.39
	Posttest	2.96	.42	3.23	.44
	Gain	0.36		0.54	
Interest	Pretest	2.15	.62	2.33	.41
	Posttest	2.43	.51	3.80	.28
	Gain	0.28		1.47	
Value	Pretest	2.28	.41	2.40	.39
	Posttest	3.20	.26	3.91	.41
	Gain	0.92		1.51	

Table 4.2 also presented the descriptive statistic of the experimental group and control group for the mean score (*M*) and standard deviation (*SD*) of for all the intrinsic motivation subscales. For competence subscale, the pretest mean score of the control group is $M = 2.33$ with $SD = .29$, whereas the pretest mean score of the

experimental group is *M* = 2.37 with *SD* = .30. In the posttest mean score of the control group shows *M* = 2.74 with *SD* = .39 whereas the posttest mean score of the experimental group is *M* = 3.69 with *SD* = .40. In pretest and posttest comparison, there is a gain of .41 in control group and 1.32 in experimental group. This indicates the experimental group has higher mean scores gain of .91 differences compared to control group in competence subscale of intrinsic motivation mean scores.

For autonomy subscale, the pretest mean score of the control group is *M* = 2.48 with *SD* = .43, whereas the pretest mean score of the experimental group is *M* = 2.60 with *SD* = .34. In the posttest mean score of the control group shows *M* = 2.63 with *SD* = .46, whereas the posttest mean score of the experimental group is *M* = 3.83 with *SD* = .44. In pretest and posttest comparison, there is a gain of .15 in control group and 1.23 in experimental group. This indicates the experimental group has higher mean scores gain of 1.08 differences compared to control group in autonomy subscale of intrinsic motivation mean scores.

For relatedness subscale, the pretest mean score of the control group is *M* = 2.60 with *SD* = .35, whereas the pretest mean score of the experimental group is *M* = 2.69 with *SD* = .39. In the posttest mean score of the control group shows *M* = 2.96 with *SD* = .42, whereas the posttest mean score of the experimental group is *M* = 3.23 with *SD* = .44. In pretest and posttest comparison, there is a gain of .36 in control group and .54 in experimental group. This indicates the experimental group has higher mean scores gain of 0.18 differences compared to control group in relatedness subscale of intrinsic motivation mean scores.

For interest subscale, the pretest mean score of the control group is *M* = 2.15 with *SD* = .62, whereas the pretest mean score of the experimental group is *M* = 2.33 with *SD* = .41. In the posttest mean score of the control group shows *M* = 2.43 with

SD = .51, whereas the posttest mean score of the experimental group is *M* = 3.80 with *SD* = .28. In pretest and posttest comparison, there is a gain of .28 in control group and 1.47 in experimental group. This indicates the experimental group has higher mean scores gain of 1.19 differences compared to control group in interest subscale of intrinsic motivation mean scores.

For value subscale, the pretest mean score of the control group is *M* = 2.28 with *SD* = .41, whereas the pretest mean score of the experimental group is *M* = 2.40 with *SD* = .39 In the posttest mean score of the control group shows *M* = 3.20 with *SD* = .26, whereas the posttest mean score of the experimental group is *M* = 3.91 with *SD* = .41. In pretest and posttest comparison, there is a gain of .92 in control group and 1.51 in experimental group. This indicates the experimental group has higher mean scores gain of .59 differences compared to control group in value subscale of intrinsic motivation mean scores.

Further ANCOVA inferential statistic analysis was measured to investigate whether the flipped classroom instructional strategy has any significant effects on the intrinsic motivation scores among Year 11 pupils. The non-equivalent group quasi-experimental design was chosen. This pretest and posttest non-equivalent groups design was used when the researcher suspects the posttest scores might be affected by the pretest scores, which then lead to inaccurate conclusions on the findings in the study (Alessandri et al., 2017). There are some assumptions that need to be fulfilled if using ANCOVA analysis test.

The assumptions for ANCOVA required are as follows:

1. The normality of data
2. Test for outliers using Boxplot
3. Homogeneity of variance (Levene's Test)

4. Scatterplot to check the linearity between covariates and dependent variables
5. Homogeneity of regression using scatterplot by comparing the regression lines slope

Test of Normality

The assumptions of normality need to be met for most of the parametric tests such as ANCOVA. In order to check the normality of the distribution for both control and experimental group, all the mean scores for the pretest and posttest of intrinsic motivation were computed. The data distribution shape that matches the normal distribution can be referred to as normality. In general, two methods to measure normality for variables which include statistical methods and graphical methods. According to Kim (2013), a visual inspection of the skewness and kurtosis z-value should be somewhere within the range of -1.96 to +1.96. Thus, the skewness and kurtosis z-value for the study reveals that the IMI scores are approximately normally distributed for both experimental and control group before and after flipped classroom intervention, with skewness of -0.249 and a kurtosis of -0.680 for the control group and the skewness of 0.031 and a kurtosis of -0.599 for the experimental group before using FC; whereas after intervention, with skewness of -0.153 and a kurtosis of -0.620 for the control group and skewness of 0.633 and a kurtosis of -0.309 for the experimental group as shown in Table 4.3.

Table 4.3

Normality Test for Intrinsic Motivation Inventory (IMI)

	Skewness z-value	Kurtosis z-value
Pretest scores		
Control	-0.249	-0.680
Experimental	0.031	-0.599
Post test scores		
Control	-0.153	-0.620
Experimental	0.633	-0.309

Graphical methods include the histogram and normality curve are represented in Figure 4.1.

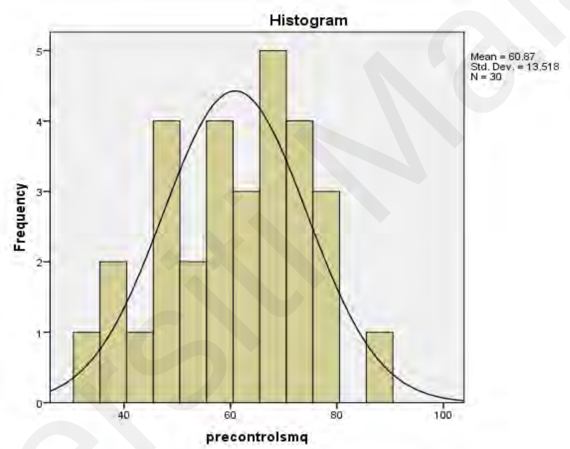

Figure 4.1. Normal distribution of pre-IMI-SMQ scores for control group

The graphical representation above illustrated normal distribution of pretest scores for control group. Figure 4.1 shows the normality of the total IMI-SMQ pretest score for the group of participants in traditional classroom. As a result, the assumption for ANCOVA is fulfilled.

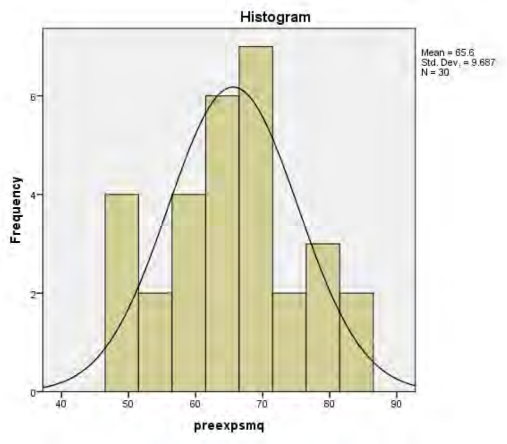

Figure 4.2. Normal distribution of pre-IMI-SMQ scores for experimental group

The graphical representation above illustrated normal distribution of pretest scores for experimental group. Figure 4.2 shows the normality of the total IMI-SMQ pretest score for the group of participants in flipped classroom. As a result, the assumption for ANCOVA is fulfilled.

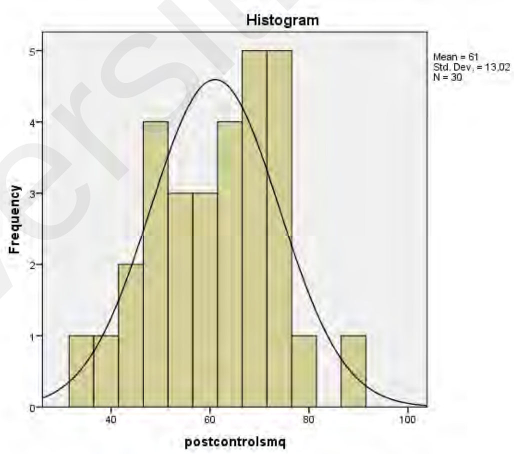

Figure 4.3. Normal distribution of post-IMI –SMQ scores for control group

The graphical representation above illustrated normal distribution of posttest scores for control group. Figure 4.3 shows the normality of the total IMI-SMQ posttest score for the group of participants in traditional classroom. As a result, the assumption for ANCOVA is fulfilled.

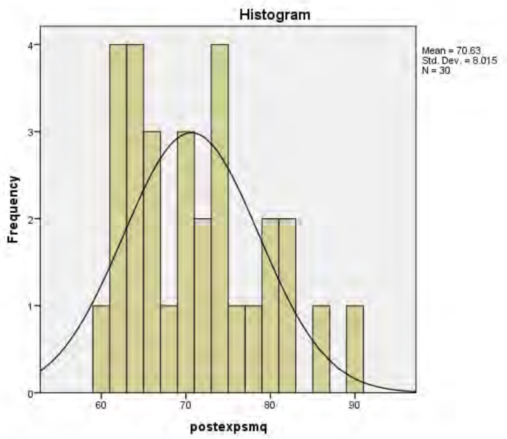

Figure 4.4. Normal distribution of post-IMI-SMQ scores for experimental group

The graphical representation above illustrated normal distribution of posttest scores for experimental group. Figure 4.4 shows the normality of the total IMI – SMQ posttest score for the group of participants in flipped classroom. As a result, the assumption for ANCOVA is fulfilled.

Test of Outliers

To examine whether the assumption of absence of outlier is tenable, an analysis of boxplots was conducted. Analysis of boxplots revealed that the assumption of absence of outliers is tenable for the IMI-SMQ data. Therefore, the assumptions of no extreme outliers were fulfilled (refer to figures below).

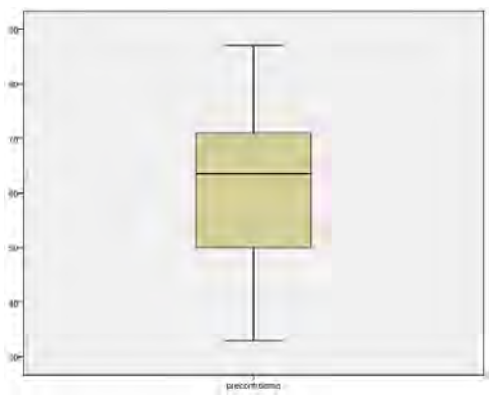

Figure 4.5. Boxplot for IMI-SMQ pretest in traditional classroom

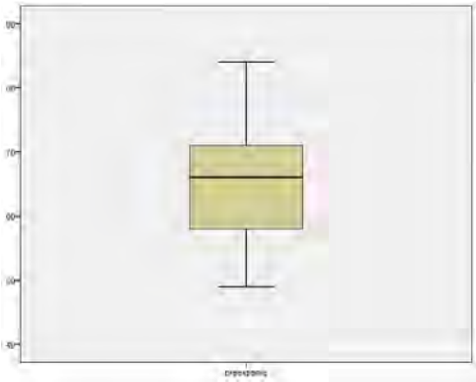

Figure 4.6. Boxplot for IMI-SMQ pretest in flipped classroom

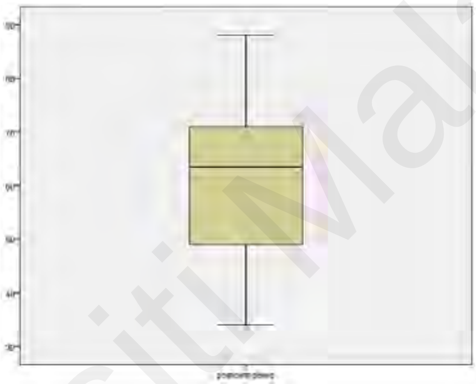

Figure 4.7. Boxplot for IMI-SMQ posttest in traditional classroom

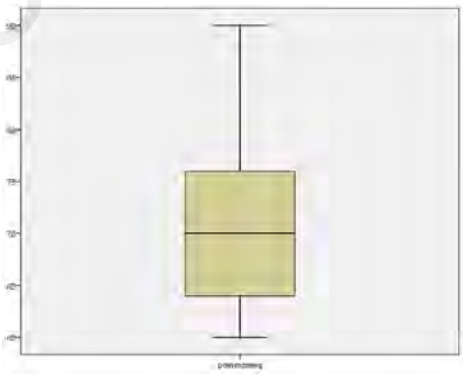

Figure 4.8. Boxplot for IMI-SMQ posttest in flipped classroom

Test of Homogeneity of Variance

Homogeneity of variance is also known as equal variance across the sample. Levene's Test was performed to examine if the two groups have equal variance. The findings are shown below.

Table 4.4

Levene's Test of Equality of Error Variances for Intrinsic Motivation Score

Levene's Test of Equality of Error Variances[a]
Dependent Variable: postIMI

F	df1	df2	Sig.
23.954	1	58	.120

Note. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + preIMI + group

Table 4.4 presented the intrinsic motivation score for Levene's test showed (F (1, 58) = 23.95, p > .05. The findings found that there was no significant difference between control and experimental group. Thus, it can be mentioned that two groups were equal in variance. These findings revealed that the assumption of homogeneity of variance was tenable. As a result, ANCOVA can be used to analyze the intrinsic motivation scores of the group of pupils who participate in both traditional and flipped classroom.

Test of Linearity

The assumption of linearity was conducted using SPSS software, which can be used to test the linear relationship between the covariates (preIMI scores) and the dependent variables (postIMI scores). The scatterplot analysis (refer Appendix H) indicates a linear relationship between both dependent variables and each covariate. Plot 1 (IMI scores) shows a strong, positive linear relationship between postIMI and preIMI scores in the flipped classroom (R^2 = .851) and the traditional classroom (R^2 = .995).

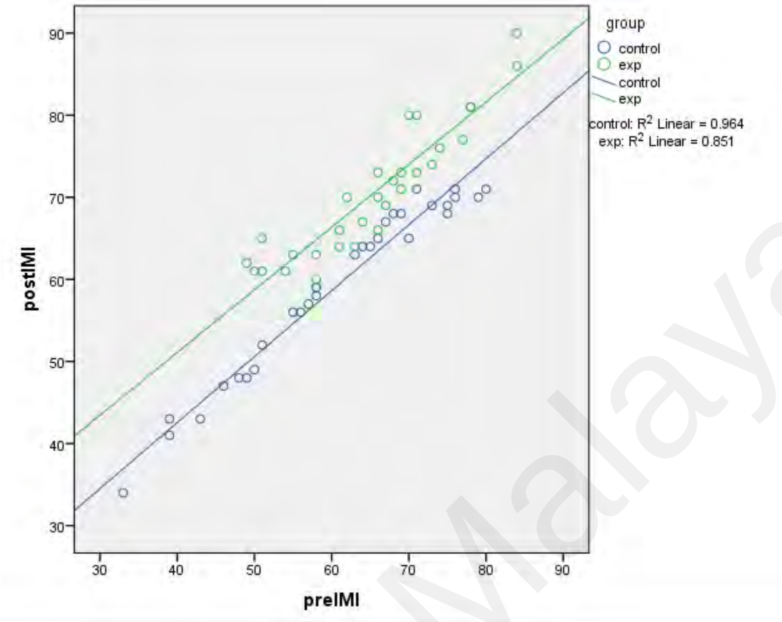

Figure 4.9. Scatterplot for regression slope

Test of Homogeneity of Regression

To evaluate the tenability of the assumption test for homogeneity of regression, a scatterplot was computed using SPSS statistical tool. The data was computed using the General Linear Model (GLM) Univariate procedure to test whether there is a significant interaction between the group (flipped and traditional classroom) and the covariates with regard to posttest scores. The significance level was fixed to $\alpha = 0.05$ and it can be mentioned that the assumption of homogeneity of regression is tenable if the interaction is not significant, which is $p > 0.05$. In this study, the interaction between intrinsic motivation and the posttest scores have a p value > 0.05. As a result, this supported the scatterplot data that the flipped and traditional groups are similar in the slopes (refer Appendix H). The assumptions of

(a) normality, (b) no outliers, (c) homogeneity of variance, (d) linearity, and (e) the homogeneity of regression were checked and fulfilled. Therefore, ANCOVA analysis was used to analyze the data for research question one. The findings from the analysis are described below.

In order to investigate the effects of flipped classroom instructional strategy on the intrinsic motivation, ANCOVA was utilized to analyze pupils IMI scores and the outcomes are presented in Table 4.5.

Table 4.5

Analysis of Covariance Based on Mean Scores of Pupils' Intrinsic Motivation

Tests of Between-Subjects Effects

Dependent Variable: postIMI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
Corrected Model	7799.068[a]	2	3899.534	597.646	.000	.954	1.000
Intercept	167.912	1	167.912	25.734	.000	.311	.999
preIMI	6407.052	1	6407.052	981.950	.000	.945	1.000
Group	420.252	1	420.252	64.408	.000	.531	1.000
Error	371.915	57	6.525				
Total	268081.000	60					
Corrected Total	8170.983	59					

a. R Squared = .954 (Adjusted R Squared = .953)

b. Computed using alpha = .05

The ANCOVA in Table 4.6 shows that there is a significant difference in the post-IMI scores, F (1, 57) = 64.41, $p < .05$, partial eta squared = .53, Power = 1.00 with pre-IMI scores as a covariate. The posttest mean score for the experimental group (M = 70.63, SD = 8.02) is significantly higher than the posttest mean score for the control group (M = 61.00, SD = 13.02) in terms of intrinsic motivation. Therefore, the flipped classroom has a significant effect on Year 11 pupils' intrinsic motivation. The partial eta squared, 0.53 shows that the effect size of the treatment on intrinsic motivation is large. For research question one, the null hypothesis was rejected. As a consequence, the answer for research question one is that there is a significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate.

Research question 2. Is there any significant difference on post achievement scores in chemical equilibrium between experimental group and control group with pretest as a covariate?

To answer the research question 2, descriptive statistical analysis was carried out to calculate the means and standard deviation of the intrinsic motivation scores. At first, all the variables for the means and standard deviation were calculated.

Table 4.6

Descriptive Statistics for Achievement Test Scores

Dependent Variable		Control (n = 30)		Experimental (n = 30)	
		Mean	*SD*	*Mean*	*SD*
Achievement	Pretest	5.80	2.47	6.87	2.79
	Posttest	9.83	3.86	15.03	2.88
	Gain	4.03		8.16	

Table 4.6 provides the descriptive statistical analysis of mean scores (*M*) and standard deviation (*SD*) of the dependent variable chemical equilibrium achievement test scores (CEAT) for both of the experimental group and the control group. The pretest mean score of CEAT for experimental group in terms of academic achievement is M = 6.87, SD = 2.79 whereas the control group is M = 5.8, SD = 2.47. For posttest mean score of CEAT for students in the experimental group (M =15.03, SD = 2.88) whereas participants in the control group (M = 9.83, SD = 3.86).

Thus, the mean score shows an increase in the CEAT posttest for both of the participants in flipped classroom and traditional classroom, where the difference is 8.16 in flipped classroom and 4.03 in traditional classroom compared to CEAT pretest scores respectively. Based on this data, the participants in experimental group have shown a higher mean score than the control group, where the experimental group found a gain of 4.4 differences compared to the control group. Overall, the findings of the descriptive statistic table of all the intrinsic motivation and achievement scores showed that the participants in the experimental group performed better than the participants in the control group after flipped classroom intervention.

In order to check whether there are any significant effects of the flipped classroom instruction on the dependent variable achievement scores, further inferential statistical analysis such as analysis of covariance (ANCOVA) was performed. There are a few assumptions need to be met before conducting ANCOVA analysis, including test of normality, test of outliers, homogeneity of variances, test of linearity and homogeneity of regression.

Test of Normality

A visual inspection of the skewness and kurtosis z-value should be in the range between -1.96 to +1.96 (Kim, 2013). The skewness and kurtosis z-value for the pretest and posttest for CEAT scores indicate both of the control and experimental groups are approximately normally distributed before and after flipped classroom intervention, with skewness of 0.538 and a kurtosis of 0.048 for the control group and the skewness of -0.231 and a kurtosis of 0.164 for the experimental group before using FC; whereas after intervention, with skewness of -

0.215 and a kurtosis of -0.714 for the control group and skewness of –0.323 and a kurtosis of -0.541 for the experimental group as shown below.

Table 4.7

Normality Test for Chemical Equilibrium Achievement Test (CEAT)

	Skewness z-value	Kurtosis z-value
Pretest scores		
Control	0.538	0.048
Experimental	-0.231	0.164
Post test scores		
Control	-0.215	-0.714
Experimental	-0.323	-0.541

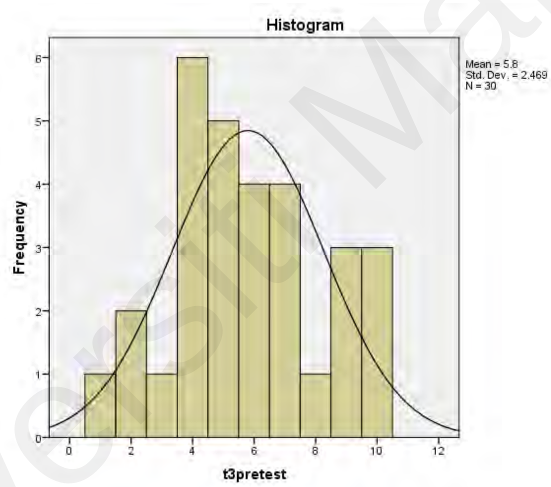

Figure 4.10. Normal distribution of pre-CEAT scores for traditional classroom group

The graphical representation of histogram and frequency above illustrated the pretest scores for traditional classroom group are normally distributed. Figure 4.10 illustrates the total pretest score normal distribution for CEAT in traditional classroom setting. Thus, the normality assumption for ANCOVA is fulfilled.

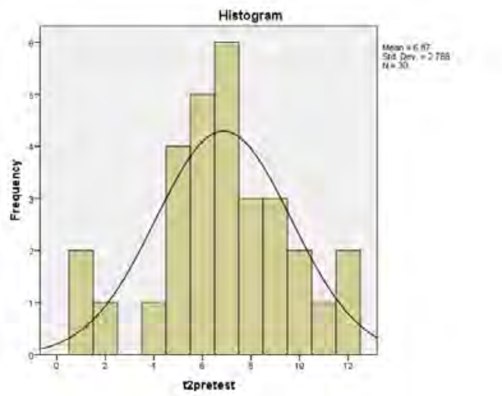

Figure 4.11. Normal distribution of pre-CEAT scores for flipped classroom group

The graphical representation of histogram and frequency above illustrated the pretest scores for experimental group are normally distributed. Figure 4.11 shows the total pretest score normal distribution for CEAT in flipped classroom setting. Thus, the normality assumption for ANCOVA is fulfilled.

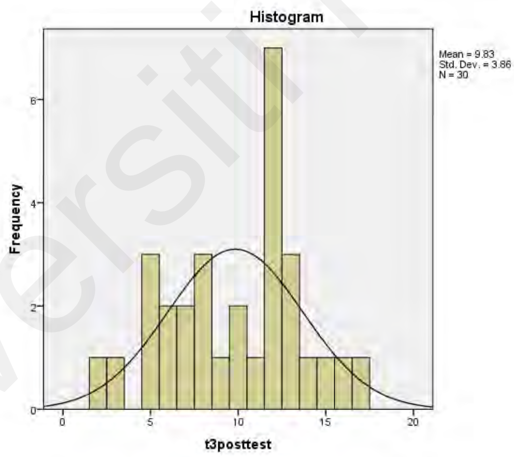

Figure 4.12. Normal distribution of post-CEAT scores for traditional classroom group

The graphical representation of histogram and frequency above illustrated the posttest scores for traditional classroom participants are normally distributed. Figure 4.12 displays the total posttest score for CEAT in traditional classroom setting. Thus, the normality assumption for ANCOVA is fulfilled.

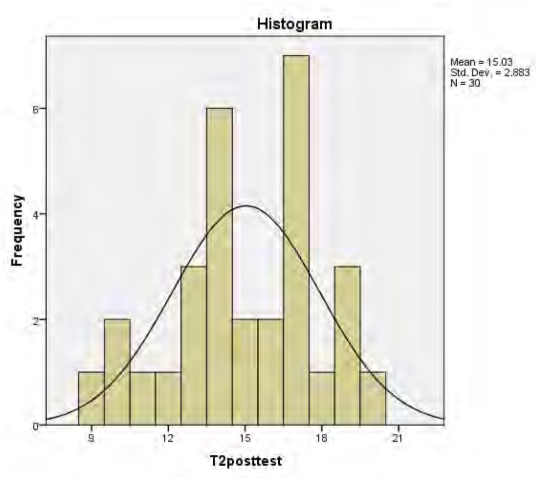

Figure 4.13. Normal distribution of post- CEAT scores for flipped classroom group

The graphical representation of histogram and frequency above illustrated normal distribution of posttest scores for flipped classroom group. Figure 4.13 displays the total posttest score normal distribution for CEAT in flipped classroom setting. Thus, the normality assumption for ANCOVA is fulfilled.

Test of Outliers

To assess whether the assumption of absence of extreme outliers is tenable, a boxplot test was performed. Boxplot inspection has shown that the assumption of absence of outliers is tenable for the CEAT data. As a result, the assumptions of no extreme outliers were fulfilled (refer to figures below).

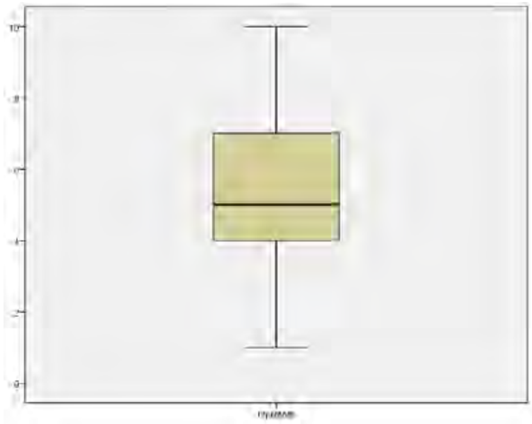

Figure 4.14. Boxplot for CEAT pretest in traditional classroom

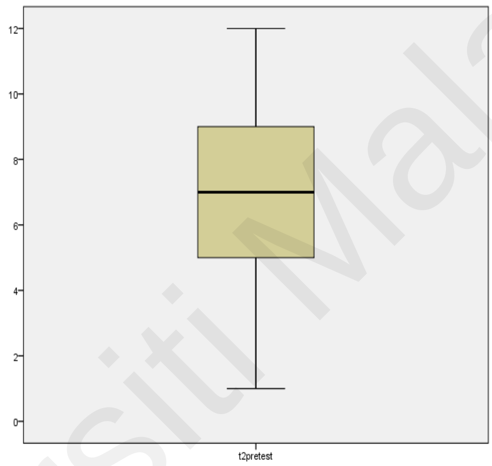

Figure 4.15. Boxplot for CEAT pretest in flipped classroom

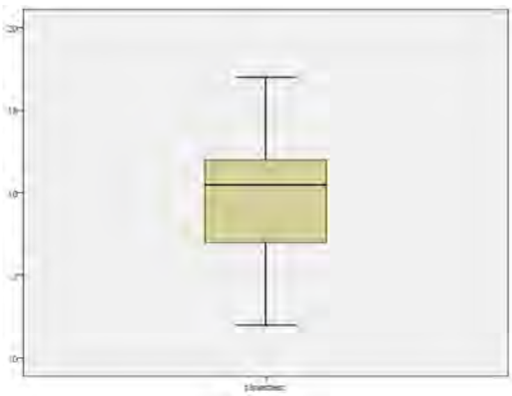

Figure 4.16. Boxplot for CEAT posttest in traditional classroom

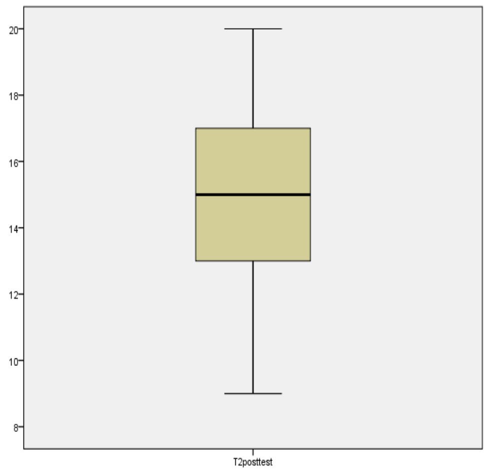

Figure 4.17. Boxplot for CEAT posttest in flipped classroom

Test of Homogeneity of Variance

An equal variance throughout the sample is referred as homogeneity of variance. In order to test whether the two groups have the same variance, Levene's test was computed and the result is shown below.

Table 4.8

Levene's Test of Homogeneity of Variance for Chemical Equilibrium Achievement

Levene's Test of Equality of Error Variances[a]
Dependent Variable: postCEAT

F	df1	df2	Sig.
.002	1	58	.960

Note. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + preCEAT + group

Table 4.8 showed the chemical equilibrium achievement for Levene's test reported F (1, 58) = .002, p > .05. The findings showed that there was no significant difference in terms of homogeneity of variance between control and experimental group. As a result, it can be stated that the two groups were equal in variance. This result showed that the assumption of homogeneity of variance was tenable. As a consequence, ANCOVA can be used to analyze the chemical equilibrium achievement scores of pupils who participate in both traditional and flipped classroom.

Test of Linearity

The assumption of linearity was conducted using SPSS software, which can be used to test the linear relationship between the covariate (preCEAT scores) and the dependent variable (postCEAT scores). The scatterplot analysis (refer Appendix H) indicates a linear relationship between both dependent variables and each covariate. Plot 2 shows a weak positive linear relationship for the flipped classroom participants (R^2 = .085) but a strong positive relationship between postCEAT and preCEAT for the traditional classroom participants (R^2 = .605).

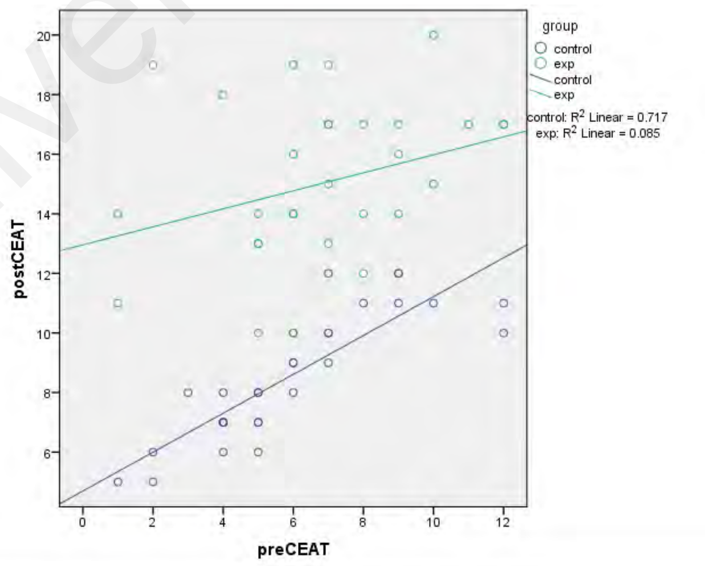

Figure 4.18. Linearity between the preCEAT scores and the postCEAT scores

Test of Homogeneity of Regression

Besides that, the assumption test for homogeneity of regression slope was conducted. The data was computed using the General Linear Model (GLM) Univariate procedure in order to test whether there is a significant interaction between the groups (flipped and traditional classroom) and the covariates with its respective posttest scores. The significance level was fixed to $\alpha = 0.05$ and the assumption of homogeneity is tenable if the interaction is not significant, where $p > 0.05$. In this study, the interaction between achievement and the posttest scores have a p value > 0.05. This supported the scatterplot data that the flipped and traditional groups have similar slopes (refer Appendix H). The assumptions of (a) the assumption of normality, (b) no outliers, (c) the assumption of homogeneity of variance, (d) the assumption of linearity, and (e) the homogeneity of regression were fulfilled. Therefore, for research question two, ANCOVA analysis was conducted to evaluate the data and the quantitative findings are outlined as below.

To examine the effect of flipped classroom instructional strategy on the chemical equilibrium achievement, ANCOVA was utilized to analyze pupils CEAT scores and the analytical findings are illustrated in Table 4.9.

Table 4.9

Analysis of Covariance of Mean Scores of Pupils' Achievement

Tests of Between-Subjects Effects

Dependent Variable: postCEAT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
Corrected Model	617.915[a]	2	308.957	38.216	.000	.573	1.000
Intercept	587.483	1	587.483	72.667	.000	.560	1.000
preCEAT	212.315	1	212.315	26.262	.000	.315	.999
Group	302.191	1	302.191	37.379	.000	.396	1.000
Error	460.819	57	8.085				
Total	10354.000	60					
Corrected Total	1078.733	59					

a. R Squared = .573 (Adjusted R Squared = .558)

b. Computed using alpha = .05

The ANCOVA Table 16 shows that there is a significant difference in the post-CEAT scores, F (1, 57) = 37.38, $p < .05$, partial eta squared = .40, power = 1.00 with pre-CEAT scores as a covariate. The mean scores of the experimental group, M = 15.30 with SD = 2.88 was significantly higher than the mean scores of the control group, M =9.83 with SD = 3.86. Therefore, the flipped classroom has a significant effect on pupils' chemical equilibrium achievement. The partial eta squared, 0.4 shows that the effect size of the treatment on achievement is large. For research question two, the null hypothesis was rejected. As a consequence, the answer for research question two is that there is a significant difference on post achievement scores in chemical equilibrium between experimental group and control group with pretest as a covariate.

Research Question 3. Is there any significant relationship between students' intrinsic motivation and achievement scores in experimental group before and after flipped classroom intervention?

To answer research question 3, the correlation coefficient of the Pearson product moment was determined to measure the correlation between the intrinsic motivation, as assessed by the intrinsic motivation inventory (IMI) and achievement, as assessed by the chemical equilibrium achievement test (CEAT). To run the Pearson Correlation inferential statistical analysis, there are a few assumptions to be fulfilled. The assumptions for Pearson correlation are as follows:

1. Normality (refer Figures 5 and 7)
2. Absence of outliers (refer Figures 9 and 11)
3. Linearity

Linearity

Since the first two assumptions have been tested in research question one and two. Hence, further test on the relationship between two variables of preIMI (variable X) and preCEAT (variable Y) was conducted and they should be linear. As a result, a straight line is seen as shown in Figure 22 below. The overall findings are displayed in Table 4.10 below.

Table 4.10

Correlation coefficients between intrinsic motivation scores and achievement scores in experimental group

	Intrinsic Motivation vs. Achievement
Pretest	0.337
Posttest	0.391*

Note: ** Correlation is significant at the 0.01 level (2-tailed).
 * Correlation is significant at the 0.05 level (2 –tailed).

Based on the findings, the correlation between intrinsic motivation and achievement was not significant before the intervention, r = .34, p > .05. After flipped classroom intervention, the correlation between intrinsic motivation and achievement was significant, r = .39, p < .05. This shows that the correlation between intrinsic motivation and achievement is stronger after the intervention. For research question three, the null hypothesis was rejected after flipped classroom intervention. As a consequence, the answer for research question three is that there is no significant correlation between' intrinsic motivation and achievement scores before flipped classroom but there is a significant correlation between the intrinsic motivation and achievement after flipped classroom intervention.

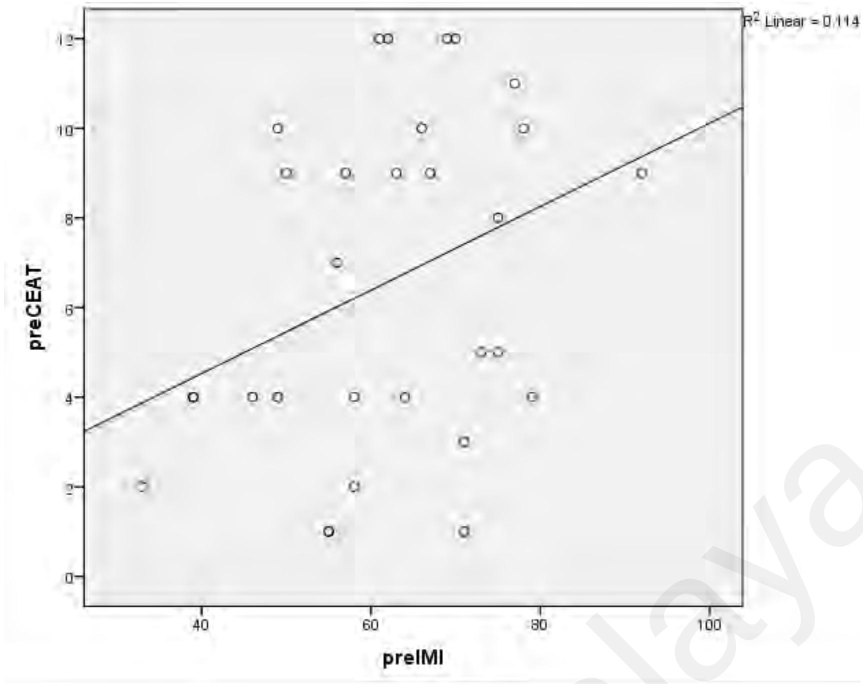

Figure 4.19. Relationship between IMI and CEAT before treatment

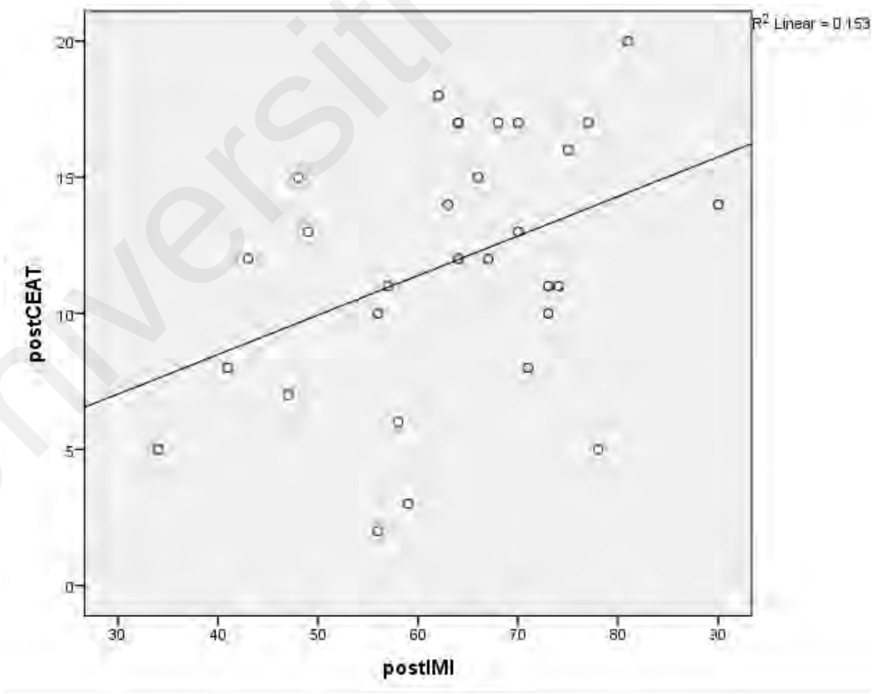

Figure 4.20. Relationship between IMI and CEAT after treatment

4.5 Summary For Quantitative Analysis Result

Hypotheses one and two were studied to access pupils' intrinsic motivation and chemical equilibrium achievement in chemistry based on the types of class settings. Hypotheses three were examined to study the relationship between the two dependent variables, which consists of intrinsic motivation, and chemical equilibrium achievement among the Year 11 pupils. Means scores for the IMI and CEAT were analyzed using ANCOVA inferential statistics. The findings for each analysis and the respective hypothesis are presented in Table 4.11 below.

Table 4.11

Summary of Findings for Each Hypothesis

Hypothesis	Rejected	Failed to Reject
H01 = There is no significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate.	×	
H02 = There is no significant difference on post chemistry achievement scores between experimental group and control group with pretest as a covariate.	×	
H03a = There is no significant relationship between Year 11 pupils' intrinsic motivation and achievement scores in experimental group before flipped classroom intervention.		×
H03b = There is no significant relationship between Year 11 pupils' intrinsic motivation and achievement scores in experimental group after flipped classroom intervention.	×	

This section describes the findings of the quantitative research methodology that addressed the research questions. Quantitative result summary is as follows:

1. The flipped classroom group has higher mean score on intrinsic motivation than the traditional classroom group of pupils.
2. The flipped classroom group has higher mean score on chemical equilibrium achievement than the traditional classroom group of pupils.
3. There was a significant difference on post intrinsic motivation scores in chemical equilibrium between experimental group and control group with pretest as a covariate.
4. There was a significant difference on post achievement scores in chemical equilibrium between experimental and control group with pretest as a covariate.
5. There was a significant relationship between pupils' intrinsic motivation and chemical equilibrium achievement scores in experimental group after flipped classroom intervention.

CHAPTER 5

DISCUSSIONS, RECOMMENDATIONS AND CONCLUSION

5.1 Overview

The study was to investigate the effect of flipped classroom on Year 11 pupils intrinsic motivation and achievement scores in chemical equilibrium. This study focus on how the learning activities in flipped classroom could lead to better peer interaction and enhance the autonomous learning skills among the pupils. Overall, this chapter summarizes the following: (i) the discussions of the research finding that further describes the results and relates them to the past literature; (ii) pedagogical implications of findings; (iii) recommendations for future studies and (iv) conclusion of the study.

5.2 Discussions of the Research Findings

The main research findings reported that there was significant difference on post intrinsic motivation and post chemical equilibrium achievement scores between control group and experimental group with pretest as a covariate. The results of this research support Abeysekera and Dawson (2015) who suggested that flipped classroom might increase intrinsic motivation and achievement with technology integration. The results of the present study are aligned with the studies mentioned in the past literature (Wang, 2015; Watson et al., 2011), which reported that learners who were facilitated with the flipped learning approach with the integration of educational games and computer based interactive multimedia program that were designed with enhance relevance of the topic related were statistically increase intrinsic motivation. Also, the results in this study were in coherence with Zarzycka-

Piskorz (2016) reported that Kahoot interactive game provides the first immediate evaluation that enables instant feedback after the Kahoot session. This allows learners to receive the constructive feedback on their progress and their level of competency. Besides, the utilization of differentiated tasks by using core and extended worksheet during facilitate phase in the lesson allows the students to expand their capabilities by providing them optimal challenges especially for the high competent students with extended worksheets. In contrast, the weaker students are able to attempt the core worksheets which are not too hard, but neither too easy for them according to their level. Therefore, all these are possible reasons that resulted the total scores for competence component is the highest compared to other subscales in intrinsic motivation in the study.

The finding of this research before treatment shows there is no significant relationship between students' intrinsic motivation and achievement before intervention. This research finding was aligned with another studies conducted by Ahmed and Bruinsma (2006). According to Ahmed and Bruinsma (2006), there was no significant relationship between student's self-determination and their academic achievement for Asian sub-sample. However, after flipped classroom intervention, the findings are supported by previous studies mentioned that intervention in education attempt to increase intrinsic motivation and is possible lead to higher achievement (Areepattamil et al., 2011; Garon-Carrier, 2016, Koller et al., 2001). According to Areepattamil et al. (2011), intrinsic motivation and academic achievement are seen as interlocking in development and the core of self-determined activity is intrinsic motivation (Ryan & Deci, 2000) and is supposed to be reciprocally correlated with achievement when appropriate learning activities is conducted. In general, there are two cognitive processes that lead to intrinsic motivation: (a) the level to which learners fulfill their satisfaction in the sense of autonomy and (b) the level to which learners fulfill their satisfaction in the sense of efficacy (Riley, 2016). There is a mutual reinforcement of intrinsic motivation and achievement in individuals when the psychological needs for competency, autonomy and relatedness are fulfilled (Niemiec, 2009; Riley, 2016). Therefore, those intrinsically motivated learners will persevere on the tasks given, and eventually they will be more likely to achieve. According to the findings, the result from this study proved that intrinsic motivation can be improved and lead to enhanced achievement in chemistry by using flipped classroom intervention in secondary school. This result is also similar with the previous study done by Cortright et al. (2013) that reported that increased level of intrinsic motivation are correlated to increased level of performance. However, there was a review by Jensen et al. (2015) claimed that flipped classroom did not result in higher learning outcomes and positive attitudes compared to traditional classroom when both settings remained using an active learning approach in the teaching and learning process. In this study, only flipped classroom group utilized more towards active learning activities in the learning process and that is the main reason explained the above conclusion proposed by previous studies.

The research findings are aligned with the past literature that suggests learning settings, such as the flipped classroom is expected to satisfy the need for pupils to be able to polish their current skills or knowledge (competency) and to be able to make connections with others (relatedness) which results in higher level of intrinsic motivation (Abeysekera & Dawson, 2015). In application of digital game elements in class learning activities such as Kahoot interactive games session, the choices of level in the game provides the freedom for the learners to choose which level to achieve. These created a sense of autonomy and competency among the participants. Competency can be generated when level-up activities in the system such as Kerboodle and Learnerscloud online education websites can be applied. If a user can achieve a higher level, this can be said that they are more competent than someone who struggled to do so. The findings of this research support the flipped classroom instructional strategy that the IMI posttest scores were higher in experimental group than in control group in traditional class setting. This indicates that the success of flipped classroom instruction to fulfill the three psychological needs of autonomy, competency and relatedness that lead to increasing students' level of intrinsic motivation which then markedly impact a students' level of self-determination (Cortright et al., 2013). According to past literature, only a few studies on interactive game based learning have been carried out within the context of flipped learning and lack of theory –derived framework to scaffold game-based interactive learning design in the context of flipped learning (Sailer et al., 2017). The finding in this study is critical as it proposed a theory- based design framework (self-determination theoretical framework) to implement game based design activities such as Kahoot and Learnerscloud in the context of flipped classroom. In addition to that, it empirically tests the effect of the self-determination theoretical framework on students' emotional cognitive and behavioral engagement in both pre-class and post-class activities. In this study, emotional engagement such as interest and enjoyment are the positive affective domain in the flipped classroom (Gonzalez, 2010). According to Rotgans (2011), cognitive engagement can be defined as pupils' psychometric characteristics in learning while behavior engagement is related to students' participation in learning activities and assignments.

In this process of meeting the needs for the sense of autonomy, the educators consider students' view and therefore provide appropriate information and choice possibilities. With that, this can minimize the students' stress and motivate them to initiate their own activities (Niemiec & Ryan, 2009). When this happens, the behavior of students becomes volitional and self-supported reflectively. As a result, the students are more willing to dedicate time and energy for their studies (Niemiec & Ryan, 2009). In this process of meeting the needs for the sense of competence, educators can introduce learning activities that are optimally challenging such as differentiation worksheets, especially for students with higher level of competency and early finishers in flipped classroom. With that, this allows learners to challenge and to improve their academic capabilities (Niemiec & Ryan, 2013). In the processes, the educators can provide students' with appropriate feedback to facilitate evaluation and promote a feeling of efficacy. In this process of meeting the needs for the sense of relatedness, through the flipped classroom activities that are students-centered activities that can make the students feel connected when engaging in small group activities (Niemiec & Ryan, 2013).

Besides that, the research findings are similar with Bryan et al. (2011) as it revealed the results of relative theoretical framework of flipped classroom instruction with traditional classroom instruction. With self –determination theory, flipped classroom activities had provided students inquiry based activities that improve their competence level, more options to make their own choices on which content delivery they prefer and social interaction in their chemical equilibrium lesson. Research done by Loukomies et al. (2013) also reported that the possibilities of learners to enhance their intrinsic motivation might improve by identification of the psychological needs and interests of learners. Consequently, the outcome of this research found that chemistry teachers could conduct the flipped classroom instruction to increase their intrinsic motivation towards science learning. This research sets a standard to the expectations of the 2003 trend in curriculum development, which suggested innovative teaching and learning strategies.

Moreover, the analytical findings were consistent with the previous study mentioned by Domenico and Ryan (2017) that SDT-led experimental and field research discovered intrinsic motivation to predict better learning outcomes and achievement. According to the findings, this further proved that there is a correlation between intrinsic motivation and achievement after flipped classroom intervention.
In supporting students' need for autonomy, during flipped classroom activities, a variety of opportunities were provided to learners to choose between different forms of learning. For example, by using Learnerscloud, Kerboodle, Google classroom, they can choose instructional videos, flashcards or slides to complete the guided notes created by the researcher. In order to support pupils' need for competency, differentiated tasks such as core and extended part of bond energy calculation using Oxford Cambridge worksheet were given to slow learners and early finishers. This was expected to give a sense of competency to pupils with different abilities. In supporting learners' need for relatedness, flipped classroom offers many opportunities for learners to interact with their classmates during lesson activities such as small group presentation using Google slides, Kahoot interactive games, etc.

The integration of online Google Apps in the flipped classroom learning activities allow interactive learning occurs in 21st century of learning. Google Apps is one of the useful collaboration tools to allow communication happens synchronously (Mallon, 2015). This tool was used in small group presentation with Google slides. Learners from the same group can edit the documents and share ideas on the same slides. This develop a sense of participation among the group members by using online collaboration tools in flipped classroom compared to face-to face discussion in traditional classroom (Keser, 2012). Feedback is a crucial part of the group work learning process as it enhances learning and promote competence level by providing the real-time feedback on their progress in that specific task (Cooper, 2013). In this way, learners can contribute as a group in a particular subject and feel more satisfaction of what they are doing and thus intrinsically motivate them to persist on task. Based on the findings in this study, there is evidence to suggest the flipped classroom instruction as a curriculum innovation that needs to be incorporated into teaching and learning pedagogies for larger chemistry teacher's group.

5.3 Pedagogical Implications

The research's results contribute understanding that increased students' intrinsic motivation is correlated to the increased achievement in flipped classroom. These findings have implications for both subject content delivery practices and educational reform strategies. In this study, out-of class learning is supported by ICT tools (Google classroom, Learnerscloud, etc.) and in class learning, more than 60 % of lesson contact time is allotted to student-centred learning activities such as individual practices and small group activities, they are considered to be significant elements in the curriculum of chemistry education. During the small group activities, it can be used to promote collaboration and therefore increase the sense of relatedness among the learners through interaction. For instance, pupils are encouraged to work in a group of three to four in completing an assignment that have posted in the Google classroom. The focus in flipped classroom us to encourage interactive discussion and establish a strong social interaction among the learners to be more participative in the lessons. For example, the learners can collaborate and communicate when editing an assignment using Google docs. This allows them to share the doc and collaborate with their group members to complete the assignment. The present study reported how to apply the flipped classroom instruction to teach learners that can affect the students' intrinsic motivation and lead to higher level of achievement. Consequently, the results of this research will shed light on how the flipped classroom approach can be used as an effective option educational strategy to meet students' satisfaction in all elements of competency, autonomy, relatedness, interest and value in secondary chemistry education. This is to say, the study also found how intrinsic motivation with the factors of competency, autonomy, relatedness, interest and value can be improved with the flipped classroom instruction in secondary chemistry classroom. This is important information as it is essential to plan flipped lessons in different classes that are based on Malaysian chemistry education curriculum with different abilities. As a result, the results of this research will be of concern to educators and researchers who want to use flipped classroom strategy when planning their lesson to fulfill different learning requirements of the learners.

According to the findings, it was suggested that learners in the traditional classroom setting only focused on the mastery of the answering skills and passive learning during the lessons. Therefore, the learners did not have the opportunity to expose to the application of ICT resources such as Kerboodle, Kahoot, Google apps, etc. Besides, they also do not have the experience of active learning such as game-based interactive quizzes, small group presentation, and peer-led discussions to reinforce their learning and understanding. Therefore, they have shorter time of interaction between the instructor and the peers in the class. Also, lack of application of the ICT tools do not provide them the opportunity to experience higher competency level on what they are doing and limited choice of learning due to lack of resources given. In addition to that, the amount of contact time for the learners in class is more on the lecture session in the class. All this is not enough for them to experience to solve the questions up to the application level. This can lower their intrinsic motivation and make them feel disconnected and not able to cope for that subject. Therefore, they will lack of self-determination in doing well in that subject and finally lead to unsatisfactory academic achievement. This is supported by previous studies found that learners who feel competent can reinforce intrinsic motivation and lead to higher achievement (Cortright et al., 2013; Khoshman et al., 2013). Therefore, the experimental group did better in intrinsic motivation scores and achievement scores.

The research findings establish that successful implementation of self – determination theory into practice in a secondary school chemistry education setting. The results also shown that the two instruments that comprised of modified intrinsic motivation inventory and chemical equilibrium achievement test can be utilized as data collection tools in the quantitative research study in the secondary chemistry education setting. However, the findings have shown that the subcomponent of the intrinsic motivation that is the relatedness, which is less than the other components scores in the modified intrinsic motivation inventory. However, the study found that learners have greater connection and interactions in the flipped classroom compared to traditional classroom. This is supported by previous studies done by Koballa and Glynn (2010), found that increased interaction resulted in higher intrinsic motivation and achievement. As shown by previous studies done in Malaysia, improved interactions has led to enhanced pupils' motivation and science achievement (Chan & Norlizah, 2017). Therefore, the experimental group did better in intrinsic motivation scores and achievement scores. Compared to other component, learners can have more interactions in a given condition they have enough time to interact with their instructors and peers. In this study, learning activities that stimulate interaction such as peer led discussion and small group presentation should have planned more sessions and extend to longer period of research time as to evaluate their experience in sense of relatedness. Since this is a new grouping to them, the learners may require more time to build up the trust and sense of belonging in order for them to proceed together in their group work.

5.4 Recommendations

Firstly, the research was carried out in a science education program for private secondary school. In this study, the finding has indicated significant effect on secondary school learners. Nevertheless, one of the downsides of the study, was this research was only conducted in a secondary school in a Selangor district. More studies need to be done in different districts in order to verify further the effect of flipped classroom prior to its school implementation. Therefore, it is suggested that it may be possible to extend the experimental study to other districts and other secondary schools. Besides, it is necessary to conduct additional research using different subject areas and different grade levels. This will increase the generalizability of this study.

Secondly, to improve the research design of the study, a qualitative component analysis needs to be included. As to get a more comprehensive perspective of the results, a mixed method design could be conducted with a combination of both deductive and inductive inquiries (Kalaian, 2008). Besides, this study was performed only for 6 weeks. The research results have shown that the theory can be correlated successfully between students' intrinsic motivation and chemical equilibrium achievement in flipped classroom. Since the requirement for technology in education is to produce effective success criteria for learners with the educational theory (Masino, 2016), it is essential to invest more time for the research study to strengthen the theoretical framework of this research.

5.5 Conclusion

In conclusion, after implementation of the flipped classroom instruction using online technology tools such as Kahoot, Kerboodle, Learnersclouds, Google applications and in class interactive learning, the findings of this research indicated that the participants in the experimental group scored significantly better than the participants in the control group in the post chemical equilibrium achievement test Therefore, the results provide empirical evidence to conclude that the experimental group and control group differ in intrinsic motivation scores and chemical equilibrium achievement scores on average. Specifically, the experimental group proved to have a higher intrinsic motivation scores and chemical equilibrium achievement scores, on average, than the control group. On the other hand, the traditional classroom teaching strategy in schools could be the greatest choice in the past, but teaching strategy has been adapted to provide learners with the highest quality education. This research has highlighted that secondary school science education teachers may be more successful in teaching chemistry in school by using flipped classroom approach. Curriculum developers may have to develop lessons that incorporate flipped instruction to learn chemistry in secondary school education program so that the learners can increase in intrinsic motivation and lead to enhance achievement in secondary chemistry education.

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