INTELLECTUAL TRANSFORMATION VIA TECHNOLOGY ENHANCED INQUIRY LEARNING ENVIRONMENT

MOHD SHAFIE BIN ROSLI

UNIVERSITI TEKNOLOGI MALAYSIA

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MOHD SHAFIE BIN ROSLI

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Educational Technology)

Faculty of Education
Universiti Teknologi Malaysia

DECEMBER 2012

To myself, my parent (Rosli bin Ahmad, Zaitun binti Hj. Dahiran) and to my fiancé, Nor Shela binti Saleh. Finally, to the blood, to the iron and to the steel that has been disbursed for the past few years.

ACKNOWLEDGEMENT

I would like to acknowledge my supervisors, Prof. Dr. Baharuddin Aris and Dr. Riaza Rias. In particular, I wish to express my ever sincere gratitude to Malaysian Ministry of Higher Education for sponsoring my doctorate studies. Indeed, it is a pride and honour to finish up this doctorate studies in two years and six months period with only RM 46 K of funding. Also I would like to acknowledge Universiti Teknologi Malaysia for their funding through Research University Grant that has been granted to me for the purpose of research and development relating to this doctorate studies. Finally, I wish my acknowledgement to all parties involved while I am working with this thesis until it is awarded with B1 grade during the viva-voce. Alhamdulillah for all the achievements.

ABSTRACT

This research is an endeavor to study the impact of using online intellectual transformation system (*i*-InTranS) on Form Four students in the context of intellectual transformation, intellectual mobilization, pattern of intellectual development, and sample's pattern of interaction while using *i*-InTranS. Thirty five Form Four students were selected using cluster random sampling technique. The proposed system was constructed by using Moodle as the Learning Management System (LMS) designed to deliver the content and was designed to use Hypothetical-Deductive Learning Cycle (HDLC) as the inquiry model. Six simulations were incorporated into *i*-InTranS to support the element of experiment in HDLC. Four Intellectual Level Tests were used to test the quantitative aspect of the research. This research applies Friedman Test, Wilcoxon Test and Bonferroni Procedure to view the changes on samples' intellectual level in long term spectrum. It was found that there were differences between samples' intellectual level before using *i*-InTranS and after using the system. However, the differences were not significant from the aspect of statistic. The research found that the samples were formed nine intellectual mobilization styles that can be classed into static, late peak, discontinuous peak, early trough, middle temporary peak, middle temporary trough, prolonged drop, dynamic and middle peak. The research also found that samples with different intellectual mobilization style interact with *i*-InTranS with their own unique and exclusive pattern. The outcomes of the qualitative study were invariable with the findings from the aspect of quantitative study. The findings suggested that *i*-InTranS has the potential to be operated as an agent for intellectual transformation among secondary school student. However, further researches are recommended in the field of Epistemology and Technology Enhanced Inquiry Learning Environment.

ABSTRAK

Kajian ini merupakan satu usaha untuk mengkaji impak penggunaan *online intellectual transformation system* (*i*-InTranS) ke atas pelajar Tingkatan Empat dalam konteks transformasi intelektual, mobilisasi intelektual, paten perkembangan intelektual dan paten interaksi sampel semasa menggunakan *i*-InTranS. Tiga puluh lima orang pelajar Tingkatan Empat telah dipilih menggunakan teknik persampelan rawak kluster. Sistem yang dicadangkan telah dibina menggunakan Moodle sebagai *Learning Management System* (LMS) direka untuk menyampaikan isi kandungan pelajaran dan telah direkabentuk untuk menggunakan Hypothetical-Deductive Learning Cycle (HDLC) sebagai model inkuiri. Enam simulasi telah diterapkan ke dalam *i*-InTranS untuk menyokong elemen eksperimen di dalam HDLC. Empat ujian tahap intelektual telah digunakan bagi menguji aspek kuantitatif kajian ini. Kajian ini menggunakan Ujian Friedman, Ujian Wilcoxon dan Prosedur Bonferroni untuk melihat perubahan terhadap tahap intelektual sampel dalam spektrum jangka panjang. Didapati, terdapat perbezaan diantara tahap intelektual sampel sebelum menggunakan *i*-InTranS dan selepas menggunakan sistem tersebut. Walau bagaimanapun, perbezaan tersebut bukanlah signifikan dari aspek statistik. Kajian mendapati bahawa sampel-sampel telah membentuk sembilan stail mobilisasi intelektual, yang boleh dikelaskan kepada *static*, *late peak, discontinuous peak, early trough, middle temporary peak*, *middle temporary trough, prolonged drop, dynamic* dan *middle peak*. Kajian juga mendapati bahawa sampel dengan stail mobilisasi intelektual yang berbeza berinteraksi dengan *i*-InTranS dengan paten mereka tersendiri yang unik dan ekslusif. Dapatan kajian kualitatif adalah tidak berbeza dengan dapatan daripada aspek kajian kuantitatif. Kajian ini telah mencadangkan bahawa *i*-InTranS mempunyai potensi untuk dioperasikan sebagai satu agen transformasi intelektual dikalangan pelajar sekolah menengah. Namun begitu, kajian lanjutan adalah dicadangkan dalam bidang Epistemologi dan *Technology Enhanced Inquiry Learning Environment.*

CHAPTER 1

INTRODUCTION

1.1 Introduction

On the ample grounds of the classroom stands a teacher. Together with the depth and complexity of her characters, her language and style, the comedy and the ethics that pervade her work, she starts to open a book. At the middle of the classroom, the desks and the chairs, organized into uniform coordinates. Here are the students, sitting in their designated position, with their bags hanging at the back of the chairs. In response to the teacher, they too start to open the book – the same version as the teacher is holding. Move from one page to another, looking at an overwhelming volume of texts and static yet colorful figures. They read it often though. Written on the white board, a word – Chemistry, short but complex. Then the teacher starts to explain and write the facts on the crystal clean white board, as usual, date and attendance are recorded at its corner. The students drive by the nature implanted into their mind start transferring anything that was written on the board into their book. Even the date does not have a chance to escape from their unattractive brown book. The students now were distracted, instead of understanding the facts explained to them, they just simply ignore it and focus on the writing. What on the board are vital – they thought. At the most front of the line, there are a number of students who are able to understand even though struggling in such setting. Indeed, their understandings are mostly premature in nature. The understandings that were achieved via blind memorizing. Near to vertex of the angle of the classroom, a group of students. A group of frustrated, confused, felt bitten by the setting and understood nothing. Members of a cohort of low achievers who make up bigger numbers that the frontline students. They are not a band of sluggish learners; just the content evolved beyond their faculty – a limitation due to low level of intellectual among them. Indeed, the present educational doctrine is the precursor toward low level of intellectual among students (Wankatz and Oreovicz, 1993; West, 2004, Lawson, 2002). This is the typical situation in Malaysian schools. Yet, it is ineffective. Since a decade ago, this should be a retrospect. And yet it to be otherwise.

The last few decades of research in Epistemology field had led to the design and development of a new educational approach that could develop human intellectual level to achieve their optimum potential. This gave birth to the new breed of educational theory called constructivism. Constructivism was believed have the potential to nurture human intellectual level to achieve a higher level (Spence and Usher, 2007). Nevertheless, implementing constructivism in average school is certainly not an easy task.

As the new millennium started, a new milestone in Science and Technology was documented. Information and Communication Technology (ICT) had rendered a very new paradigm in education. This development had paved way for constructivism to be actively integrated into the classroom. In the long run, this created an initiative for a mechanism to solve the problem of low level of intellectual among students to be taken. What left between an educational environment that could facilitate the development of human intellectual level and the present traditional methods is the ability to design and develop a system that could accommodate the demanding nature of education.

1.2 Problem Background

Dropped out from the Asian Tigers status, Malaysia maneuvers herself to regain the momentums through a flagship policy known as the Government Transformation Programme (GTP). Under the GTP, education sector had been listed as a National Key Result Area (NKRA), rolling as a national strategic initiative to uplift Malaysian economic power. Today, Malaysian education system is pressing toward high-end education, strong foundation of literacy and numeracy as well as inspiring innovative skills in order to generate high quality work force as mapped out by the NKRA. Thus, looking at recent deals, no argument at all that Malaysian government gives a serious concern on education to be a national strategic capital to fuel and drive the nation. In fact, years before the introduction of GTP, Ministry of Education had incepted a milestone for quality workforce through the introduction of Malaysian National Syllabus for Secondary School (KBSM). The KBSM was cored on generating science and technological oriented work force to catalyze the national progress toward an industrial nation at that time.

The KBSM was engineered mainly to unfold student's reasoning capacity through active interaction and stress on problem solving skills that eventually will develop students to achieve top intellectual level. With the massive integration of computer in modern age classroom, the application of Information and Communication Technology (ICT) was also being consolidated into KBSM. However, KBSM seemed not to work as planned (Mohd Shafie, 2009). Result in a range of reflections and criticism as teachers are still adopting the traditional methods (Hajah Asiken, 2006). Although some resort into ICT supported classroom emerged for the last few years through the Teaching and Learning of Science and Mathematics in English (PPSMI), yet, the program is short lived. The impact, students are incapable to push their intellectual level to a higher level (Sopiah Abdullah, 2006).

The perseverance of traditional methods of teaching had rendered low level of intellectual as a momentous hindrance. To some measure, it is actually a total blockage for learning to take place. Principally due to the fact that this barrier can only be degraded through maturation of intellectual capacity (Lawson, 2002). Intellectual maturation is a natural phenomenon that vanguards upgrade of individual intellectual level from a lower level to the higher one (Kevin Coll *et al.*, 2005) – a process defines by the researcher as ***intellectual transformation***. Through traditional methods, student progress toward intellectual transformation was not optimized. More likely, no progress has a chance to break ground at all (Wankat and Oreovicz, 2003).

National education is a key component in state formation. Playing position as means for national languages application, state ideologies and shaping state identities.

As economy is flourishing, national education shifts toward skills and knowledge establishment to secure national economic competitiveness (Green, 2011). In spite of that, our current system does not fit to guarantee economic competitiveness (Narayanan and Wah, 2002). On the contrary, industrialized countries such as US, UK, Australia, New Zealand and Ireland have a different education system compared to our current system. These countries are the Liberal Regime members. The liberal countries consider curriculum as one. A curriculum intended to catalyze intellectual transformation (Lawson, 2002; Wankat and Oreovicz, 2003; Silk *et al.* 2009; Duncan, 2009). They are implementing a curriculum that was designed to excite questioning, to put ahead openness via having different viewpoints, and encourage student to actively contributing their own knowledge in classroom sessions (Carneiro and Draxler, 2008). To such a degree, not at all similar to a great extent from our practice (Mohd Shafie, 2009).

In the case of Malaysian secondary schools with students who are, age around thirteen to seventeen years old. Naturally, to be able to learn at optimized pace they should already possess the highest intellectual level as the subjects being indoctrinate to them demanded. A number of valuable studies have been conducted in Malaysia debating the matter of students' intellectual levels. Corresponding to the studies, there is a strong conformation that Malaysian secondary schools students do have low level of intellectual. Ibrahim *et al.* (2004) found that majority of students in southern of Malaysia are having low intellectual levels. In the north provinces of Malaysia, Sopiah and Merza (2006) reported the same problem. This problem had reduced the effectiveness of the education system, as the problem of low level of intellectual persistent, even when students had left the secondary education system. Research by Syed Anwar (2000) reports that 81 % of Matriculation Students in Malaysia are still at low level of intellectual with a large gap recorded when compared to American students. Furthermore, the finding issue that the objective of education is still not achieved. Thus, a countermeasure is deeming appropriate to make Malaysian students a competence learner in science subjects.

To be a competent learner in science, student should already achieve a suitable intellectual level. Students at the age of secondary school mainly possess two major intellectual levels. The intellectual levels for secondary school student according to

Lawson (2002) are ***Empirical-inductive*** (EI) level and ***Hypothetical-deductive*** (HD) level. Nevertheless, some experts favor to propose the existence of three intellectual levels when dealing with subjects at the age 14 years old to 18 years old by including ***Transitional Level*** (Trans) as one of the three upper most intellectual levels. The intellectual levels for teenagers according to the theory proposed by Lawson (2002) are in Figure 1.1:

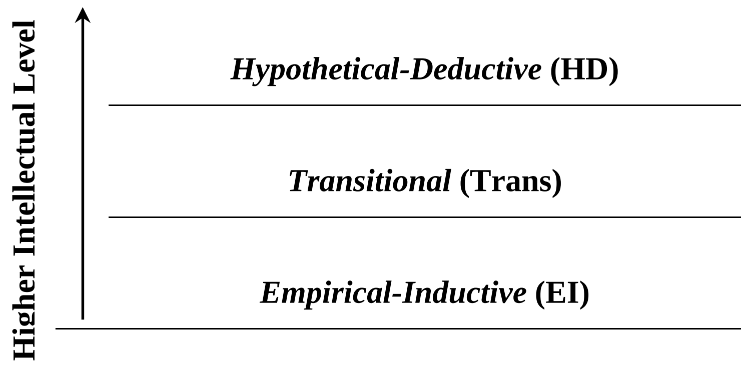

Figure 1.1: Intellectual Level (Lawson, 2002)

Empirical-Inductive level (EI) is the lowest intellectual level while Hypothetical-Deductive level (HD) is the highest. EI possess notable limitations compared to HD (Lawson, 2002). The differences between EI and HD will be discussed in Chapter Two. Students with low level of intellectual, EI, counter numerous difficulties in understanding abstract concepts in science subjects. To understand science concepts, students must already achieved HD level or at least at Trans level. Student with Trans level has the ability to apply HD thinking but with a limited capacity (Lawson, 2002).

Despite problem arose around the low levels of intellectual among students. Researches show that it is actually possible to nourish intellectual level to attain higher level (Lawson, 1995; Wankat and Oreovicz, 2003). It was discovered that intellectual transformation could be catalyzed through actively interacting and learning in inquiry environment as what scientists and researchers encounter (Lawson, 2002; Wankat and Oreovicz, 2003). At the same time, inquiry is the optimum way of generating scientific knowledge at any levels (National Science Learning Centre, 2010).

Inquiry learning environment as a mean of catalyzing student's intellectual transformation had been the foundation of curriculum among industrialized nation. In US for instance, inquiry learning environment can be seen as a mandatory part of the education. In Malaysia, endeavor to put into action the inquiry learning environment into school is not as easy as being hoped. Hashimah *et al*. (2004) find that lack of teachers' skills, lack of knowledge and insufficient understandings about inquiry are the factors that separates inquiry learning environment away from Malaysian schools. Lanita (2010) had conducted a holistic study deliberating this issue. Relying on 237 Malaysian secondary schools as sample, Lanita (2010) finds that teachers are reluctant to practice inquiry based learning due to:

i. Insufficient of apparatus and materials

ii. Teacher favoring non-experiment activities and prefer not to conduct experiments in the laboratory.

iii. Teachers have little confidence on their ability to conduct inquiry-based classroom.

iv. Teachers lack the skills of formulating questioning and searching a systematic answer on inquiry-based classroom.

However, with the rapid progress in technologies, it has become feasible to assert numerous ICT technologies into teaching and learning process (Riaza Riaz, 2006). Technology supported classroom enable the inquiry learning environment to be actively press into action to all Malaysian secondary schools indiscriminately. A system contrived for inquiry learning environment can solve the barrier faced by teachers and students toward inquiry-based teaching and learning. To ensure limitless access and total learning to the system, an online system is suitable as an alternative.

At the present day, numerous websites had adopted inquiry as its fundamental learning theory. These online inquiry websites may exist in various configurations such as guided inquiry, structured inquiry and open inquiry (Irfan Naufal and Sajap, 2007). However, the websites principally do not have any temptation to endure the intellectual levels enigma. As an example, online inquiry website developed by Irfan Naufal and Sajap (2007) only give focus on achievement based on different cognitive styles.

The development of ICT and its integration into learning have brought a reassuring solution toward students' low level of intellectual affair. A vigilantly planned Technology Enhanced Inquiry Learning Environment that embraced seemly approach and strategy in learning have a notable promising positive impact that may resolve low intellectual level problem away from the mist of our national education ameliorate process.

1.3 Problem Statement

Effective education, for most nations around the globe, is a dynamic necessity. Indeed, it is a basic requirement for development, positioned as a global benchmark for national competitiveness. Malaysia, frantic for economic expansion refuses to renounce to such necessity, therefore had summoned an intensive effort to refine the education decisively - an endeavor that currently is echoing throughout the whole nation. Majority are craving for an effective education. Parents demand excellent education that could safeguard their child's future. Students, of course wish for an education that is fun, attractive and give them as much as possible authorities. They had enough of this pale, bored, tedious and monotonous classroom. Diversely, the teachers, who have a different stand of view, dream of an education that has the capacity to facilitate their tasks. An instrument that could bridge the gap between students, having the elements of attractions and interactions might be an excellent instrument for the teachers.

Malaysian students are still having low level of intellectual in which notably decreases the effectiveness of education. Then, the main concern is now, how to uplift Malaysian students' intellectual level to achieve a higher level? At this point, inquiry learning environment seem to provide an ideal resolution for this matter. As being mentioned before, through inquiry learning environment, students are catalyzed toward intellectual transformation. Yet, teachers are having difficulties to practice inquiry learning environment in school. Even if the government is deters to incept an educational renaissance, such exertion will not be a holistic effort unless a system that make available online being press into service to ensure an extensive improvement could take place indiscriminately. Online inquiry learning environment according to research give remarkable positive effects. Irfan Naufal Umar and Sajap Maswan (2007) find that online inquiry learning environment give effective gain on sample's achievement. It was also establish that an online inquiry learning environment will proceeding student's motivation (van der Meij *et al.* 2012). However, none of the research focuses on the application of online inquiry learning environment for the purpose of intellectual transformation. In addition, little has been known about the effect of exposure toward online inquiry environment in long-term spectrum. How user with specific intellectual level surfing through the online inquiry learning environment is also remain puzzling around the research scope. At the same time, researches that debates about intellectual levels are focusing merely on lower intellectual level problem. None of these rstudies any mechanism of countermeasure for this problem in nowadays technology-oriented classroom. Thus, little has been written and discussed about inducing intellectual levels to advance to a higher stage, left a gap to be inquired: is an individual intellectual level wills only increasing throughout the life or just simply fluctuating depending on experience? Does human intellectual level develops in linearity and in sequence from lower level to the higher level? Or, can individual that had achieved a particular intellectual level to some extent revert back to a lower level? – creating a resonance nature of intellectual level development.

On that account, the researcher is enthusiastic to develop *i*-InTranS that embraces inquiry learning as its main pedagogical overlay and capable of catalyzing user's intellectual transformation. So far, the technology enhanced inquiry environment has lacked such a measure. Apart from the fact that a number of research had done with the navigational issue in Technology Enhanced Inquiry Learning Environment (e.g. Manlove, 2007), how users contextually approach their learning task in the system during the process of intellectual level nurturation is still not within the range of current research in the related field. To such a degree, the researcher will identify and explicate samples activities within *i*-InTranS to glean meaningful intelligence regarding how to support samples during their learning and not to mention to make suggestion on the design decision for the design and development of Technology Enhanced Inquiry Learning Environment that put the intellectual level transformation as its main ambition. Hypothetical-Deductive Learning Cycle (HDLC) was used as *i*-InTranS learning cycle. For the purpose of evaluation, Electrochemistry was selected as the domain mainly due to its compatibility with Hypothetical-Deductive Learning Cycle.

1.4 Research Objectives

Current research aims to address the following objectives:

i. To analyze current intellectual levels of Form Four students in Johor Bahru.

ii. To design and develop a Technology Enhanced Inquiry Learning Environment named as Online Intellectual Transformation System, *i*-InTranS with Electrochemistry.

iii. To design and develop *i*-InTranS based on HDLC.

iv. To develop simulations as a support tool for HDLC in *i*-InTranS.

v. To investigate the effects of continuous three weeks learning using the *i*-InTranS on samples' intellectual level from the prospect of:

   a. Gain in intellectual level scores.
   b. Overall intellectual level development trend during the time allocated while using *i*-InTranS.
   c. Intellectual mobilization

vi. To identify the interaction pattern of samples while engaging with *i*-InTranS.

1.5 Research Questions

Based on the research objectives, current research was aimed at investigating and providing insights to the following research questions:

i. What are the current intellectual levels of Form Four students in Johor Bahru?

ii. Will there be any gain in intellectual level score as a result of using *i*-InTranS for three continuous weeks?

iii. What is the intellectual level development trend exhibited by samples after using *i*-InTranS for three continuous weeks?

iv. What is the intellectual mobilization after each session of intervention?

v. What are the intellectual mobilization trends after samples had used *i*-InTranS for three continuous weeks?

vi. How do samples approach the learning task as evidenced by their interaction patterns while using *i*-InTranS?

1.6 Theoretical Framework

Current research is evolved around the matter of low intellectual levels among Malaysian students and the designed countermeasure alternative. In general, there are two main theories that were applied; the *Theory of Thinking* and the Constructivism Theory. The theories were then incorporated in order to construct the theoretical framework as in Figure 1.2.

The Theory of Thinking, proposed by Lawson (2002) is a new epistemological sight offering alternative to the orthodox epistemological enlightenment. Group of researchers who bestow to Theory of Thinking conceive the existence of three levels of dominant intellectual levels in the top stage of intellectual development of humanity. The three levels are Empirical-Inductive, Transitional and Hypothetical-Deductive. Individual intellectual level that proceeds to a higher level was known as intellectual transformation. Movement of intellectual level either from lower level to higher level or vice-versa was known as intellectual mobilization.

For the purpose of intellectual transformation, an online system engineered to contrive intellectual transformation was developed. The online system was named as *i*-InTranS. The *i*-InTranS was developed based on HDLC. The activities in HDLC such as open experiments, elasticity in proposing hypotheses and predictions and active involvement in experiment were applied into *i*-InTranS.

HDLC was supported by simulation and inquiry learning environment. The inquiry learning environment was consolidated into the system as HDLC to give samples the authentic learning experience as the scientists. In HDLC, it demands heavily on laboratory activities. At this point, the dynamic simulation was put in to replace the traditional laboratory activities to maximize the safety aspect as well as effective time management.

As samples are using *i*-InTranS, their pattern of interaction was logged in order to understand samples' approach to the learning and their preference so that in the future any appropriate support system could be designed. The data from their pattern of interaction was also manipulated in order to understand the process of intellectual transformation and intellectual mobilization.

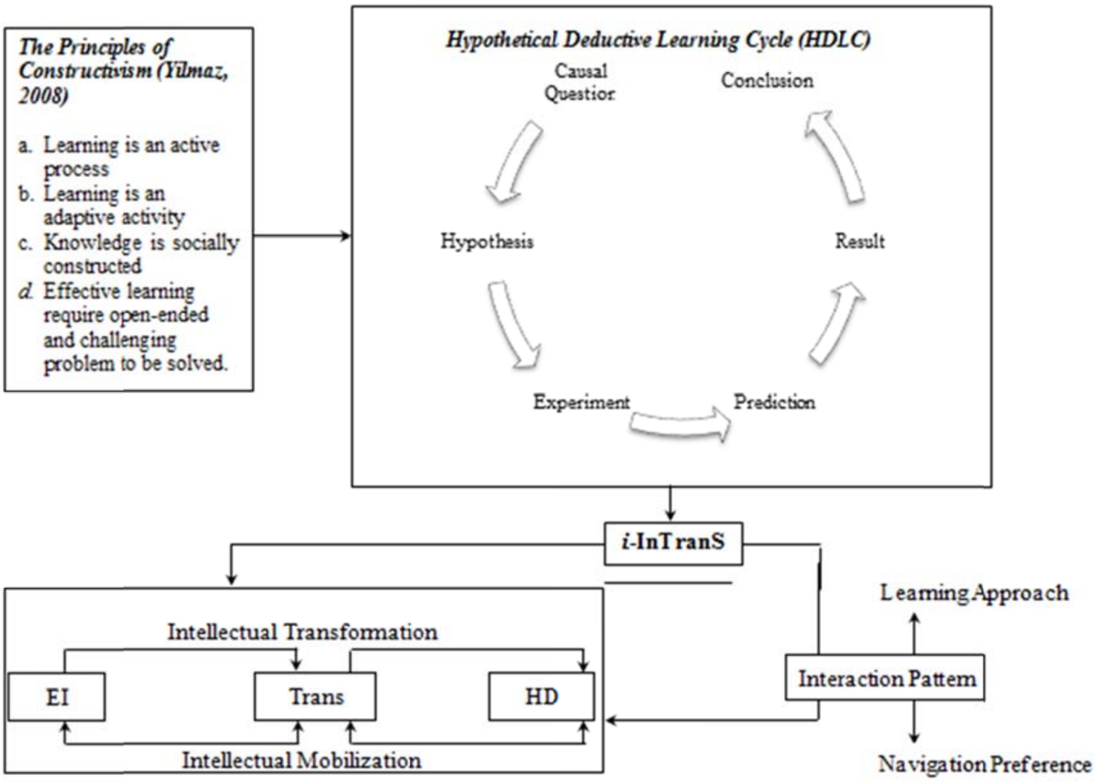

Figure 1.2: Theoretical Framework

1.7 Rational of Research

The rising evolution of the global competitiveness had marked science and technology as the backbone of a nation development. The scientific and technological oriented utopia is seamlessly demanding for highly intellectual, scientifically thinking and improvisation minded work force. However, in Malaysia, the secondary school students are still at low level of intellectual. That alone put Malaysia at a disadvantage. The Government of Malaysia, eager for a swift development, realized that the education system should undergo an ameliorate process. That should already place the inquiry learning environment into the production line. Yet, it is not an easy task. The teachers cannot be simply pushed toward the inquiry learning environment. An ill-prepared endeavor might spark more and more problems. Nevertheless, if an online system that was engineered to contrive intellectual transformation is adopted, all quarters of the education sectors could gain notable positive benefits.

Much of the world had abdicated the traditional methods of instruction and emphasizing on the priority to exchange to a technology-oriented classroom. Therefore, it is now the perfect time to apply online inquiry learning environment to contrive intellectual transformation. Even though a number of online inquiry websites already unrolled in the web, they are not specifically designed to catalyzed intellectual transformation. Whereas researchers have examined the application of technology enhanced inquiry environments in performance, literacy, regulative supports and as advance as the process of modeling and social collaboration, comparatively little research has focused on the catalyzation and nurturation of intellectual level. There is no empirical evidence showing that research concerning the intellectual level transformation in Technology Enhanced Learning Environment is not feasible. In this way, the researcher accumulates a perspective that the application of Technology Enhanced Learning Environment to catalyze human intellectual level transformation is required as the curriculum demands a revolutionary idea to enhance the process of teaching and learning as well as the availability of basic computer facilities in schools to supports such experiment.

1.8 Importance of Research

Intellectual transformation is a common objective for most educational institutions in the information age. The same thing goes to Malaysian Ministry of Education with the introduction and revisions of KBSM could be view as a wise projection of such maneuver (Malaysian Ministry of Education, 2001). Theoretically, under the scope of KBSM, the inquiry-based approach is emerging. Meanwhile the outdated traditional methods should be in the progress of abolishment or minimization as the inquiry-based approach slowly taking place with much more promising impacts. However, practically, Wong (1994) reports that the reality is in the reverse, teachers in our schools are practicing the traditional methods with no element of inquiry can be found. Thus, a resolution is needed, not only to solve the matter regarding low level of intellectual problem from Malaysian education system but also to assist the teachers to be able to embrace the Inquiry into the system systematically. In combination with that, conceptually current research has a number of latent capacities to contribute to the body of knowledge practically through its importance such as follow:

i. This research tried to probe into a new countermeasure to the intellectual levels enigma via the application of Technology Enhanced Learning Environment.

ii. This research explores the stimulation toward intellectual transformation in Technology Enhanced Learning Environment.

iii. This research investigates the resonance of intellectual in the Theory of Thinking – the result may give new insight whether individual intellectual level is rising throughout the life or fluctuating during the learning sessions.

iv. This research explores the intellectual mobilization in Technology Enhanced Learning Environment – the result may contribute to facilitate the design and development of online inquiry websites in the future to accommodate optimized learning environment for intellectual transformation.

1.9 Scope of Research

The scope of research involved the design and development of *i*-InTranS to uplift students' intellectual level based on the Theory of Thinking on the field of education, specifically on the domain of Electrochemistry.

The scope of this study also involved the implementation of *i*-InTranS to form four students that later their intellectual level development was measured. Besides, the effects of using *i*-InTranS in long-term spectrum were probed. The navigational pattern or also known as pattern of interaction of samples while interacting with i-InTranS was also studied.

1.10 Limitation of Research

Current research was conducted based on a number of limitations as follows:

a. The research only applies HDLC as the exclusive learning cycle in *i*-InTranS.

b. The research only involves the population of Form Four students that taking Chemistry in Johor Bahru fully government aided schools.

c. The research only adopt Electrochemistry as it domain.

d. The research excludes the side effects of some factors such as computer literacy, interest in electrochemistry, learning style or any other external and internal factors except the one that the research had stated.

e. As a mean to countermeasure the multiple testing effects, current research had only applied the Bonferroni Procedure to compensate the error inflation from Type I error.

1.11 Operational Definition

Operational definitions of terms used in this research are as follows:

i. Inquiry Learning Environment

John Dewey is one of the major figure and pioneer in the "*learning by doing*" theory who eventually leads and contributes to the birth of constructivism theory of learning in modern age. From his scholarly works, he had introduced two famous instructional strategies; inquiry-based and problem solving. Inquiry-based learning mainly is about the process of learning that make student come to understand and recognize the power of experience as they learn through open-exploration rather than simply screened for correspondence to what the teacher wanted (Duckworth, 1987).

As the result of literature reviews, the researcher finds that majority of researches as well as writing use the word enquiry, inquiry and inquiry-based interchangeably but refer to the same meaning. However, in this research, the terminology inquiry learning environment is uses multiply in this research to refer to the meaning of enquiry, inquiry, and inquiry-based.

As a summation, the inquiry learning environment in current research is defined according to the definition of inquiry by National Research Council (1996) and National Research Council (2000). National Research Council (1996) and national Research Council (2000) define inquiry as a pedagogical strategy and learning goal that stimulate students to construct their own knowledge through doing, ask scientifically oriented questions, plan investigations, use appropriate tools and techniques to gather data, formulate explanations from appropriate evidence, evaluate their explanations in light of alternative and then communicate and justify their proposed explanations.

ii. Electrochemistry

Electrochemistry is a topic in chemistry for Form Four secondary schools under Malaysian Ministry of Education supervision and it is a compulsory subject for pure science, IT and technique stream students. Stephen (2004) conclude that Electrochemistry is the study of reactions in which charged particles (ions or electrons) cross the interface between two phases of matter, typically a metallic phase (the electrode) and a conductive solution, or electrolyte. Much of the importance of electrochemistry lies in the ways that these potential differences can be related to the thermodynamics and kinetics of electrode reactions.

iii. Traditional Methods of Teaching

The traditional methods of teaching may cover several definitions within the same scope and perspective. In this research, the definition of traditional methods of teaching is as follows. According Ragasa (2008) the traditional method consisted of lectures given by the teacher, recitation, and class activities involving the topics discussed during the class. Meanwhile, Carpenter (2006) suggest that traditional methods of teaching as the learning situation that advocates learning material to be distributed or delivered to students via lecture-based technique and it also includes the situation of deductive even with multimedia. National Research Council (2001) relates a traditional method of teaching as an approach that press on students to solve problem using a standardized method or memorization of facts in classes.

Therefore, in conclusion, researcher conclude that traditional methods of teaching as any teacher-centred method either involving the use of technology or not that advocates passive involvement of student in class and memorization of facts.

iv. Theory of Thinking

The Theory of Thinking by Lawson (2002) is a new epistemological sight that offering an alternative to the orthodox views of the operative knowledge or the procedural knowledge. The operative knowledge or the procedural knowledge in the modern age begun with Immanuel Kant works in Prussia on *The Critique of Pure Reason* that being regards as *Kant's Copernican Revolution*. Kant's works gained the sympathetic of Piaget. Nevertheless, as Kant's Theory of Perception lacks the element of empirical testing, Piaget himself embarked his own scientific research. Piaget's brainchild later gave birth to a new dimension of Theory of Thinking, well known as well as well cited by the Piagetian camps such as Collea, Karpus, Fuller and Inhelder.

In information age, researchers begin to realize the shortcomings of Piaget's Theory. The drawbacks of Piaget's Theory are:

i. Genetically predetermined was assumed as not affecting the thinking development.

ii. Maturation of nervous system was excluded.

iii. Social interactions were not accounted as process of thinking development.

Therefore, Lawson (2002) proposes for a new stage theory that was adopted by this research known as the Theory of Thinking. The terminologies uses in current research that were originated from the Theory of Thinking are Empirical-Inductive (EI), Transitional (Trans) and Hypothetical-Deductive (HD).

v. Empirical-Inductive Level (EI)

The term Hypothetical-Deductive as well as Empirical-Inductive has been used by many researches in the discipline of intellectual development and brain cortex studies (Musheno and Lawson, 1999). In general, Empirical-Inductive level possesses some major disadvantages that could deter a successful and meaningful scientific understanding. Therefore, an individual with thinking dominated by empirical-inductive commonly faces with a lot of difficulties, misinterpretation and misunderstanding while learning science. Lawson (2002) defines Empirical-Inductive level as a thinking level that enable an individual to achieve ability to describe, seriate, classify objects, events and situations. Major disadvantage is that this level totally relies on direct observation and thinking in abstract manner is totally out of their capability (Musheno and Lawson, 1999; Lawson, 2002).

vi. Hypothetical-Deductive Level (HD)

During the early age, Piaget (1964) had stated that there are several stages of thinking skills, levels, ability and capacity. The two most famous levels of the four are concrete operational level and formal operational level. As intellectual development is a theory, it exposes toward perfections. While the Piaget’s theory seemed out-dated, Lawson (1995) successfully came out with new levels deduced from his vast researches. Lawson (2002) defines hypothetical-deductive as thinking patterns that could enhance an individual ability to identify and control variables. At the same time, an individual with Hypothetical-Deductive capacity is capable of performing high level thinking such as proportional thinking, probabilistic thinking, combinatorial thinking, and correlation thinking (Lawson, 2002).

vii. Transitional Level (Trans)

Lawson (2002) defines that transitional intellectual level as the intellectual level that is in between Empirical-Inductive level and Hypothetical-Deductive level. Student with Transitional has the ability to apply HD thinking but with a limited capacity (Lawson, 2002).

viii. Hypothetical Deductive Learning Cycle (HDLC)

HDLC consists of six stages of doing in science. The stages are questions rising, hypotheses generation, experimentation, predictions, analysis of data or result and drawing conclusion. This learning cycle is heavy incorporated to the inquiry learning environment. In HDLC, students are requiring heavy usage of initiative and thinking skills.

ix. Intellectual Transformation

Intellectual transformation is the process or a condition where an individual’s intellectual level advanced from lower intellectual level to a higher intellectual level. The intellectual transformation can be nurtured through learning via inquiry environment. The intellectual levels as they being transformed will have a substantial effect on an individual as it affect the performance on reasoning ability as well as capacity. The intellectual level is a term that is exchangeable with reasoning capacity. Intellectual level is mainly associated with a number of reasoning ability – proportional reasoning, probabilistic reasoning, correlational reasoning and combinatorial reasoning. Also, intellectual level is associated with a reasoning trend – the ability to identify, isolate and manipulate variable(s) (Yenilmez *et al.* 2005; Lawson, 1980).

Simply, intellectual transformation is defined as a phenomenon where individual intellectual level is being uplifted from a lower level to a higher level. In this research, EI is being considered as the lowest intellectual level and HD as the highest intellectual level with Trans as the intellectual level that exist between the EI and HD. Movement from EI to Trans or Trans to HD is an example of intellectual transformation. As intellectual transformation takes place, reasoning capacity is increased (Yenilmez *et al.* 2005; Lawson, 1980).

x. Intellectual Mobilization

Intellectual mobilization is the process of movement of individual's intellectual level. The difference between intellectual transformation and intellectual mobilization is that intellectual mobilization is advancement from lower level to a higher intellectual level. Meanwhile, intellectual mobilization included the movement of intellectual level both from lower level to a higher level and from higher level to the lower one.

xi. Technology Enhanced Learning Environment

In recent years, research in the area of Technology Enhanced Learning Environment had flourished (Wang and Hannafin, 2005). The term Technology Enhanced Learning Environment occurs along a very broad spectrum and definitions.

Specifically in current research, the term Technology Enhanced Learning Environment is referring to a system designed for learning with technology that normally involved cognitive tools and cognitive theories as well as epistemology knowledge. In standard practice, the Technology Enhanced Learning Environment involved the application of technologies to maximize learning in an environment that was able to offer users with options of time, pace as well as space (TEL Committee, 2004).

xii. Technology Enhanced Inquiry Learning Environment

Technology Enhanced Inquiry Learning Environment in present research refer to the Technology Enhanced Learning Environment that employs inquiry as the pedagogical approach in the system or learning environment as operated by Manlove *et al.* (2007) and Dettori and Paiva (2009).

1.12 Thesis Outline

The thesis is organized as follows:

Chapter One: This chapter presents the general background information discussing the matter of low level of intellectual and its impacts to the education. Chapter One also presents the objectives, research questions, rational and significant of the research as well as the theoretical framework of the research.

Chapter Two: This chapter analyzes the problems stated in chapter one. It also critically discuss the previous researches relates to the current research and the improvement that could contribute to the body of knowledge.

Chapter Three: This chapter presents the research methodology and the research designs uses in current research. Details on instrumentations, the system and the process for and achieving the research objectives and answering the research questions are being discussed.

Chapter Four: Chapter Four discuses about the process of design and development of *i*-InTranS according to ADDIE as its ID model.

Chapter Five: In Chapter Five, the thesis progress toward the presentation of the collected data and the analysis of the data gathered. The statistical models and tests used were also being justified. Objective of this chapter is mainly to deliberate the research questions

Chapter Six: The last chapter of this thesis discusses the findings of the whole research and debating this matter as an intellectual writing. Eventually, the researcher wraps up the thesis with conclusion and recommendation for more intensive research.

1.13 Summary

Low level of intellectual among students is no argument at all a serious matter. Rapid development and changes globally had triggered competitive competition. The concept *Survival of the Fittest* been well filled the competition among adversaries. Therefore, a maneuver to countermeasure this intellectual enigma is a wise step to once again align Malaysia with the world.

This chapter identifies the purpose of this study as setting forth the crucial need of designing and developing an online inquiry learning environment that could facilitate the development of students' intellectual levels. Findings of this research may then contribute to the growing literatures and provide useful information for more sophisticated research in the future. The next chapter presents an overview of related research on simulation, inquiry-based learning and all the related variables.

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