# EXTRACTION, VALIDATION, AND EVALUATION OF MOTIVATIONAL TACTICS RULES IN A WEB-BASED INTELLIGENT TUTORING SYSTEM (WITS)

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**by**

**NEHAD T. A. RAMAHA**

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**for the degree of**
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# TABLE OF CONTENTS

# LIST OF APPENDICES

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATION

| | |
|---|---|
| AI | Artificial Intelligence |
| AIED | Artificial Intelligence and Education |
| CAI | Computer Assisted Instruction |
| CIS | The Course Interest Survey |
| CSCL | Computer-Supported Collaborative Learning |
| GSI | The Generic Survey Instrument |
| HCI | Human Computer Interaction |
| ICAI | Intelligent Computer-Assisted Instruction |
| ICALL | Intelligent Computer Assisted Language Learning |
| ILE | Intelligent Learning Environments |
| IMMS | Instructional Materials Motivation Survey |
| ITS | Intelligent Tutoring System |
| MOOC | Massively Open Online Course |
| PMS | Perceived Motivation Survey |
| TDD | Test-driven development |
| WBEL | Web-Based e-Learning |
| WITS | Web-Based Intelligent Tutoring System |
| WWW | World Wide Web |

# EKSTRAKSI, PENGESAHAN, DAN PENILAIAN KAEDAH-KAEDAH TEKNIK MOTIVASI DALAM SISTEM TUTOR PINTAR BERASASKAN WEB (WITS)

## ABSTRAK

Kajian ini memberi tumpuan terhadap cara menlestarikan serta meningkatkan motivasi pelajar semasa proses pembelajaran dalam persekitaran Sistem Pentutoran Cerdas Berasaskan Web (Web-Based Intelligent Tutoring System, WITS). Kajian menunjukkan bahawa satu daripada cabaran terbesar dalam persekitaran e-pembelajaran asinkroni atau tidak segerak (seperti WTTS) adalah memastikan bahawa pelajar sentiasa bermotivasi sepanjang proses pembelajaran. Alasan utama bagi masalah ini adalah bahawa pelajar sering terasa terasing dan tahap interaktiviti dengan guru biasanya dianggap trivial. Justeru, persoalan utama adalah cara terbaik yang perlu ada pada sesuatu sistem untuk melestari serta meningkatkan motivasi pelajar dalam persekitaran tersebut. Berdasarkan kajian terhadap penyelidikan terdahulu dalam bidang ini, maka kajian ini mencadangkan bahawa WITS boleh menggunakan aturan taktik motivasi untuk melestari serta meningkatkan motivasi pelajar semasa proses pembelajaran. Oleh itu, kajian ini menggunakan proses rekayasa ilmu yang diutarakan oleh Turban, Sharda, Delen, and Efraim (2007) untuk menyari, mengesah, dan menilai aturan taktik motivasi ini. Fasa pertama kajian ini menggunakan pendekatan temu bual dengan empat orang pensyarah dan pelajar siswazah yang mempunyai sekurang-kurangnya 10 tahun pengalaman dalam pengajaran dan e-pembelajaran untuk menyari aturan taktik motivasi. Daripada dapatan temu bual, sebanyak 64 aturan taktik motivasi berjaya disari dan diwakilkan dalam bentuk peristiwa-keadaan–tindakan. Aturan tersebut disahkan dalam fasa kedua kajian. Fasa kedua dijalankan dalam bentuk soal selidik yang melibatkan

seramai 19 orang pensyarah dan 103 orang pelajar siswazah dari pusat pengajian ilmu pendidikan dan pusat pengajaran teknologi dan multimedia di sebuah universiti awam di Malaysia, yang berlatarbelakangkan pendidikan dan e-pembelajaran dan sekurang-kurangnya dua tahun pengalaman mengajar. Dapatan menunjukkan bahawa pakar bidang menerima kesemua 64 aturan tersebut. Setelah penyarian dan pengesahan, sistem WTTS dibangunkan sebagai asas pengujian (testing-bed) untuk menguji dan menilai aturan yang disari. Proses TDD (test-driven development) diaplikasi untuk mereka bentuk dan membangunkan kefungsian WITS bersama dengan UML (unified modeling language). Fasa ketiga kajian melibatkan kuasi-eksperimen, reka bentuk pascaujian sahaja, dan penggunaan kaedah kuantitatif untuk menilai keberkesanan aturan yang disari. Dalam fasa ini, instrumen yang digunakan adalah soal selidik pascaujian yang dikenali sebagai PMS (perceived motivation survey), 74 orang pelajar antarabangsa yang mengikuti kursus Bahasa Malaysia Asas di universiti awam di Malaysia, yang menggunakan WITS selama dua minggu sebelum memberi respons terhadap PMS. Dapatan fasa ini menunjukkan bahawa aturan yang disari adalah berkesan dan berguna untuk melestari serta meningkatkan motivasi pelajar semasa proses pembelajaran dalam persekitaran e-pembelajaran yang asinkroni. Justeru, kajian ini menyediakan para pendidik dan pereka bentuk pengajaran dengan aturan taktik motivasi yang boleh disepadukan dengan sebarang persekitaran e-pembelajaran asinkroni untuk melestari serta meningkatkan motivasi pelajar semasa proses e-pembelajaran. Penggunaan aturan yang sedemikan diharapkan dapat memotivasikan lagi pelajar sepanjang proses pembelajaran.

# EXTRACTION, VALIDATION, AND EVALUATION OF MOTIVATIONAL TACTICS RULES IN A WEB-BASED INTELLIGENT TUTORING SYSTEM (WITS)

## ABSTRACT

The current study focuses on finding a way to sustain or enhance the learners' motivation during the learning process within a Web-Based Intelligent Tutoring System (WITS) environment. Studies showed that one of the biggest challenges in asynchronous e-learning environments (such as WITS) is how to keep learners motivated for the entire learning process. The main reason for this problem in asynchronous e-learning is that the learners often feel isolated and levels of interactivity with the teacher are usually considered trivial. Thus, the main question was how best the system should behave in order to sustain or enhance the learners' motivation in such environments. After investigating the previous research in this field, the current research suggested that the WITS may use motivational tactics rules to sustain or enhance the learners' motivation during the learning process. Therefore, this research followed Turban, Sharda, Delen, and Efraim (2007) knowledge engineering process to extract, validate, and evaluate those motivational tactics rules. The first phase of this study uses an interview approach with four lecturer and postgraduate students with at least 10 years of teaching and e-learning experience to extract the motivational tactics rules. The result of the interviews was extracting 64 motivational tactics rules, those rules were represented in the form of event-condition-action. Those rules were validated in the second phase of this study. The second phase was conducted in the form of questionnaire involving 19 of the lecturers and 103 of the

postgraduate students from a Malaysian public university with education and e-learning background and at least two years of the teaching experience. The results showed that the field experts accepted all the 64 motivational tactics rules. After extracting and validating the motivational tactics rules the WITS system was developed to be used as a testing-bed to test and evaluate the extracted rules. Test-driven development (TDD) process was applied to design and develop the WITS functionalities along with the Unified Modeling Language (UML). After building the WITS system, the third phase of this study was conducted in the form of quasi-experimental, post-test-only design, using quantitative methods to evaluate the effectiveness of the extracted motivational tactics rules. The instrument that was used in this phase was a post-test questionnaire named Perceived Motivation Survey (PMS), 74 of the international students that enrolled to study elementary Malay language at a public Malaysian university, used WITS for two weeks before the responded to the PMS. The result of this phase showed that the extracted motivational tactics rules were effective and useful to sustain or enhance learners' motivation during the learning process within asynchronous e-learning environment. Thus, this study provides the educators and instructional designers with the motivational tactics rules that could be integrated with any asynchronous e-learning environment to sustain or enhance the learners' motivation during the e-learning process. The use of such rules is hoped to help in the design and development of e-learning environments that can help learners be motivated for the entire learning process.

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

The role of technology in education has evolved and radical changes have occurred since the emergence of the Internet. The Internet has provided various ways of the delivery of education where the web can be used as a medium for education such as Web-Based e-Learning (WBEL), Adaptive Hypermedia, and Web-Based Intelligent Tutoring Systems. Learning via the web enables everyone to obtain all types of knowledge, at all levels, at any time and in any place.

E-learning is an educational paradigm based on the delivery of learning materials via electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM (Alian & Al Akhras, 2010). In an e-learning system, information can be delivered by two different methods. The first is the asynchronous method where learners can acquire knowledge at any time and any place; they can learn following their own pace. The most popular forms of asynchronous e-learning are instructional websites, WBEL, email, and forum. The second method of e-learning is the synchronous method where the teacher and the learner interact in real time, including real-time web chats and video conferences (Hrastinski, 2008).

Motivation plays a key role in learning and teaching. Teachers give a lot of time to assess and sustain their learners' motivation. Experienced teachers understand that it is important to keep learners motivated all the time in order to

achieve optimal learning results. This is according to a large amount of research (Ghergulescu & Muntean, 2010; Snow, Corno, & Jackson, 1996). According to Martens, Gulikers, and Bastiaens (2004), the performance of the learners with high intrinsic motivation was often better than the learners with low intrinsic motivation, and as stated by Miltiadou and Savenye (2003), learners with high motivation were more likely to complete a course, since they engaged more in learning activities.

Studies illustrated motivation as a key element of education with an important role in the success of the learning process, being one of the important factors that drive learners' performance (Lin, Wu, & Wang, 2010; Weiner, 1985). According to Hrastinski (2008), synchronous e-learning learners felt more motivated than asynchronous learners since synchronous communication closely resemble face-to-face communication. Although there are similarities among motivational problems in all e-learning settings, there are specific motivational challenges within each major environment. One important challenge in asynchronous communication is drop-out rates that tend to be higher than in face-to-face settings, since learners often feel isolated and levels of learning interactivity are usually considered trivial (Keller & Suzuki, 2004).

For a long time, motivation has been seen in an e-learning field as a matter of design. In other words, proper instructional design and suitable learning activities would engage all learners (Cocea & Weibelzahl, 2006). Although designing a motivating e-learning environment was important, keeping learners motivated for the entire learning period was found to be one of the biggest challenges, not only in e-learning, but also in all forms of learning (Ghergulescu & Muntean, 2010).

However, in traditional face-to-face learning and synchronous e-learning, teachers have direct contact with the learner, thus being able to analyze the learner's whole behaviour and thus can infer his/her motivational state. But in the context of asynchronous e-learning (such as WBEL), motivation detection became a more challenging process (Ghergulescu & Muntean, 2010). Thus it is important if the WBEL systems are able to detect a learner's motivational state during the learning process; as information about the motivational state of the learner would allow enhancing and sustaining his/her motivation during the use of the system.

Therefore, this research aims to develop an approach to sustain or enhance the learners' motivation during the learning process in a WBEL environment.

### 1.2 Background of the research

The use of Artificial Intelligence techniques with WBEL systems brought the hope of developing systems that would become personalized to each learner and thus be of more benefit to him/her (Kose, 2014; Ma, 2006). Although with added complexity, intelligent systems (such as Intelligent Tutoring System (ITS), Intelligent Learning Environments (ILE), and Intelligent Computer Assisted Language Learning (ICALL)) did not always succeed in engaging the learner. According to de Vicente (2003), while a lot of effort was spent investigating how to adapt an instructional interaction to the learners' knowledge, almost no work was done to adapt the instruction to their motivational state. This is surprising, given the big impact that a learner's motivation has on his/her performance.

During the last decades, many Computer Assisted Instruction (CAI) systems were designed and developed. Few of these systems attempted to make explicit

use of the knowledge about human teaching and learning in order to create an instructional environment that could adapt to the learner characteristics (de Vicente, 2003). These systems are usually known as Intelligent Tutoring Systems (ITS), differed from other CAI systems by showing their intelligence through the implementation of at least one of these three modules: the domain module, the tutorial module and the learner module. The domain module contains the knowledge about the domain; the learner module contains information about the learner (such as how many times he used the system, how long he took to perform the task); and the tutorial module contains the knowledge about tutoring (such as, in which order to present the lessons, and what type of feedback to give) (Nkambou, Mizoguchi, & Bourdeau, 2010).

Implementing an ITS that takes into account the learner's motivational aspects is crucial for the asynchronous e-learning environments, as these types of environment have no direct interaction between the learners and the teacher, leading to some motivational problems such as high drop-out rates. Thus, one of the biggest challenges of the WBEL systems was how to keep learners motivated for the entire learning process (Ghergulescu & Muntean, 2010; Song & Keller, 2001). To overcome this challenge, the learning system needs two functions: (i) to detect the learner's motivational state during the learning process; (ii) to react against any motivational problems such as less confident or discontented learners; enhance learners' motivation, or sustain the motivational state of already motivated learners (Ghergulescu & Muntean, 2010).

To date, there have been few research addressing these issues. The most relevant works were that of del Soldato (1994) and de Vicente (2003). del Soldato

(1994) developed a system called “MORE”, that uses a combination of traditional domain and motivation-based strategies to plan the instruction. The domain-based planner referring to the progress across the domain and suggest actions to “advance” across the domain every time a topic or skill was mastered by the learner, while the motivational planner is driven by both the motivational state and the performance state suggesting tactics to sustain or enhance the learner's motivation. A negotiation planner attempts to keep balance between the tactics suggested by the domain-based and the motivational planner in case of contradictions. del Soldato formalized a number of knowledge-based motivation diagnosis rules, and a of number motivational tactics rules for sustaining learners’ motivation. But the rules were formalized partly based on common sense and partly on theories of motivation (de Vicente, 2003). del Soldato rules were also neither validated nor evaluated (du Boulay & del Soldato, 2016). Thus, the present research will extract, validate, and evaluate a new motivational tactics rules to sustain or enhance the learner’s motivation during the e-learning process.

de Vicente and Pain (2002) and de Vicente (2003) were other researchers who dealt explicitly with detecting the motivational state of the learners in an e-learning environment. They developed a game-based learning system called “MOODS” as a simple tutoring system with an added self-report facility. The facility was based on a motivational model which they developed based on the relevant studies. With this facility, learners reported on their motivational state during interaction with the system. Later, they performed another study (motivation diagnosis study) to extract and comprise tutors’ knowledge in relation to motivation detection. In de Vicente (2003) study, the participants were asked to watch the recorded interactions of a learner with MOODS and infer or comment

on the motivational state of the learner. As a result of his study, de Vicente extracted a set of 85 rules for detecting learners' motivation. After that, he validated and evaluated the extracted rules in two other studies. The work of de Vicente (2003) regarding motivation detection rules were used in this study to detect learners' motivation after it was validated one more time during this study. But one of the issues not explored in de Vicente research was how to sustain or enhance learners' motivation, which is the focus of this research.

## 1.3 Problem Statement

With the early emergence of the WBEL in the 1990s, static web pages were used as a media to present the same learning contents for all learners without any adaptation or tailoring. Thereafter WBEL became more popular and advanced techniques emerged such as adaptive learning content according to learner performance (Ebner, 2007).

Due to motivation being one of the major factors contributing to the success of the learning process, there has been an increasing amount of research interest in the attempt to integrate motivation into e-learning instructions. These studies were carried out in various contexts such as in general computer-based instructions (Keller, 1983), interactive environments (Chen, Deng, Chou, & Chan, 2005; Robertson & Good, 2003; Waraich, 2004), and intelligent learning environments (D'Mello & Graesser, 2010; de Vicente, 2003; del Soldato & du Boulay, 1995; Lepper, Woolverton, Mumme, & Gurtner, 1993; Malone & Lepper, 1987). Research carried out in the interactive context focused on the creation of motivational learning environments. On the other hand, research done in the

intelligent context focused on strategies in detecting learners' motivational states during interactions with learning environments such as that done by del Soldato and du Boulay (1995) as well as by de Vicente (2003).

Figure 1.1 which presents the problem statement shows that one important challenge in asynchronous e-learning is the high drop-out (attrition) rates (Chaiprasurt & Esichaikul, 2013; Martinez, 2003). For example, according to a large number of research, MOOC (which is a well-known platform for an asynchronous e-learning (Kay, Reimann, Diebold, & Kummerfeld, 2004)) suffers from this problem; which is high drop-out rate (Adamopoulos, 2013; Boyatt, Joy, Rocks, & Sinclair, 2014; Clow, 2013; Wright, 2013). The main reason for the high drop-out rates in asynchronous e-learning is that the learners often feel isolated and levels of interactivity with the teacher are usually considered trivial (Keller & Suzuki, 2004). However, motivational factors are known to be highly correlated with drop-out rates; low learners' motivation leads to high drop-out rates, and high learners' motivation leads to low drop-out rates (Park & Choi, 2009). Thus, keeping learners motivated for the entire learning process is an important issue in order to achieve better learning results.

As stated previously, designing an e-learning environment to be motivating for learners is not enough to keep learners motivated for the entire learning period, not only in e-learning, but also in all forms of learning (Ghergulescu & Muntean, 2010). according to a large number of research, asynchronous e-learning such as MOOC suffers from high drop-out rate problem (Adamopoulos, 2013; Boyatt, Joy, Rocks, & Sinclair, 2014; Clow, 2013; Wright, 2013). Even if the learners are intrinsically motivated, the high drop-out rates will still be high in an

asynchronous e-learning as the main reason for that drop-out rates is that the learners often feel isolated and levels of interactivity with the teacher are usually considered trivial (Keller & Suzuki, 2004).

However, as an asynchronous e-learning environment, the WBEL system has to perform two functions on behalf of the teacher in order to keep learners motivated for the entire learning period. The first function is to detect the learners' motivational state through the learning process, and then react against any motivational problem in order to sustain or enhance their motivational state (Ghergulescu & Muntean, 2010).

In this research area, there are two main research categories to detect the learners' motivational state; one category focused on (i) utilizing physical sensors (example: D'Mello & Graesser, 2010; Derbali, Chalfoun, & Frasson, 2011a, 2011b), this type of research is applicable for research purposes only and very difficult to be used widely for motivation detection in e-learning systems. The other category focused on (ii) utilizing data generated from the interaction of the learner with the e-learning system such as time, mouse movements, and other performed actions data. These data are usually saved by the system in a log file, making these studies applicable for motivation detection in e-learning systems. Examples for this category are the de Vicente (2003) motivation model, del Soldato (1994) motivational tactics, as well as the Qu and Johnson (2005) motivational states model.

Although numerous studies attempted to detect learners' motivation in e-learning systems, there was a lack of research work focusing on sustaining or enhancing learners' motivational state in WBEL. Therefore, the question still

remains as to how best the system should behave in order to sustain or enhance the learners' motivational state (du Boulay & del Soldato, 2016).

Therefore, the main objective in this study was to extract, validate, and evaluate motivational tactics rules to sustain or enhance the learners' motivation in real time within a WBEL environment. The researcher believes that such study will be potentially of great benefit for instructional system designers in trying to build a learning environment that takes into account the motivational aspects of the learners, such as Game-based learning and e-learning environments. The study will help by providing a way to sustain or enhance learners' motivation dynamically in the system. In addition, the study contributes to the research in the contexts of both interactive learning environments and human computer interaction (HCI). However, in contrast to other related studies, this study not only focused on detecting learners' motivational state, but also on enhancing the WBEL system with the ability to avoid learners' motivational problems. Therefore, this study addresses new challenges for web-based e-learning: how the system can interact with the learner to sustain or enhance his/her motivation during the learning process.

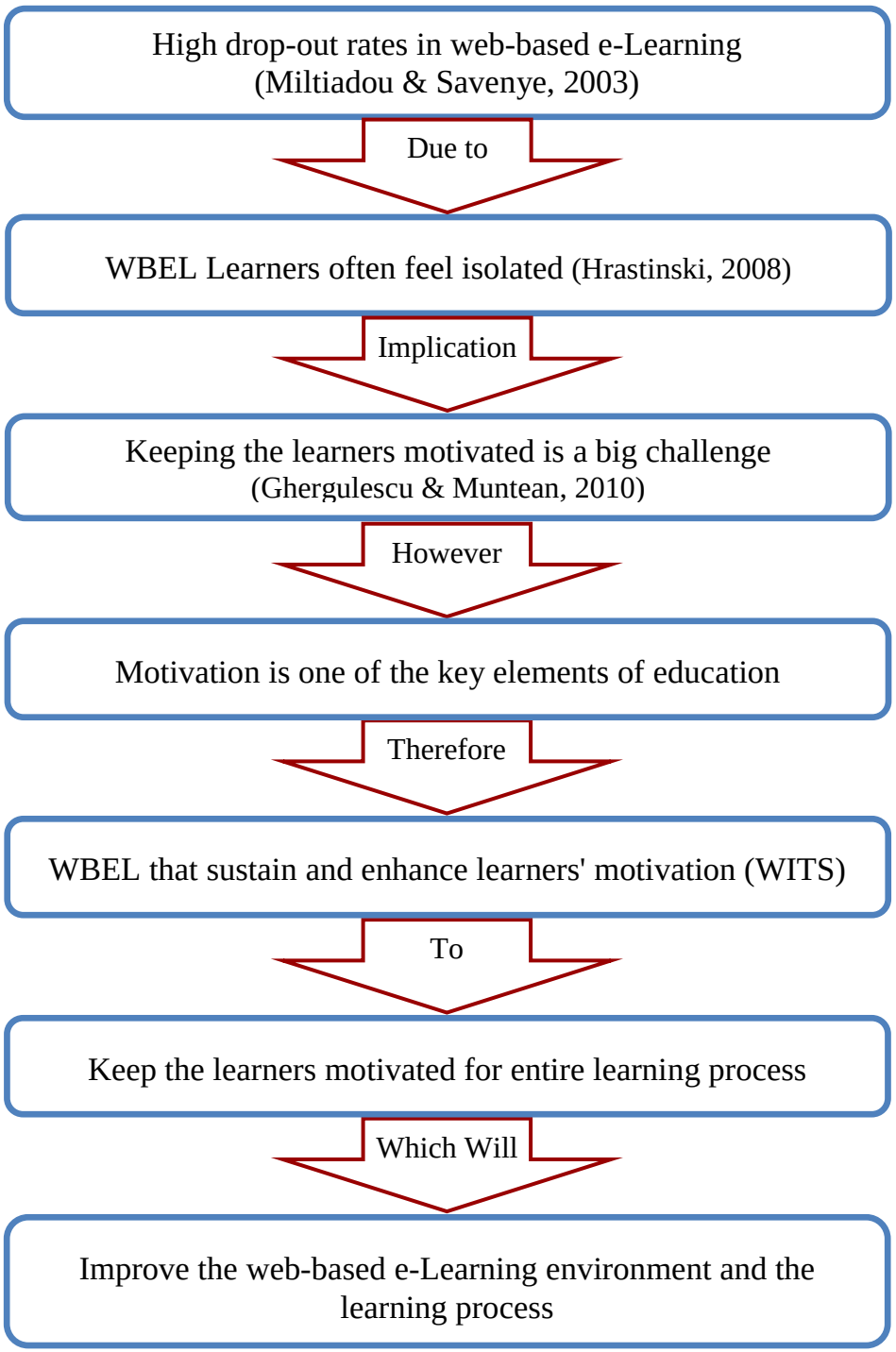


Figure 1.1: Problem statement

## 1.4 Research Objectives

The focus of this study is on the detection of WBEL learners' motivational state and how to sustain or enhance their motivation. Thus, the research objectives are:

- To explore issues of detecting the learners' motivational state, include identifying the methods to be used and selecting the most suitable one. This goal was addressed in this thesis based on existing literature.
- To extract the motivational tactics rules needed to sustain or enhance learners' motivation during the e-learning process.
- To validate whether the extracted motivational tactic rules valid to be used in WBEL environment.
- To evaluate the proposed learners' motivation enhancing and sustaining approach. To address this goal, a Web-Based Intelligent Tutoring System (WITS) was built as a test-bed.

## 1.5 Research Questions

This study attempted to find and develop an approach to detect, sustain, and enhance the learners' motivational state during the interaction with a WBEL environment (WITS in this research). The reason for choosing a WBEL environment, which is an asynchronous e-learning environment, was because this environment faces motivational challenges such as high learners' drop-out rates, as in this type of environment the learners often feel isolated and the levels of learning interactivity are considered trivial. Therefore, the main research questions centred on:

- What are the relevant rules to detect learners' motivational state during the interaction with the system?
- What are the applicable motivational tactics rules that are needed to sustain or enhance learners' motivation during the e-learning process?
- Are the extracted motivational tactics rules valid to be used in WBEL environment?
- Are there any significant differences in learners' perceived motivation between using WITS system with motivational tactics rules (experimental group) and without (control group) these rules as measured by Perceived Motivation Survey (PMS)?

## 1.6 Research Framework

The research framework, which can be seen in Figure 1.2, was constructed and linked based on the knowledge engineering process of Turban, Sharda, Delen, and Efraim (2007).

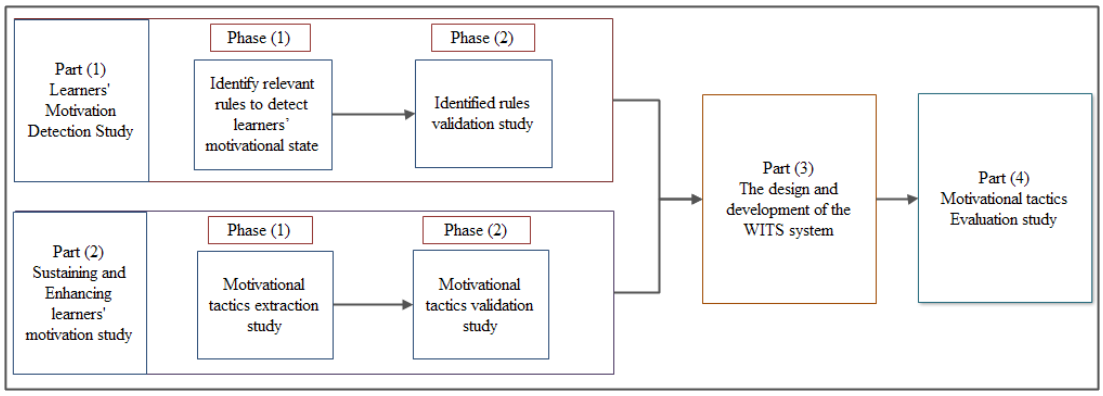


Figure 1.2: Research Framework

This research consists of four parts:

i) Learners' motivation detection study: this part of the research contains exploring the issue of measuring the learners' motivational state during the learning process within WBEL environment. It consists of two phase:

1. Identify relevant rules to detect learners' motivational state during the e-learning process: this phase addressed based on existing literature.
2. Identified rules validation study: in this phase the identified rules to detect learners' motivational state was validated.

ii) Sustaining or enhancing learners' motivation study: this part of the research contains the elicitation of the knowledge regarding sustaining

or enhancing learners' motivation in real time within WBEL environment. This part consists of two phase:

1. Motivational tactics extraction study: This phase involved the extraction of expert teachers' knowledge regarding how to sustain or enhance the learner's motivation during the e-learning process. In this research the extracted knowledge was represented in the form of condition-action rules, those rules called "motivational tactics rules".
2. Motivational tactics validation study: In this phase, the extracted motivational tactics rules from the previous phase were validated.

iii) The design and development of the WITS system: This part of the research involved the design and development of the WITS system as a test-bed for the evaluation of the extracted motivational tactics rules.

iv) Motivational tactics evaluation study: This part of the research involved the evaluation of the extracted motivational tactics rules.

More details about the knowledge engineering process components were discussed in the next chapter.

## 1.7 Theoretical Framework

The theoretical framework of this study covers a number of theories and models from the literature. One of the key theories of this research is the Keller motivation theory (Keller, 1979), according to literature review his theory is widely accepted by researchers in the field of e-learning. Keller has also created a model named as Keller's ARCS (Keller, 1987) to design and incorporate motivation in instruction. The acronym ARCS is derived from four categories of motivational factors: Attention, Relevance, Confidence, and Satisfaction. Meanwhile, Malone and Lepper's Taxonomy of Intrinsic Motivation Model (1987) is another key model of this research, also widely used in the field of e-learning. The taxonomy focused on several factors that can intrinsically influence learners' motivation. These factors are: challenge, sensory curiosity, cognitive curiosity, control and fantasy.

Then, de Vicente (2003) developed a general model of learners' motivation based on the extracted variables from the Keller ARCS Model (1987) and Malone and Lepper's Taxonomy Model (1987). In his research, de Vicente (2003) classified the extracted variables into two categories: trait variables, or "permanent" characteristics of the learner, which are not likely to change during an instructional interaction; and state variables, or more "transient" characteristics which are likely to change during an instructional interaction. Four motivational variables (control, challenge, independence and fantasy) were categorized as traits, and six variables (relevance, confidence, sensory interest, cognitive interest, effort and satisfaction) were categorized as states. The de Vicente model, considered to be useful within this research as the theoretical background of his

model is suitable to the research context which is web based learning. However, some modifications were made to de Vicente model to make it more suitable to the research context (see section 2.6.1 for the details of these modifications).

In her work, del Soldato (1994) suggested a number of motivational tactics in the form of set of production rules in order to sustain/enhance learners' motivation. She used motivational tactics such as feedback and next problem difficulty. She implemented her motivational tactics through the application of these rules to a database consisting of information about the learners' progress and motivational state. del Soldato's motivational tactics will form the basis of identifying the motivational tactics factors in this research. In addition, one of the incorporated models in the theoretical framework is the Hattie and Timperley's model of feedback (Hattie & Timperley, 2007), which has been widely cited and accepted by researchers in the educational field. The aim of their model is to suggest the effective way of feedback to enhance learning. Hattie and Timperley's model was the basis to select and give the appropriate feedback for learners during this research.

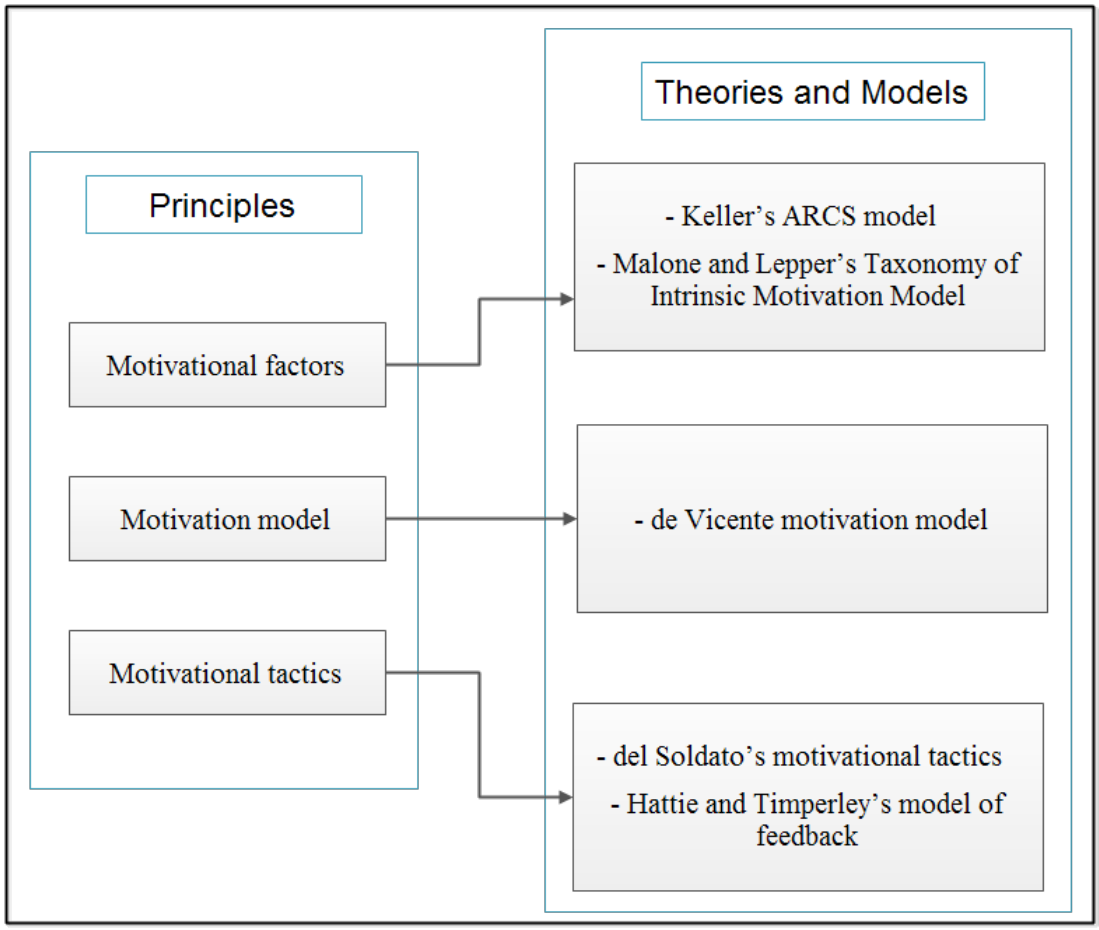


Figure 1.3: Theoretical Framework

More details about the key theories and models were presented in the next chapter.

## 1.8 Research Significance

A model for sustaining or enhancing learners' motivation in WBEL was created. In addition, a structure for a WBEL environment that is able to detect, sustain, and enhance learners' motivational state during the learning process was suggested (called WITS). Since this research derived from a number of different disciplines and applied techniques used in the area of e-learning, artificial intelligence, and education, it has the potential to contribute to more than one research area. In particular, the major outcome of the research presented here is intended to be of value to the designers of interactive and intelligent learning environments that incorporate a way to sustain or enhance learners' motivation.

As discussed previously, one of the biggest challenges in asynchronous e-learning environment (e.g. WBEL) is keeping the learners motivated for the entire learning period since they often feel isolated and the levels of learning interactivity are often considered trivial. Thus, it is believed that the proposed model and software will be of value in facing these challenges, by providing e-learning environments' designers with an example of detecting, sustaining or enhancing the learners' motivational state dynamically during the learning process.

In addition, the event-condition-action rules were produced based on the results of the analysis. The benefits of the rules are that they represent the findings of the study in a symbolic manner, which is easier to understand, implement and incorporate into the computer software. Thus, the rules should be considered as stepping stones in the development of ITS environment that can sustain or enhance learners' motivational state during the learning process.

## 1.9 Research Limitations

This research:

i) Was limited to find and validate a set of rules to detect, sustain, and enhance learners' motivation in WBEL environment during the learning process. Thus, this research result may not be generalized to other types of learning environment.

ii) Uses a sample for the evaluation part of this research consist of international students enrolled in "LKM100" course to study the Malay language. This use of "LKM100" in the research is for the purposes of evaluating the extracted rules. Thus, this research results may be applied to other types of courses.

iii) Evaluation study limited to the evaluation of motivational tactics rules. Therefore, this study will not evaluate the WITS system itself or other educational factors like learner's achievement or engagement.

## 1.10 Operational Definition

i) E-learning is an education paradigm that is based on the delivery of learning materials via electronic media (Alian & Al Akhras, 2010). In this research, E-learning is considered to be asynchronous e-learning; learning based on electronic delivery of learning materials almost anytime, anywhere over the web.

ii) Asynchronous e-learning: an e-learning method where learners can get learning materials at any time and in any place (Hrastinski, 2008). One of the most popular forms of asynchronous e-learning is Web-Based e-learning (WBEL), which was used in this research.

iii) Web-Based e-learning (WBEL) is one of the asynchronous e-learning forms that use the World Wide Web (WWW) as an education delivery medium.

iv) Motivation: One of the accepted definitions of motivation for this research is that of Kleinginna and Kleinginna (1981). Motivation was seen as an internal state or condition that activates behaviour and gives its direction. In this study, the learners' perceived motivation was measured using "Perceived Motivation Survey" (PMS) instrument.

v) Sustain Motivation: According to de Vicente (2003), sustain or retain student motivation is the ability to maintain a need or desire to learn. In this research, sustain motivation is the process of keeping the learner motivated by applying a set of appropriate motivational tactics.