FUZZY-BASED USER MODELLING FOR MOTIVATION ASSESSMENT IN PROGRAMMING LEARNING ADAPTIVE WEB-BASED EDUCATION SYSTEMS

RAJERMANI A/P THINAKARAN

UNIVERSITI TEKNOLOGI MALAYSIA

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RAJERMANI A/P THINAKARAN

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DEDICATION

To my lovely husband and sons, for their patience, support, love and for enduring the ups and downs during completion of this thesis.

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ABSTRACT

Learning programming is not an easy task and students often find this subject difficult to understand and pass. One way to improve students' knowledge in programming is by using Intelligent Tutoring System (ITS) through Adaptive Web-Based Education Systems (AWBESs). The objective of ITS is to provide a personalized tutoring that is tailored to the student's needs. User modelling is one of the key factors that can meet the ITS intended objectives. From the literature, it was discovered that motivation stands out as one of the critical students' characteristics that need to be considered when designing a user model. However, from the previous studies, it was discovered that almost all the researchers and educators constructed the user model based on knowledge and skills as students' characteristics. Thus, the aim of this study is to develop a user model based on students' motivation known as the Motivation Assessment Model. This is a model that is able to assess students' motivation level and deliver tutorial materials accordingly. The Motivation Assessment Model was developed based on Self-Efficacy theory that contributes to the fundamental motivation factor which influences students' motivation during the learning process. Furthermore, to assess the motivation level, fuzzy logic technique was applied. A tutoring system was then developed based on the proposed model using ITS architecture and ADDIE instructional design model. In order to determine students' knowledge level after using the tutoring system, pre- and post-tests were conducted on the controlled group and experimental group (30 and 31 students). The learning achievements between experimental group (mean = 3.00) and control group (mean = 2.00) indicated that the tutoring system is significantly more effective in improving students' knowledge level compared to the traditional approach. A usability evaluation was also conducted whereby the effectiveness was evaluated at the number of errors (7.5%) and completion rate (86.5%); efficiency (mean = 4.85); satisfaction evaluated at task level (mean = 6.77) and test level (mean = 83.55). As a conclusion, the overall tutoring system usability results are accepted by students in the experimental group. The research contribution to knowledge is the development of the proposed Motivation Assessment Model for ITS.

ABSTRAK

Pembelajaran pengaturcaraan bukan suatu tugas yang mudah dan pelajar sering mendapati subjek ini sukar untuk difahami dan lulus. Salah satu cara untuk meningkatkan pengetahuan pelajar dalam pengaturcaraan adalah dengan menggunakan Sistem Tunjuk Ajar Pintar (STAP) berasaskan sistem pendidikan sesawang secara penyesuaian (AWBESs). Tujuan utama STAP adalah untuk menyediakan tunjuk ajar peribadi yang disesuaikan dengan keperluan pelajar. Pemodelan pengguna merupakan salah satu faktor utama yang boleh memenuhi matlamat yang dimaksudkan oleh STAP. Dari kajian terdahulu, didapati motivasi menonjol sebagai salah satu ciri pelajar yang perlu dipertimbangkan untuk mereka bentuk model pengguna. Walau bagaimanapun, kajian ini didapati bahawa hampir semua penyelidik dan pendidik membina model pengguna berdasarkan pengetahuan dan kemahiran sebagai ciri pelajar. Oleh itu, matlamat kajian ini adalah untuk membangunkan model pengguna berasaskan motivasi pelajar yang dikenali sebagai model penilaian motivasi. Model ini dapat menilai tahap motivasi pelajar dan menyampaikan bahan pembelajaran dengan sewajarnya. Model ini dibangunkan berdasarkan teori keberkesanan diri dimana teori ini dapat mempengaruhi motivasi pelajar semasa proses pembelajaran. Tambahan pula, untuk menilai tahap motivasi, teknik logik kabur digunakan. Manakala senibina STAP dan model rekabentuk ADDIE digunakan untuk pembinaanya. Bagi menentukan tahap pengetahuan pelajar selepas menggunakan aplikasi yang dibina, ujian pra dan pasca dijalankan dalam kumpulan kawalan dan kumpulan ujikaji (30 dan 31 orang pelajar). Pencapaian pembelajaran antara kumpulan ujikaji dan kawalan (min 3.00 dan 2.00) menunjukkan bahawa STAP adalah jauh lebih berkesan dalam meningkatkan tahap pengetahuan pelajar berbanding pendekatan tradisional. Penilaian kebolehgunaan telah dijalankan di mana keberkesanannya dinilai dengan jumlah kesilapan (7.5%) dan kadar penyiapan (86.5%); kecekapan (min 4.85); dan kepuasan dinilai dengan tahap tugas (min 6.77) dan tahap ujian (min 83.55). Sebagai kesimpulan, hasil kebolehgunaan aplikasi secara keseluruhannya diterima oleh pelajar dalam kumpulan ujikaji. Sumbangan kajian kepada pengetahuan adalah pembangunan model penilaian motivasi dalam pembelajaran yang dicadangkan untuk STAP.

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LIST OF ABBREVIATIONS

ADDIE	-	Analysis, Design, Development, Implementation and Evaluation
AI	-	Artificial Intelligence
ARCS	-	Attention, Relevance, Confidence, and Satisfaction
ARCS+G	-	Attention, Relevance, Confidence, Satisfaction + Gamification
CS	-	Computer Science
CAI	-	Computer-Aided Instructions
CAL	-	Computer-Assisted Learning
CBI	-	Computer-Based Instruction
CBT	-	Computer-Based Training
COL	-	Critical Occupations List
CVI	-	Content Validity Index
CVR	-	Content Validity Ratio
eLearning	-	Electronic Learning
FIS	-	Fuzzy Inference System
FL	-	Fuzzy Logic
Gen Y	-	Younger Generations
IT	-	Information Technology
ICT	-	Information and Communication Technologies
ILMIA	-	Institute of Labour Market Information and Analysis
IPT	-	Intelligent Programming Tutor
ISO	-	International Organization for Standardization
ITS	-	Intelligent Tutoring System
JITS	-	Java Intelligent Tutoring System
LMS	-	Learning Management System
mLearning	-	Mobile Learning
OOP	-	Object Oriented Programming
PBL	-	Problem Base Learning
PICOC	-	Population, Intervention, Comparison, Outcomes and Context
PIKOM	-	Persatuan Industri Komputer dan Multimedia Malaysia

SEQ	-	Single Ease Question
STAP	-	Sistem Tunjuk Ajar Pintar
SLR	-	Systematic Literature Review
SUS	-	System Usability Scale
WWW	-	World Wide Web

LIST OF SYMBOLS

CA	-	Choice of Activities
EF	-	Effort
ML	-	Motivation Level
PF	-	Performance
PS	-	Persistence
wa	-	weightage average
cvr	-	Content Validity Ratio
cvi	-	Content Validity Index
cAns	-	total number of correct answers
kPF	-	Knowledge Performance
numOfQuest	-	total number of generated questions
oKaML	-	overall Knowledge and Motivation level
perCans	-	percentage of correct answers
perSquest	-	percentage of skipped questions
sQuest	-	total number of skipped questions

LIST OF APPENDICES

CHAPTER 1

1.1 Overview

The aim of this research was to develop a motivation assessment model in the Intelligent Tutoring System (ITS) mainly in Adaptive Web-Base Education Systems (AWBES) to improve students' knowledge in programming subject. This motivation assessment model can potentially be used to evaluate students' motivation level and provide learning module accordingly similar to a human tutor.

This chapter provides an outline of the research. It first examines the research background of the problem in Section 1.2, followed by the statement of problem in Section 1.3. Sections 1.4 and 1.5 present the research objectives and research questions that guided the research. In addition, the significance of the research is also highlighted in Section 1.6 followed by details of the scope of the research described in Section 1.7. In Section 1.8, thorough explanation on the conceptual framework of this study are explained while Section 1.9 provides details on the operational definitions of key terminologies used in this research. Finally, Section 1.10 highlight the overall organization of the thesis.

1.2 Background of the Problem

Information technology and communication development in this globalization era have impacted humans in various areas. Rapid developments in these areas have created a high demand for knowledgeable and skilful programming specialists in the market both at national and international levels as numerous organizations are depending on computerized system for their daily operational processes.

A report published by EduAdvisor, an educational course comparison website in Malaysia reveals that the most in-demand employment for the year 2017 was in the field of Information and Communication Technologies (ICT) (Ain, 2017) while in

2018, the most demanding employment opportunities are in the fields of software developing and applications programming (Natasha, 2018). Another Critical Occupations List (COL) report published by TalentCorp Malaysia and the Institute of Labour Market Information and Analysis (ILMIA) also identified employments that are high in demand within various industries in Malaysia. The reports were published by the Critical Skills Monitoring Committee, which was established under the 11th Malaysia Plan. From the reports issued for the year 2017/2018, ICT has been identified as one of the sectors that provide the greatest number of sought-after jobs compared to other sectors. One of the ICT jobs in demand is Applications Programmers whereby the requirement includes possessing knowledge and skills in programming languages such as Java, .Net, C and C++ and PHP.

A survey conducted by The World Economic Forum website is lead by a non-profit international organization for public-private cooperation (Cadie, 2016) involving more than 350 employers across nine industries in 15 of the world's largest economies came up with its predictions about how the labour markets will grow. The survey reported that the computer and mathematical jobs as shown in Figure 1.1 is one of the eight most demanding jobs among which every company will be hiring by 2020. These jobs include computer programmers, software developers and information security analysts.

It was reported in The Star online dated 30 August 2015 that by 2018, the total demand for ICT professionals is projected to be 134,438 vacancies. However, to date, there was a shortage of 5,800 Computer Science (CS) and Information Technology (IT) talent workforce against the demand of 13,300. The shortage is mainly in programming, big data, web development, database administration, mobile applications, network and information systems security, project management, and multimedia authoring. Malaysia is complementing its requirements by hiring foreign talents from India, Thailand, UK, Japan, China and the Middle East. However, looking beyond the alternative of hiring foreign talents, there is a crucial need to address the shortage of local talents and to bridge the supply-demand gap from the domestic workforce.

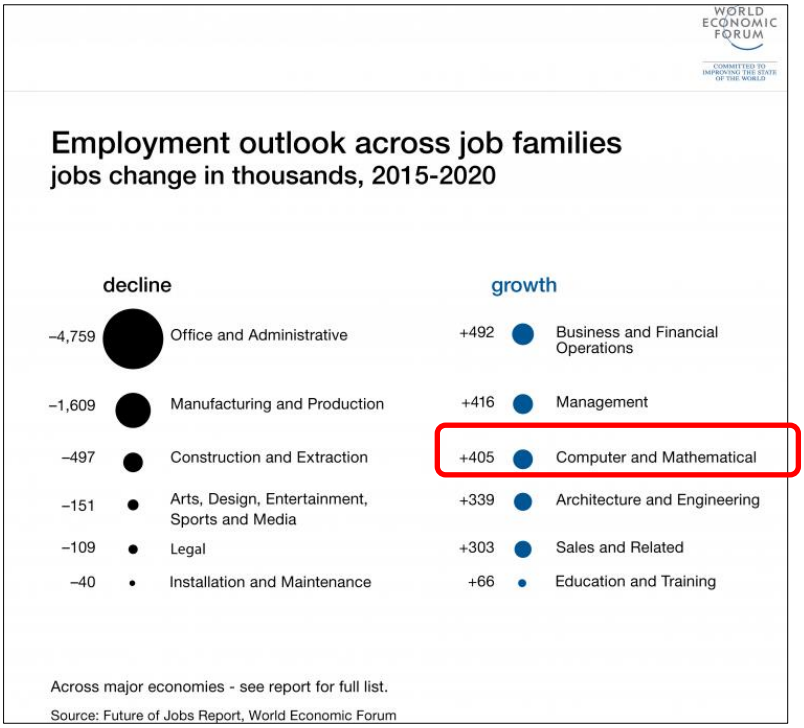

Figure 1.1 The World Economic Forum Jobs Report

PIKOM (Persatuan Industri Komputer dan Multimedia Malaysia) or known as the National ICT Association of Malaysia is the association representing the ICT industry in Malaysia. In PIKOM annual report "ICT Job Market Outlook in Malaysia 2015", one of the issues that was highlighted is ICT jobs that will likely be in demand for the next five years. Of the total jobs listed and presented in Table 1.1, 45% are concentrated on computer programmer. Based on the report, there is a shortage in the supply of qualified and experienced candidates across many areas of the industry including software engineering with candidates possessing skills and qualifications in C#, C++, Java are highly sought after as shown in Figure 1.2.

Table 1.1 ICT Job Functions Demand Distribution Source: US Bureau of Labour Statistics and PIKOM Estimates

Job Functions	Score on Job in Demand	Projected Growth Rate in Next 5 Years	New Jobs in Demand Next 5 Years
Software Developer	4.0	22.8	14
Computer Systems Analyst	3.8	24.5	13
Information Security Analyst	3.8	36.5	3
Web Developer	3.8	20.0	15
IT Manager	3.6	15.3	5
Computer Systems Administrator	3.4	11.7	4
Database Administrator	3.4	15.1	2
Computer Programmer	3.1	8.3	31
Computer Support Specialist	3.0	17.0	13
			100

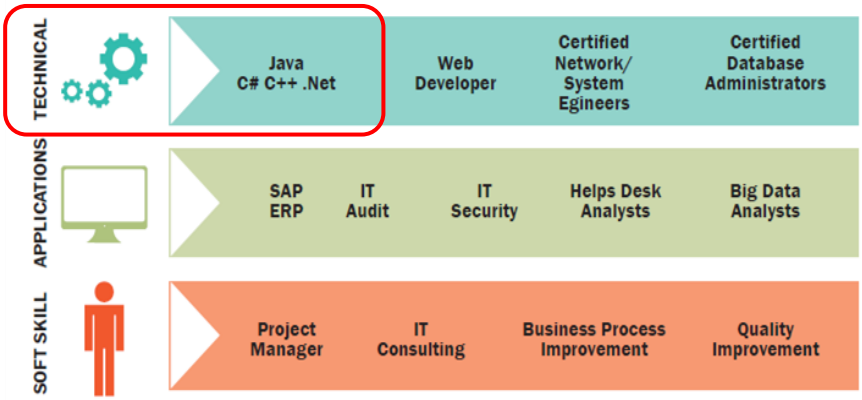

Figure 1.2 Software Engineering Skill Demands

Meanwhile, a report published by The Manpower Group's entitled "Talent Shortage Survey 2015" found that IT staff are one of most difficult-to-fill jobs (Figure 1.3) in the Asia-Pacific region and also globally. Some of the IT staff employment that are on demand include developers and programmers. The survey has been carried out involving more than 41,700 human resource managers in 42 countries. From the findings, it was found that 35% of the candidates lacked technical competencies which lead to the shortage of workforce filling in these jobs.

Figure 1.3 Hardest Jobs to Fill from Manpower Group's Talent Shortage Survey 2015

Based on JobStreet.com and MSC Malaysia Talent Supply-Demand studies, although the demands in ICT have grown rapidly in Malaysia, there are short in supplying the talents in the workforces. From the June 2014 report on "ICT Job Market Outlook in Malaysia", the following are the percentage of key technical skills of the existing workforce in 2014 and 2017 as presented in Table 1.2.

Table 1.2 MSC Malaysia Talent Supply-Demand Study 2013 – 2017

Technical Skills	**2014**	**2017**
Java	11%	14%
C, C++, C#	9%	12%
.NET	8%	11%
JavaScript	8%	10%

As shown in Table 1.2, there is a high demand for ICT graduates based on stated statistics in technical skills particularly in the programming area. In ICT programmes, especially in Computer Science, all the core courses are related to

programming. Changing programming paradigms and technologies in the job market have forced the higher institutions to switch their first programming subject from procedural language to the object-oriented language. The common object-oriented language such as C++ and Java not only requires learning of imperative language concepts but also programming concepts.

The students' ability to get a job depends on their knowledge and skills in programming (Gunbatar, 2018; Ibrahim et al., 2010; Papadakis et al., 2016; Rahmat et al., 2012). A failure in grasping programming concepts such as logical reasoning and problem-solving skills will have a negative impact on students' academic performance (Abdul, Othman and Warris, 2016). This problem has lead to a high failing and dropout rate that was recorded at the national level (Gilal et al., 2017; Hooshyar et al., 2016; Osman and Elmusharaf, 2016) and international level (Dolgopolovas, Jevsikova and Dagiene, 2018; Feijóo-García and De la Rosa, 2018; Kori et al., 2016; Nolan and Bergin, 2016; Papadakis et al., 2016; Qian and Lehman, 2017; Tuparov et al., 2014). These claims are further supported by a study conducted investigating students enrolled in the programming subject at Universiti Teknologi Mara which found that more than 35% students failed in their programming subject (Jono et al., 2016). Another study conducted by Ramle et al. (2017) reported that although programming subject offered at Universiti Tun Hussein Onn Malaysia (UTHM) utilized interactive visualization to engage and motivate the students, they still find it difficult to understand the subject. Findings of the study reveled that only three percent of the students received grade 'A' in their data structure subject.

There are some assumptions made on the difficulty experienced by students in programming contributed to the low number of students enrolling in Computer Science (CS) or Information Technology (IT) (Maddrey, 2011). There are various reasons that may lead to students failing in their programming subjects. Some of the reasons include students' perception on programming concepts as being very hard to understand, their relative lack of logical thinking as well as problem solving skills (Gilal et al., 2017; Gunbatar, 2018;) failing to finish course tutorial, copying from friends and their inability to answer questions from the main text books (Ibrahim et al., 2010). Based on reasons stated, it can be said that the students affected by these

problems may feel more demotivated to study programming (Supli and Shiratuddin, 2017).

To support Supli and Shiratuddin's (2017) statement, a preliminary study has been conducted by the researcher to identify students' motivation level in learning programming. Using an adapted questionnaire attached in Appendix D on 110 undergraduate students from 8 higher learning institutions. The results obtained from the preliminary study indicated that 55% or 58 students have low motivation level; 31% or 33 students have average motivation level; and 14% or 15 students have high motivation level. From the findings it can be said that students' motivation level is low when studying in their programming subjects.

To mitigate students' motivation problem, educators use a variety of teaching strategies in their classes to improve and motivate students in their learning process. Among the areas of research conducted investigating students' motivation level and the teaching of programming include aspects on ways to improve in teaching programming (Othman and Wahab, 2016); programming concepts (Torres and Sentí, 2017); students' memory and understanding (Azliza et al., 2014); application on Problem-Based Learning (Chiang, 2017); application on Pair Programming (Jackson et al., 2016); Flipped Classroom (Çakıroğlu and Öztürk, 2017), Blended Learning (Priyalushinee, 2017), Project Based Learning (Doddamani, 2018) and the use of eLearning (Tambunan, Rusdi and Miarsyah, 2018).

In recent years, with the rapid growth in ICT, educators have used the eLearning environment to motivate and improve students' knowledge (Hanafi et al., 2017; Majid, 2014; Manaf et al., 2015; Tambunan, Rusdi and Miarsyah, 2018). In achieving this goal, our Malaysian government through the Ministry of Education (MoE)'s Malaysia Education Development Plan 2015-2025 has also emphasized and encouraged higher learning institutions to fully utilize the use of technology (Hanafi et al., 2017).

To motivate students in learning programming using eLearning, various methods such as games (Dolgopolovas, Jevsikova and Dagiene 2018), visualization

(Mao et al., 2017), animation (Osman and Elmusharaf, 2014), simulation (Tuparov, Tuparova and Jordanov, 2014), online video tutorials (Hegarty-Kelly et al., 2015), program visualization kit (Derus and Ali, 2016), system clicker (Hauswirth and Adamoli, 2013) and robots such as Lego Mindstorms (Kunduracioğlu, 2018). In recent years, mobile augmented reality (Hanafi et al., 2017) has also been used in the teaching and learning of programming. In general, all the methods are used with the hope of motivating students through the use of interactive user interface, devices or game playing.

Since the 1960s, eLearning are actively researched to support students in learning programming (Douce, Livingstone and Orwell, 2005). VanLehn (2011) identified two types of eLearning which are Computer Based Instruction (CBI) and Intelligent Tutoring System (ITS). CBIs have several limitations. For instance, students must solve the problem manually using their head or solving problems on paper and then enters the answer. Therefore, to overcome the limitations of CBI, ITS has been introduced. In current years, ITSs were in cooperated with web-based system to provide learning materials which known as Adaptive Web-Based Education System (AWBES) (Ghazal, Zin and Muda, 2016).

The main aim of ITS is to improve students' problem-solving process (Vesin et al., 2015) and provide a personalized tutoring that is tailored to the student's needs (Price, Dong and Lipovac, 2017). Therefore, in order to meet these requirements, a Student Model or known as User Model, as a critical part in ITS architecture, has to be considered. According to Chrysafiadi and Virvou (2013) in order to use a User Model, students' characteristics are also needed to be considered. The students' characteristics comprise student knowledge and skills; their common errors and misconceptions; their learning styles and learning preferences; their affective and cognitive features; their motivations and their meta-cognitive features (Chrysafiadi and Virvou, 2013).

Among the student characteristics stated in their study (Chrysafiadi and Virvou, 2013), motivation stands out as one of the critical factors that need to be considered when designing User Model in ITS (Cocea and Weibelzahl, 2011; De

Vicente and Pain, 2002; Derbali and Frasson, 2012; Duffy and Azevedo, 2015; Hanafi et al., 2017; Hurley, 2006; Korkmaz, 2016). Even though many educators and researchers have proposed and developed ITS for teaching and learning programming, it was found that only two researchers have acknowledged motivation to be a student characteristic in their ITSs. The researchers are Hooshyar et al. (2016) where they used a game play strategy to motivate students to learn programming algorithm and Tuparov, Tuparova and Jordanov (2014) who used simulation-based tutoring system to help motivate students to understand array sorting. However, these motivations only encourage students as per view only.

Meanwhile, there are a number of educators and researchers have proposed and developed motivation assessment model in ITS for different domain. The researchers are de Vicente (2003) and Endler, Rey and Butz (2012) use questionnaire-based approach where student need to answer some questions regarding their motivation level while using the tutoring system; Derbali and Frasson (2012) use sentic modulation approach where Galvanic Skin Resistance (GSR) electrodes and the blood volume pulse (BVP) sensor were attached to the fingers of participants' to evaluate their motivation level during their learning process; while Rebolledo-Mendez, Du Boulay and Luckin (2006) and Hurley and Weibelzahl (2007) use interaction-based approach where the approach apply on-screen character during student interact with the ITS.

Even though the approaches bring new dimensions in students' motivation assessment in ITS but in the real world, it may not be applicable. Each of these approaches may cause interruptions in students' concentration during their learning process. The interruption also can make students to lose interest to continue their learning process. Thus, taking motivation as a students' characteristic to develop a user model for ITS to teach programming should be considered in which the tutoring system will deliver tutorial materials according to students' motivation level without disruptions in students' attention during their learning process.

1.3 Statement of the Problem

One way to improve students' knowledge in programming is using ITS through their use in AWBES. The objective of ITS is to improve students' problem-solving process and provide a personalized tutoring that is tailored to the student's needs. User modelling is one of the key factors that can meet the ITS intended objectives. In order to construct a user model, it has to be considered what type of students' characteristics need to be used. In face-to-face learning, motivation is considered as an important factor where it can influence student learning process, thus, the same consideration needs to be taken in ITSs. From the literature, it was discovered that, motivation stands out as one of the critical students' characteristics that need to be considered when designing user model. However, from the study, it was discovered that, almost all the researchers and educators construct the user model based on students' programming knowledge and skills as students' characteristic. Only a few researchers have considered motivation as a student characteristic. They use game play or simulation-based approach as motivation to construct the user model where these approaches encourage students as per view only.

In meanwhile, there are some researchers have proposed how to assess students' motivation level during their learning process using ITSs with different approaches such as questionnaire-based, sentic modulation and interaction-based. However, these approaches may not be applicable because these approaches may cause disruptions in students' concentration during their learning process through the tutoring system, thus, more realistic approach needs to be considered.

Therefore, in this study, motivation as students' characteristic was identified and will be embedding as a part of tutoring system user model which is known as motivation assessment model. The model able to identify students' motivation level and able to deliver the tutorial materials according to students' motivation level without distractions in students' attention during their learning process.

1.4 Research Objectives

Based on background of the research and the problem statement, the objectives of this research were:

RO1) To identify students' motivation level in programming.

RO2) To identify motivation factors and motivation attributes for motivation assessment model as user modelling for learning programming in AWBES.

RO3) To develop a motivation assessment model as user modelling using the identified motivation factors and motivation attributes for learning programming in AWBES.

RO4) To validate the developed motivation assessment model by

i) embedding in the user model of ITS known as JITS.
ii) evaluating JITS's effectiveness and usability.

1.5 Research Questions

Consistent with the research objectives outlined, four research questions were formulated based on the existing gaps identified and posed as follows:

RQ1) To what extent are students motivated in learning programming?

RQ2) What are the motivation factors and motivation attributes for motivation assessment model as user modelling for learning programming in AWBES?

RQ3) How to develop a motivation assessment model as user modelling using the identified motivation factors and motivation attributes for learning programming in AWBES?

RQ4) How to validate the developed motivation assessment model?

1.6 Research Significance

Based on the study conducted by MSC Malaysia Talent Supply-Demand (2014); The Star online report dated 30 August 2015; PIKOM 2015 annual report on "PIKOM ICT Job Market Outlook in Malaysia 2015"; COL report by TalentCorp Malaysia and ILMIA for the year 2015/2016, 2016/2017 and 2017/2018; and most in-demand ICT job by EduAdvisor and The World Economic Forum thoroughly discussed in Section 1.2, there is a high demand in software programming industries. However, due to the required programming knowledge and skills, students often find programming subject difficult to understand and to meet the subject requirement. This led to a high student dropout rate from the programme. Some educators have proposed and used AWBES to motivate students in learning programming. Since student motivation is an important factor in learning programming, the same consideration needs to be looked in ITSs.

This study has suggested a motivational assessment model in ITS mainly in AWBES to learn programming. This study will be a significant contribution to the software industries and to the growing body of academic research in this area. To gain programming knowledge, a motivational assessment model embedded in the user model will be another contribution for the ITS.

1.7 Research Scope

This study was conducted in order to obtain deeper insights on students' motivation level and to propose a motivation assessment as user modelling for learning programming using ITS in the AWBES platform. The focus of this study was mainly on the IPT derived from ITS. According to Chrysafiadi and Virvou (2013), in order for the ITS to become more adaptive and personalized, a student characteristic(s) need to be considered. Based on the review of literature, there are six different characteristics that have been proposed (Chrysafiadi and Virvou, 2013) as previously highlighted in Section 1.2. This research focused on motivation as a students' characteristic to develop an IPT system.

The IPT system is developed to teach an introduction to Object-Oriented Programming (OOP) using Java with the scope of the study being limited to undergraduate students in higher learning institutions education taking ICT as a major programme. The main reason for this research to focus on Java language is due to the findings from the report "ICT Job Market Outlook in Malaysia June 2014" by MSC Malaysia Talent Supply-Demand which found that Java language was the highest in demand programming language that is sought after by the industry. A study by Imran Kunalan (2016) highlighted that the highest demand was Java language for both MSC InfoTech (Information Technology) and MSC SSO (Shared Services and Outsourcing). According to Stephen (2018), Java has been ranked as one of the top 10 programming languages in 2018. Consequently, in this study, the introduction chapter of OOP include method, class and objects following the recommendation from 7 lecturers and 2 Java programmers who are experts in OOP subject interviewed in this study (refer Appendix E).

1.8 Conceptual Framework

The conceptual framework for this study was designed based on three fundamental elements which are *People* consisting of undergraduate students, *Technology* as ITS in AWBES and *Psychology* consisting of motivation as illustrated in Figure 1.4. The impetus of this study is to improve the undergraduate students' knowledge in introductory programming through AWBES.

Firstly, the result of the preliminary study shows that students' self-efficacy is rated low in terms of their motivation and knowledge in introductory programming. From the review of literature, it was noted that in order to improve students' knowledge in introductory programming, some researchers have proposed to use ITS in the AWBES environment. However, the aspect of motivation as a student characteristic was least considered in user model of ITP systems. Therefore, the original contribution to knowledge of this study is the inclusion of motivation assessment model in ITS.

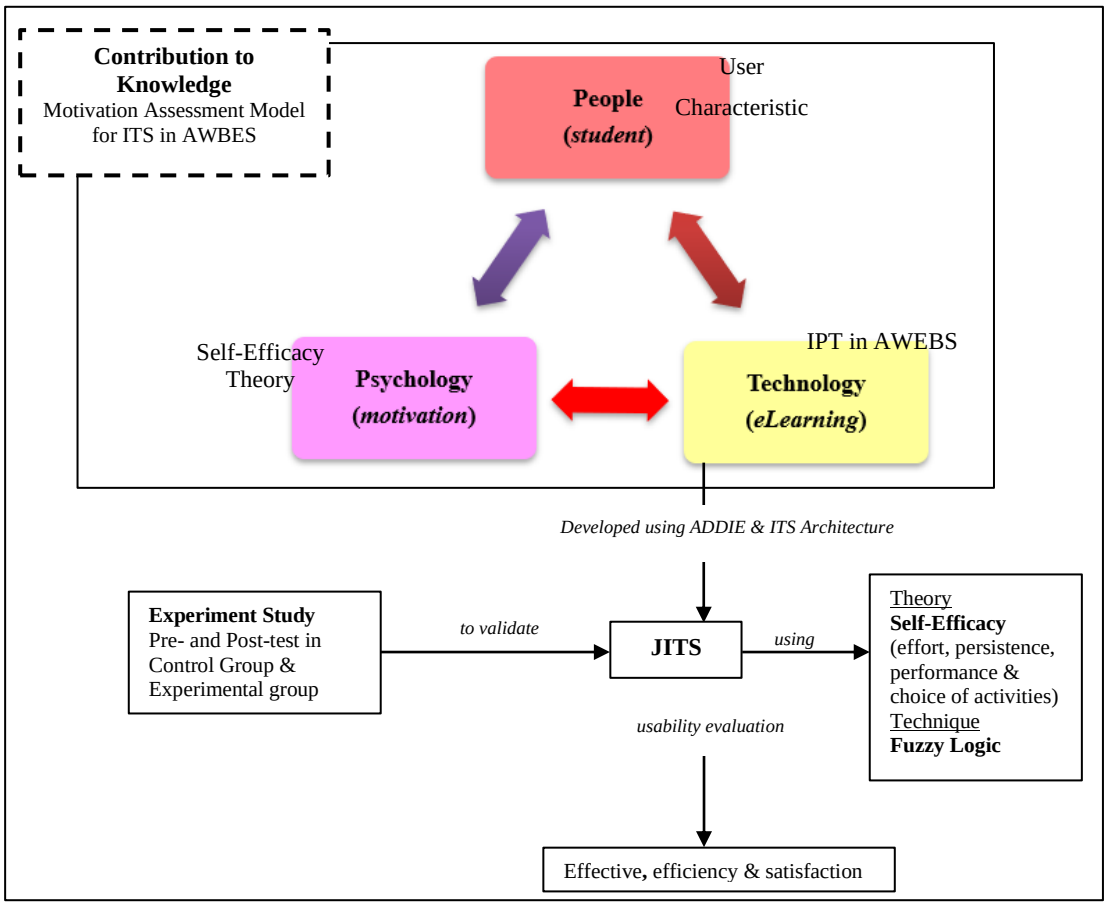

Figure 1.4 Conceptual Framework

A motivation assessment model was developed as a part of user model for ITS to teach and learn the introductory programming in the AWBES environment. The model was developed based on the self-efficacy as a motivation theory which consists of effort, persistence, performance and choice of activities. The fuzzy logic technique was employed along with the motivation assessment to predict students' motivation level and to deliver the tutorials accordingly. The tutoring system was developed using ADDIE instruction design with an ITS architecture. To evaluate the usability of the tutoring system, ISO/IEC 9241-11 Metrics was adopted consisting of effective, efficiency and satisfaction. To validate the results of the study, an experimental study was conducted in terms of pre- and post-tests conducted to control and experimental groups. Finally, IPT known as Java Intelligent Tutoring System (JITS) was proposed to assist educators and application developers in diagnosing and improving students' knowledge on programming in the AWBES environment.

1.9 Operational Definition

The operational definitions of terminologies used in this research are sequenced in alphabetical order for ease of reference and are presented below.

AWBES: Flexible one-to-one tutoring system in web environment that improves students' performance according to the specific characteristics of each student.

ITS: Intelligent Tutoring System is a computer software system that seeks to mimic the methods and dialog of natural human tutors, to generate instructional interactions in real time and on demand as required by individual students.

IPT: Is a specific implementation of an ITS for learning programming.

Knowledge level: The range of student understanding on particular subject or topic.

Motivation: A state of mental and emotional encouragements, which brings to a firm decision to act, and which gives rise to a period of sustained knowledge and/or physical effort in order to reach a set of aim or aims.

Motivation Assessment Model: Integration of self-efficacy theory and Fuzzy Logic technique in the learning process through WBES mainly in IPT to diagnose and improve student domain knowledge.

Motivation Level: Outcome of motivation assessment whether it is low, average or high.

1.10 Organization of the Thesis

This thesis comprises five chapters as detailed below:

Chapter 1 Introduction: Provides an overview of this research area. It consists of background of research problem, statement of the problem, research questions and also research objectives. The significance of this research was also explained and followed by the scope of the research. To achieve the objectives of this

study, a conceptual framework has also been discussed. Finally, operational definitions of terminologies used in this research are presented.

Chapter 2 Literature Review: This chapter reviews literature on students difficulties when learning programming and the use of eLearning to overcome these difficulties. This chapter begins by providing definitions and concepts of programming and discussions on the difficulties faced by the undergraduate students. Following this, definition of eLearning is also presented along with discussions on students' motivation level when learning programming using eLearning. In this chapter, the IPT in eLearning was identified and discussed along with its features. Additionally, a systematic literature review was conducted to identify possible gaps in IPTs. Finally, a possible approach is highlighted along with discussions on the intervention strategies and the ways to evaluate the usability of the proposed motivation assessment.

Chapter 3 Research Methodology: Explains the research methodology used in this research in achieving the research objectives. This chapter outlines the research design to show the overall process that was carried out in the research methodology. The procedures s that the researcher underwent in order to meet the intended objectives and obtain the expected deliverables are also been included in the operational framework. Then, to answer each research question, a research method also has been outlined.

Chapter 4 Results: In this chapter, detailed findings and results were presented for each research question. The findings on students' motivation level are also discussed. The motivation attributes are also identified and explained. The motivation assessment model is developed using the identified motivation attributes with the description on the Mamdani Fuzzy Inference System. The tutoring system development using ADDIE instruction model and ITSs architecture with the proposed motivation assessment model were explained. The experimental study results from control and experimental groups using pre- and post-tests of developed tutoring system are also presented. The findings on the usability evaluation of the developed tutoring system with proposed motivation assessment are also presented.

Chapter 5 Discussion and Conclusions: This chapter concludes the thesis. First, the researcher recaps and thoroughly discuss the findings obtained on each of the research objective. Next, the major contributions are stated, following with recommendations and suggestions for future work derived from limitation of the research are presented to mark the end of this thesis.

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