Domain independent strategies in an affective tutoring system

Mohd Zaliman Mohd Yusoff

Submitted for the degree of MPhil.

University of Sussex

January, 2011

Acknowledgements

I wish to thank Tenaga Nasional Berhad, in particular, to Haji Sobri for providing the financial support throughout this research project. I would also like to thank the management of the Collage of Information Technology (COIT), UNITEN, especially to the Dean (Dr. Shariffudin) for allowing me to conduct the final experiment study.

I am also indebted to my colleagues at COIT (lecturers, tutors and technicians) for supporting and helping me during the experimental study at UNITEN. I would like to also thank the students of UNITEN and Sussex university for their participation in this research.

I am deeply grateful to my supervisor, Benedict du Boulay whose valuable support, advice and comments made this work possible. His tireless effort, advice, encouragement, support and guidance helped me learn valuable lessons throughout the duration of my study. The chance to work under Ben's supervision has been the most important opportunity in my educational life. I also wish to thank the members of my thesis committee; Nicola Yuill and Rose Luckin, for their insightful recommendations and suggestions which helped me a lot in improving this thesis.

Thanks to my colleagues and members of the IDEAS lab especially to students of Room C35; Maddy, Joe, Katy and Genaro for all the fruitful discussions we had. To all my Malaysian friends in Brighton: Zeeda, Kak Finas (thanks for the food), Kak Chom and others, who have helped me to cope with the challenges of living abroad.

I owe a lot to my beloved wife Nurzeatul Hamimah and my beloved sons; Harraz and Luqman, who have been my life glory and motivation. To my mum, I will always treasure your words and prayers.

Finally, I thank Allah for given me the opportunity to do this research. I thank Him for all the sad and happy moments, the substance, and the good health, which He has bestowed upon me all these years and my He grants me the best for this quest.

Abstract

There have been various attempts to develop an affective tutoring system (ATS) framework that considers and reacts to a student's emotions while learning. However, there is a gap between current systems and the theory underlying human appraisal models. The current frameworks rely on a single appraisal and reaction phase. In contrast, the human appraisal process (Lazarus, 1991) involves two phases of appraisal and reaction (i.e. primary and secondary appraisal phases).

This thesis proposes an affective tutoring (ATS) framework that introduces two phases of appraisal and reaction (i.e. primary and secondary appraisal and reaction phases).This proposed framework has been implemented and evaluated in a system to teach Data Structures.

In addition, the system employs both domain-dependent and domain-independent strategies for coping with students' affective states. This follows the emotion regulation model (Lazarus, 1991) that underpins the ATS framework which argues that individuals use both kinds of strategies in solving daily life problems. In comparison, current affective (ITS) frameworks concentrate on the use of domain-dependent strategies to cope with students' affective states.

The evaluation of the system provides some support for the idea that the ATS framework is useful both in improving students' affective states (i.e. during and by the end of a learning session) and also their learning performance.

Table of Contents

List of Figures: Page

List of tables **Page**

Chapter 1

Introduction

There is a growing recognition that emotions play an important part in learning (Kelleher, 2003; Goetz et al., 2008; Pekrun et al., 2002, 2006). This is shown by the increase in research on the role of emotion in an educational context (e.g. Claxton, 1989; Hargreaves, 1998; McCarthy, 2000; Day & Leitch, 2001; Jones & Issroff, 2005; Efklides & Volet, 2005; Linnenbrink, 2006; Schutz & Pekrun, 2007). Emotions are believed to be one of the key factors underpinning success in learning (Pekrun et al., 2002; 2006; Goetz et al., 2008; Van der Meij, 2008). There is evidence that positive emotions (i.e. feeling secure, happy and satisfied) facilitate students to perform better in learning (e.g. Boekaerts, 1993; Oatly & Nundy, 1996; Fredrickson, 1998; Benson et al., 2000; Bandura, 1997; Lazarus, 1991; Gross, 1999; Fridja, 1986).

However, uncontrolled negative or positive emotions can distract students from learning activities. For example, negative emotions (e.g. fear and frustration) reduce a student’s problem-solving ability (Garder et al., 1990; Bandura, 1997; Scherer, 1999; Pajares, 2002; Fridja, 1986; Gross, 1999; Lazarus, 1991). Likewise, overly intense positive emotions make students more likely to work carelessly or quickly rather than working methodically and carefully (Darling-Hammond, 1997; Tiba & Szentagoi, 2005; David et al., 2002; Efklies & Petkaki, 2005; Pekrun, 1993; Ashby et al., 1999; Lazarus, 1991).

It is important to regulate and control emotions to some degree during a learning episode (Bandura, 1997; Lazarus, 1991; Gross, 1999). According to Salovey & Mayor (1990) the regulation process involves three important skills:- the recognition, the regulation and the adaptation of one’s emotional state. There is evidence that the improvement of such skills can create a better learning environment and improve students' academic achievement (e.g. Noddings, 1992; Baker et al., 1997; Charney, 2000; Bandura, 1997; Gross, 1999).

There have been attempts to develop computer frameworks that have the ability to recognise and express emotion (e.g. Fridja & Swagerman, 1987; Bates, 1994; Johnson & Rickel, 1998; Gratch & Marsella , 2001; Jiang & Vidal, 2006; Broekens et al., 2008). These frameworks are mainly derived from emotion theories (e.g. Fridja & Swagerman, 1987; Bates, 1994; Ortony et al., 1988; Ortony, 2003) and this research area is often referred to as affective computing (Picard, 1997). The aims of affective computing include giving a computer the ability to recognize, regulate and utilise emotions, and respond intelligently to human emotions (Picard, 1997, 2007; D'Mello et al, 2007; Kapoor et al., 2007; Ahn & Picard, 2006).

Moreover, within the educational context, there are also attempts to study the relationship between learners' emotions and computer tutoring systems especially within the intelligent tutoring system (ITS) and intelligent learning environment (ILE) domains (e.g. del Soldato & du Boulay, 1995; Lester et al., 1999a; Reilly et al., 2000; Conati & Zhou, 2002; Qu & Lewis, 2005). They believe that modelling learners' emotions within an intelligent learning environment would allow the ITS to be able to help students recognise and regulate their emotions using adaptive strategies.

Emotions are assumed to influence learning (Kelleher, 2003; Goetz et al., 2008; Pekrun et al., 2002, 2006), but learning achievement outcomes are also among the antecedents of students' emotions (Ortony, 2003; Bandura, 1997; Pajares, 2002), thus implying that emotion and learning performance are linked by reciprocal causation (Efklides & Volet, 2005; Linnenbrink, 2006; Schutz & Pekrun, 2007). For instance, students' enjoyment and enthusiasm can improve students' effort and degree of focus thus leading to a better performance. Likewise, failure in an exam may reduce students' self-confidence and result in lower effort in learning.

This thesis has developed an affective tutoring system (ATS) framework as well as a system that has been evaluated. This framework is based on theories of emotional intelligence (Salovey & Mayor, 1990) and emotion regulation (Lazarus 1991; Gross, 1999; Bandura, 1997).

There is a need to define the direction of this thesis with regard to the causal relationship between emotions and students performance. Whilst we acknowledge that students' emotions are likely be influenced by their performance, the primary focus of this work is on the impact on the improvement of students' emotional state (i.e. state of well-being) through the use by the system of domain-independent strategies and thus to assist students' performance and not vice-versa.

1.1 Problem Statement

Picard (1997, 2007) argues that the adaptation of the emotional intelligence concept into an affective computing framework may foster a better quality of human-computer interaction. She proposed that an affective computing framework should include the ability to recognise, regulate and utilise users' affective states. This is in line with the emotion regulation process (Lazarus, 1991). Within the ITS community, an affective ITS framework usually consists of two components: the appraisal or recognition of the user's affective state, and the reaction or response to the user's affective state (e.g. del Soldato & du Boulay, 1995; Conati & Zhou, 2002).

However, current ITS affective approaches typically do not conform to the complete emotion regulation process, which has two phases of appraisal and reaction, process (Gross, 1999; Lazarus, 1991). The first appraisal and reaction phase takes place before the potentially affective situation has fully activated while the second regulation process takes place after the potentially affective situation has been activated. In contrast, current ITS frameworks often have only one appraisal and reaction phase which is conducted during a lesson (e.g. del Soldato & du Boulay, 1995; Jaques et al., 2002; Conati, 2002).

In addition, individuals use two kinds of strategy for regulating their emotional states; namely an emotion-focused strategy and a problem-focused strategy (Folkman & Lazarus, 1985; Folkman & Lazarus; 1988; Lazarus, 1991). There is evidence from across a wide research spectrum that the use of both strategies helps to regulate individuals' affective states (e.g. Bernstein & Borkovec, 1973; Borkovec & Sides, 1979; Barber, 1982; Matthews, 1983; Clum et al., 1993; Rasid & Parish, 1998; Benson et al., 2000; Deckro et al., 2002). Moreover, there is evidence that incorporating both kinds of strategy improves students' academic achievement. (e.g. Johnson, 1982; Barber 1982; Matthews 1983; Benson et al.,1994; Britton & Virean, 1999; Benson et al., 2000; Deckro et al., 2002; Efklides & Volet, 2005; Linnenbrink , 2006; Schutz & Pekrun, 2007).

By contrast, current affective tutoring frameworks largely depend on the use of problem-focused strategies such as providing examples and hints, for regulating students' affective states. This thesis argues that the integration of an emotion-focused strategy makes an affective tutoring system (ATS) framework more effective.

1.2 Research Objectives

The objectives of this thesis are three fold:

a) To explore and identify the components of an emotion-focused, i.e. domain-independent, strategy and incorporate it into a two stage system of appraisal and reaction phases of an affective tutoring system framework.

b) To build a system for teaching an area of computing science (data structures subject) based on the framework.

c) To evaluate the outcome for students using the system and, in particular, any benefit of including the domain-independent strategy in the framework.

1.3 The development of the affective tutoring system (ATS) framework

1.3.1 Synthesizing an affective tutoring system (ATS) framework

The starting point (October 2003) for synthesising the affective tutoring (ATS) framework was to analyse the architecture of current affective tutoring frameworks and compare these frameworks with individual emotion regulation models. Based on the comparison, the gap between the current affective tutoring frameworks and their underlying theories (i.e. emotional intelligence and emotion regulation models) was identified. To bridge the gap, two adaptive modifications of the current affective ITS frameworks were proposed: 1) the introduction of a primary appraisal and reaction phase at the beginning of a lesson and 2) the integration of domain-independent strategies into the reaction phases of the framework.

1.3.2 Conducting exploratory studies

To check the viability of the approach, two exploratory studies were conducted in the context of both UK and Malaysian undergraduate students learning computer science. The first study explored UK students' affective states at the beginning of a lesson (February 2004) and the second study was conducted to explore Malaysian students' coping strategies for dealing with problems (November, 2004). Results from these studies provided positive support for the adaptive modifications proposed.

1.3.3 Formulation of the appraisal phases of an affective tutoring system (ATS) framework

Based the results from the experimental studies, an appraisal mechanism was developed. In the primary appraisal phase (i.e. before the start of a lesson), the PANAS questionnaire was chosen as the instrument to appraise the student's affective state (Watson, Clark & Tellegen, 1988).

In the secondary appraisal phase, the student's interaction activities were used to infer his affective state during the lesson. Furthermore, following the OCC model (Ortony, 2003), a formula to calculate the intensity of the elicited affective state was developed based on the student's self-belief and effort.

1.3.4 Formulation of the reaction phase of the affective tutoring system (ATS) framework

Techniques for the reaction phase of the framework were also based on the studies described in section 1.3.2. Two techniques were identified for use as the domain-independent strategies (i.e. positive affirmation and relaxation exercises). Their viability was checked by incorporating them into the developing system and trying them out with Malaysian students (from October to November 2005). In addition, domain-dependent strategies were developed following common strategies currently used in current affective ITS systems.

1.3.5 Pilot study of the ATS system

To evaluate the ATS system, a pilot study was conducted with students from the Department Computer Science, University of Tenaga Nasional, Malaysia in Mei 2006. The pilot study was then used to formulate an improved version of the ATS framework.

1.3.6 Evaluation of the ATS system

Finally all the components were brought together in a working system. This was then tested and evaluated in an experimental study conducted with students from the Department Computer Science, University of Tenaga Nasional, Malaysia in August 2007.

1.4 Terminology

Before proceeding, it is necessary to clarify the terminology used. Throughout this thesis, terms such as affect, emotion, appraisal, reaction, domain-dependent and domain-independent are used frequently. In this thesis, the term ‘affect’ is defined as a generic or an ‘umbrella’ term used to describe the phenomena such as emotion, mood and well-being.

Following the cognitive perspective (Ortony et al., 1988; Ortony, 2003; Lazarus, 1991) the term ‘emotion’ refers to an elicited affective state (e.g. frustration or joy) as a result of a cognitive appraisal of the desirable or undesirable outcomes of learning activities. A desirable learning outcome (e.g. completing a lesson successfully) elicits a state of positive well-being. In contrast, an undesirable learning outcome (e.g. failing to complete a lesson successfully) elicits a state of negative well-being

The term ‘state of well-being’ refers to an overall sense of the student’s affective state (Bradburn, 1969). It is viewed as the difference between two independent affective states (i.e. positive emotions, (e.g. joy, happiness, excitement) and negative emotions (e.g. frustration, anxiety, sadness)). A student is inferred to be in a state of positive, well-being if his averaged positive emotions scale scores on the PANAS questionnaire (Watson, Clark & Tellegen, 1988) is greater than his averaged negative emotions scale scores. Likewise, a student whose averaged positive affect scale scores are less than his averaged negative emotions scale scores is considered to be in a state of negative well-being.

Using Lazarus’s (1991) definition, the term ‘appraisal’ refers to a process in which an Affective Tutoring System (ATS) framework evaluates the outcomes of the students’ learning activities (desirable or undesirable), estimates whether the situation is relevant and/or important to the system (known as primary appraisal) and if so, whether it requires the mobilisation of coping strategies, and whether the necessary strategies are available and deliverable (referred to as secondary appraisal).

The term ‘reaction’ refers to the process in which an affective ITS system responds as a result of the appraisal of learning outcomes (desirable or undesirable). It is about a judgment and a decision by the ATS system as to whether any action can be taken to improve the situation. This includes the decision about which adaptive coping should be selected from the available resources and, how they can be applied. In this thesis, these coping resources are classified into two broad categories: ‘domain-dependent’ and ‘domain-independent strategies’.

The term ‘domain-dependent strategies’ is defined as active strategies used by an affective ITS system in solving the cause of the problem. They correspond to Lazarus’s (1991) problem-focused coping strategies. Within the thesis, three domain-dependent strategies are deployed; a) the provision of feedback and analysis of the students’ answers, b) the provision of different levels of help (i.e. scaffolding) to the students and c) the organization or suggestion of the student’s next task.

Finally, ‘domain-independent strategies’ refer to adaptive strategies of the ATS system aimed at improving students’ state of well-being. These strategies do not deal with the cause of the problem, but are efforts to regulate the emotional consequences of stressful outcomes (i.e. failing to complete a learning session). They are what Lazarus (1991) defines as emotion-focused coping strategies. In this thesis, relaxation exercises and positive affirmation are examples of domain-independent strategies.

1.5 Overview of the thesis

The thesis is organised into eleven chapters. It presents a detailed analysis of the theoretical and empirical studies on which the affective tutoring (ATS) framework rests. Chapter 2 reviews the literature regarding emotions and learning, emotional intelligence, emotion regulation theories, and emotion and computation. It also presents a review of other work that has influenced this thesis, in particular work surrounding emotion and intelligent tutoring systems.

Chapter 3 discusses the development of an affective tutoring (ATS) framework which utilises emotional intelligence and emotion regulation models. It also presents an analysis of two user-centred studies which explored the emotion regulation strategies used by Malaysian students.

Chapter 4 describes the appraisal phase of the ATS framework. It includes the rationale for the appraisal strategies used at two different learning stages; at the beginning of a lesson, and by the end of a lesson.

Chapter 5 presents the literature on the domain-independent strategy and the rationale of the integration of the domain-independent strategy into the ATS framework. In addition, results of two user-centred studies, which explored the suitability of the integration of this approach are also presented.

Chapter 6 discusses the implementation of the reaction phases within the ATS framework. It includes a discussion of the approaches used for reaction at two different learning stages: the primary reaction, which is deployed at the beginning of a lesson, and the secondary reaction which is deployed at the end of each lesson.

Chapter 7 presents an overview of the ATS system.

Chapter 8 describes the pilot study used to evaluate the ATS framework.

Chapter 9 describes the empirical study used to evaluate the ATS framework, analyses the results and provides the overall conclusions of the work.

Chapter 10 discusses answers to the research questions presented at the outset of this thesis by examining the evidence collected in Chapters 8 and 9.

Chapter 11 concludes the thesis by reviewing and critiquing the work done and proposing future work.

Chapter 2

Affective States and Learning

2.1 Emotion and learning

For a long time, educational theorists largely failed to acknowledge the important role of emotion in academic achievement and learning. Until recently, our knowledge about students' emotions in educational environments remained rather limited (Pekrun, 2006; Goetz et al., 2008) even though traditional theories of achievement and motivation posited emotions such as pride and shame as central components (Pekrun, 2006). According to Pekrun et al. (2002, 2006), the relationship between emotion and learning achievement was rarely analysed empirically. One possible reason for the lack of research in learning involves ethical consideration, such as the direct assessment of students' emotions during their learning process might negatively influence their learning outcomes and interrupt their problem solving efforts (Goetz et al., 2008).

Much research in educational settings has been concerned predominantly with the rational and scientific approaches to intellectual enquiry (Boud, 1994). Hargreaves (2000) shares a similar view. For him, most efforts are geared towards understanding the cognitive dimension in the search for improvement of quality in teaching and learning. Similarly, Goetz et al. (2003) report that more focus is given to the cognitive domain in instructional and assessment strategies. However affect, particularly emotions, has been acknowledged recently as an important factor in shaping the change in cognitive functions (Mesquita et al., 1997). Jones & Issroff (2005), for instance, argue

> *"Underpinning such change is a belief that cognitive, social and emotional development cannot be viewed separately as parallel activities as each is closely linked and intertwined with the other"- (Jones & Issroff, 2005, p 396)*

Likewise, Piaget noted that:

> *".. at no level, at no state, even in adult, can we find a behaviour or a state which is purely cognitive without affect nor a purely affective without a cognition element involved" - (as cited in Clark & Fiske, 1982, p 130)*

So, if cognition is indeed intertwined with affect, then there may be some value in studying the role of emotion in educational settings. Emotions mediated by appropriate attention, self-regulation and motivation strategies can lead to a positive effect on learning and achievement (Pekrun et al., 2002). For example, positive emotion promotes a more inclusive form of thinking that permits a person to be more creative and willing to take risks that could guide him to produce better learning outcomes.

Likewise, negative emotion such as fear and anxiety can assist students in learning. These elicited emotional states may alert students to become more careful and analytic in their learning so that a better learning outcome can be produced which, in turn, improves their negative affective states. However, excessive negative emotions may reduce student's problem-solving ability in learning (Aspinwall, 1998).

A growing concern for the vital role of affect in education is evident from the work of academics over the last 10 years (e.g. Claxton, 1989; Boud & Miller, 1996; Efklides & Volet, 2005; Linnenbrink, 2006; Schutz & Pekrun, 2007; McCarthy, 2000). The growing awareness and interest in emotions and students' achievement is reflected in several special issues on emotion in learning (e.g. Efklides & Volet, 2005; Linnenbrink , 2006; Schutz & Pekrun, 2007; Van der Meij, 2008).

Boud and Miller (1996) for instance, express a strong view about the importance of emotion in learning. They argue that the affective experience is the most powerful determinant of learning outcome. They say

> *"The affective experience of learners is probably the most powerful determinant of learning of all kinds……Feelings and emotions provide the best guides we have as to where we need to devote our attention. This may be uncomfortable for animators (i.e. learner), especially if they are not reconciled with their own emotional agendas, and they may be set aside because of immediate circumstances, but we cannot learn if they are continually denied."*
> *- (Boud & Miller, 1996, p 17)*

In a similar vein, Beard (2005) expresses his view on the importance of emotion to a learning environment. He suggests that understanding emotion is one of the key factors that underpin success in learning. He argues that learning can be enhanced when people discover things for themselves through their own affective engagement. He postulates

> *"Being able to acknowledge and sense underpinning emotions, and where appropriate, steer the emotional bases of student behaviour, is a key skill requiring and an understanding of factors affecting student motivation, such as identity, sociality, meaning and orientation."- (Beard, 2005, p 12)*

O'Regan (2003) conducted phone interviews with eleven US students studying online and found that emotions were central to their online learning Coles (1998) has also studied the links between learning and emotion. He found that poor learning can produce negative emotions; negative emotions can impair learning; and positive emotions can contribute to learning achievement and vice versa. Izard's work (Izard, 1984) shows that induced negative emotions seem to damage performance on cognitive tasks, and positive emotions have the opposite effect.

In addition, negative emotions such as anxiety and frustration are commonly established to have a negative correlation with student achievements (e.g. Steven et al., 2006; Ashcraft and Kirk, 2001). Ashcraft and Kirk (2001), for example, argue that the negative relationship is likely due to the disruption of mental processing caused by the negative affective state.

In summary, it seems that emotions play an important role in learning and students achievements. Nevertheless, across the literature, students' achievement in learning is attributed to many other affective factors such as students' perceived ability, motivation and its environmental conditions, and not just emotions (e.g. Bandura, 1997; Steven et al., 2006; Jarvela et al., 2008; Pekrun, 2006). Examining the relationship of these factors can capture a more complete view of the enterprise and subsequently allows better adaptive strategies to be deployed to improve students' achievement in learning.

2.2 Student ability and learning achievement

Many researchers have documented significant and positive relationships between ability and academic performance (e.g. Stevens et al., 2006; Heng-yu & Sulivan, 2002; Bandura, 1997). Heng-yu & Sulivan (2002), for instance, report that high ability students had better attitudes and performed better in their mathematics test than low ability students. In a similar fashion, Denis et al. (2006) report that a student's ability is a significant factor that affects academic achievement in both traditional and technology-enabled environment.

In their experiment, Thompson & Zamboaga (2002) document that specific prior student's knowledge and ability can facilitate better learning in an introductory psychology class. In another study, Harackiewicz et al. (2002) examined the roles of achievement goals, ability and high school performance in predicting academic success over the students' college career. Results from the study indicate that ability and prior performance predicted academic performance.

In contrast, there have also been a substantial number of studies which have produced contrasting results (e.g. Doris, 1994; Keig & Rubba, 1993; Durr, 2006; Job & Depamo, 1991). Doris (1994), for instance, reports no significant relationship between a student's ability level and performance, though the high ability students scored higher than the low ability students. While studying the roles of ability in learning science, Keig & Rubba, (1993) document a similar result. In a more recent study, Durr (2006) provides more evidence. She reports that students who obtained high scores on a standardized entrance exam failed to establish a significant relationship with their future grades in all areas of academic study.

In view of the contradictory results, cognitive self-perception theories (Bandura, 1997; Schunk, 1991) offer some plausible explanation. Based on these theories, individual natural ability alone is not adequate to guarantee student achievement. Students' learning performance is attributed to many factors including affect, motivation and effort (Pajeras, 2002). Bandura (1997), for instance, believes that students who possess a strong sense of self-efficacy and confidence are more motivated to achieve their potential. These students are more likely to choose a task, try harder, and persist longer in the face of difficulties, and to ultimately complete their assignment successfully.

A proponent of the view, Schunk (2000), asserts that motivated students are more often willing to engage effectively with their repertoire of learning strategies and persist in the use of them. They normally put forth a high degree of effort, recover quickly after a failure, and subsequently are more likely to achieve their learning goals. In contrast, low motivated students often believe they cannot be successful. Consequently, they may have low learning aspirations and are less likely extend effort and commitment which may result in a disappointing academic performance (Margolis & McCabe, 2006).

There is growing empirical evidence to support the view that students' achievement is dependent on multiple factors (e.g. Pekrun et al., 2008; Jarvela et al., 2008). Steven et al. (2006), for example, develop a model to explain the gaps between Hispanic and White student's math performance is not only influenced by the student's ability but also by their emotional feedback and self-confidence level. Likewise, Pekrun et al. (2005) develop their control-value theory which postulates that students' academic achievement is shaped by students' emotions, perceived control and environmental setting.

In a similar vein, Green & Miller (1996) used path analysis to support a causal model in which perceived ability and learning goal influenced student cognitive engagement which in turn influenced student mid exam achievement. In fact, depending only on students' ability as the predictor of learning outcome has adverse harmful effects to students in learning. Without other important elements such as motivation and affective states, teachers may adopt incorrect or insufficient appropriate actions to remedy those struggling students' learning problems (Brunning et al., 1999).

According to cognitive self-perception theories, the enhancement of a sense of efficacy about students' cognitive (knowledge) and affective states (motivation and emotions) contributes to better performance. Van der Meij (2008) suggests that the deployment of innovative instructional design such as FEASP (Asletnier, 2000) and ECOLE (Zikuda et al., 2005) and a cognitive learning approach (e.g. a minimalism approach or cooperative or collaborative learning, (see Bandura, 1997)) improves both students' mastery (i.e. cognitive knowledge) level and learning performance.

Furthermore, such improvements (i.e. at the cognitive level) can elicit positive emotional states (Schutz & Pekrun, 2007). In turn, the elicitation of the positive emotions boosts students' belief in their self-confidence. Fredrickson & Levenson, (1998) believe that the sense of feeling good encourages students to increase their effort in learning. Likewise, Pekrun et al. (2002) highlight that positive emotions foster students' resilience in addressing challenges during their learning and effectively contribute to their self-regulation. Taken together, positive experiences play an important role in academic achievement, and have considerable impact on students' cognition, behaviour and ultimate success in the academic domain (Goetz et al., 2008).

Self-perceived theories suggest that a student's ability to appraise, regulate and utilise his cognitive and affective state within his environment is the vital factor underpinning success in learning (Pajares & Schunk, 2002; Schunk,1995 ;Bandura, 1997). Similarly, Goleman (1995) postulates that self-awareness, the ability to control how one responds to the elicited affective states, is the key to achieving success. Likewise, according to Gardner (1993), the ability to understand, to perceive correctly, to appraise and facilitate action within the environment are paramount to one's intellectual growth. Solavey & Mayer (1990) and Gardner (1993) refer to such abilities as emotional intelligence. There are several empirical studies that support the premise that emotional intelligence skills are important in improving a student's emotional behaviour and academic achievement (e.g. Goleman, 1995; Bar-On, 2001; Parker, 2002; Jordan et al., 2002). Thus, the emotional intelligence concept is reviewed next.

2.3 Emotional Intelligence

In 1990, psychologists Mayer of the University of New Hampshire and Salovey of Yale coined the term Emotional Intelligence. They define emotional intelligence as the ability to monitor one's own and others' emotions, to discriminate among these emotions and to use this information to guide one's thinking and actions (Salovey & Mayer, 1990). The development of emotional intelligence skills is expected to guide individuals to cope better with the demands of daily life, including life satisfaction, the quality of interpersonal relationships, and success in occupations (Bar-On, 2001; Goleman, 1995; Salovey & Mayer, 1990).

Salovey and Mayer (1990) propose a model which assists people in integrating emotion and thinking. In this model, they postulate three main pillars of the emotional intelligence concept as follows (Figure 2-1)

(1) The ability to appraise or identify the affective state
(2) The ability to regulate the affective state
(3) The ability to utilise the affective state.

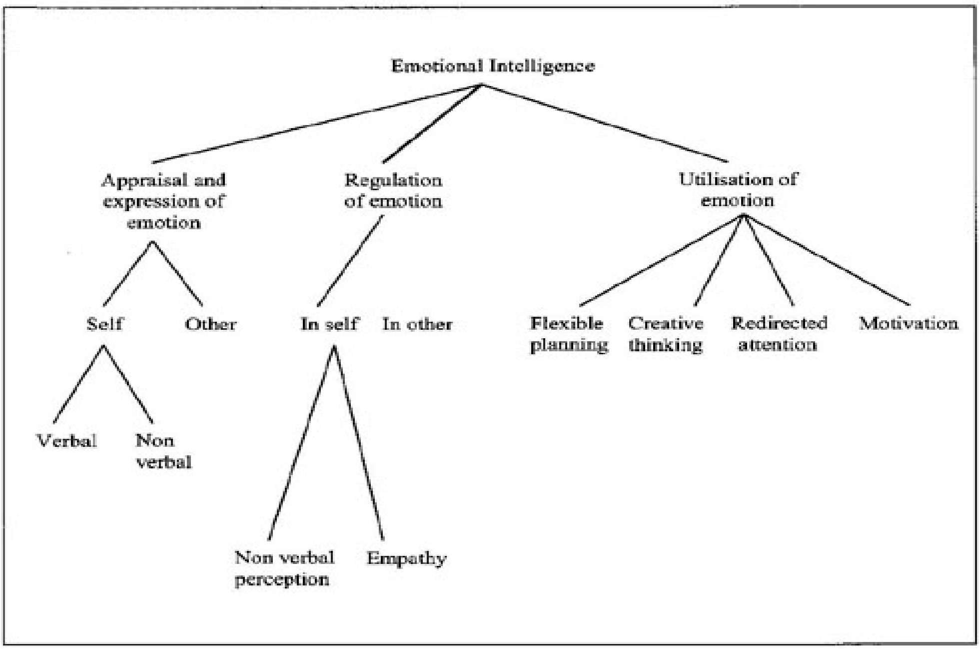


Figure 2-1: The Conceptualisation of Emotional Intelligence (adapted from Salovey & Mayer, 1990)

According this model, an emotionally intelligent individual should possess the ability to appraise or recognise his own emotional state and those of the people around him. Such ability should allow an individual to choose the more appropriate adaptive behaviour, thus improving his social relationships.

In a learning environment, enhancing the students' appraisal and recognition of emotional state skills (e.g Asletnier, 2000; Zikuda et al., 2005) within a learning context (e.g. Jarvela et al., 2008; Van der Meij, 2008; Pekrun et al., 2002) should foster better learning interactions (e.g. Parker, 2002; Jordan et al., 2002) and achievement (e.g. Pajares & Schunk, 2002; Schunk,1995; Bandura, 1997; Bar-On, 2001; Goleman, 1995).

Emotionally intelligent individuals are said to be particularly adept at regulating their emotions (Salovey & Mayer, 1990). This involves the deployment of a variety of methods including the emotion-focused (e.g. positive thinking or physical exercise) and problem-focused strategies (e.g. Seeking advice from an expert or understanding the problem in details) (Lazarus, 1991). The possession of good emotion regulation skills enables individuals to become more adaptive in achieving their goals.

Finally, Salovey and Mayer (1990) propose that an emotionally intelligent individual should be able to utilise his emotional state. The utilization of emotional state should allow the individual to be more creative (i.e. able to generate better planning strategies in the face of a challenge) and be more responsive to opportunities without being impaired by the emotions. Rather, he should be able to channel his emotions (i.e. anxiety) to improve his motivation and performance (Goleman, 1995). Within an education context, there is evidence that the utilization of students' emotional state is able to improve their learning engagement and their academic achievement (Bandura, 1997; Goleman, 1995; Efklides & Volet, 2005; Linnenbrink, 2006; Pajares & Schunk, 2002; Benson et al., 2002; Pekrun et al., 2006).

2.4 Emotion regulation process

According to Frijda (1986), people not only just "have" emotions, but they also regulate them to suit their goals. Emotion regulation, defined broadly, is the process of modulating and managing individual emotional state (Gross, 1999). According to Baumeister & Heatherton, (1996), the modulation activities are directed towards achieving individuals' conscious or unconscious goals. They are aimed to remediate or moderate any overly intense negative emotional or positive emotional state. The emotion regulation adaptation skill has also been recognised as a major component of the Emotional Intelligence concept (Salovey & Mayer, 1990; Goleman, 1995).

Lazarus (1991) postulates two stages of the individual's emotion regulation mechanism. The first stage is the primary appraisal stage, which evaluates the relevance of the potential emotion elicitor to the individual. In a similar vein, Gross (1999) proposes that the primary appraisal phase of the emotion regulation process should take place before an emotion has become fully activated. The evaluation then leads to a coordinated set of behavioural, psychological or experiential emotional responses (Gross, 1999). According to Lazarus (1991), the coordinated responses of adaptive strategies should focus on using available resources as a means to manage problematic situations and thus improve the elicited emotional state. For instance, a weak student who is unprepared for a test might decide to stay up late as a strategy to make him feel better. Similarly, doing breathing exercises before a sprint event by athletics is another example of an emotion regulation strategy.

The second emotion regulation process occurs after the emotion has been fully generated (Gross, 1999; Lazarus, 1991; Master, 1991). Lazarus (1991) refers to this regulation process as the secondary appraisal phase. The aim of the secondary regulation process is to manage the elicited emotional state. It consists of behaviour or cognitive responses or strategies that are designed to reduce, overcome, or tolerate the demands placed on the individual. People are observed using different strategies to deal with their elicited emotional states depending on their background, knowledge and culture (Lazarus, 1991; Ortony et al., 1988).

For example, Asian students are culturally reserved. To them, revealing personal problems to others can cause shame for themselves. Thus, they tend to keep to themselves and endure the problem without revealing it. Yeh (2005) found that the Asian immigrant students in the US are more likely to use religious practice as compared to their local students. In contrast, European students are more self-expressive in confronting learning problems (Lam & Zane, 2004). They are more likely to discuss their problems with classmates and teachers.

Lazarus, (1991) has classified the strategies used by individuals to deal with the different intensities of the elicited emotional state into two categories. The first category consists of emotion-focused strategies. Emotion-focused strategies refer to thoughts or actions whose goal is to relieve the emotional impact of stress. They are mainly palliative in the sense that such strategies do not actually alter the threatening domain or damaging environment but are apt to just make the person feel better (Cornelius, 1996). Avoiding thinking about trouble, denying that anything is wrong, distancing or detaching oneself by deep breathing or doing relaxation therapy are examples of emotion-focused strategies.

There is empirical evidence to suggest that the deployment of emotion-focused strategies such as relaxation therapy is effective in improving emotional state (e.g. Benson et al., 2000; Deffenbacher, 2000; Rasid & Parish, 1998; Sapp, 1996; Spalding, 2000). For example, Deffenbacher et al. (1990) attributed the ability of patients to control their hostile and aggressive behaviour to the relaxation exercise sessions that the patients undertook. There is also evidence that relaxation exercises are clinically effective in treating headaches. For instance, Blanchard et al. (1979) found that relaxation exercises helped to reduce between 40% and 80% of tension headaches that patients suffered. Similar results were found in Primavera & Kaiser's (1992) and Mehta's (1992) studies.

In another study, Toivanen et al. (1993) reported that relaxation exercises significantly reduced physiological tension and depression levels amongst a group of hospital cleaners. Likewise, Ortiz & La Grange,(2006) found that progressive relaxation exercises technique could enhance recreational golfers' performance.

Several studies suggest that there is a positive relationship between relaxation exercises and students' performance within the classroom environment. For instance, Benson et al. (2000) studied the relationship between a *relaxation response* curriculum and academic achievement amongst middle class students. The results suggest that students who had more exposure to the relaxation exercises curriculum showed an improvement in their grade point average scores, work habit scores and cooperation scores over the course of a two-year period (Benson et al., 2000). Recently, there has been an attempt to develop commercial computer-based relaxation exercise software which has produced a positive result (TestEdge, 2003). Results of the study revealed that the students who used the software were observed to record a 35% improvement in maths scores and a 14% improvement in reading scores.

Problem-focused strategies are the second category employed by people in regulating their emotional states. Lazarus (1991) refers to problem-focused strategies as active or as direct cognitive or adaptive behavioural efforts to work on the problem itself. It involves attempting to change the problem by generating and implementing options and steps to solve or make the problem less problematic (Baker & Berenbaum, 2008). Seeking information about what to do or confronting the person or persons responsible for one's difficulty are examples of such strategies.

For example, Lester et al. (1999a) report that the deployment of different problem-focused coping strategies (i.e. by scaffolding students using different levels of help) had a positive impact on their affective state and improved their performance. Likewise, Baker & Berenbaum (2008) report that the use of problem-focused strategies (different levels of help) improved students' problem-solving skills.

Within the affective tutoring system (ATS) context, three approaches to problem-focused strategies are noted:- a) to provide feedback or analysis of the students' answers, b) to provide different levels of help (i.e. scaffolding) to the students and c) to organize or suggest the student's next task. Furthermore, there is evidence of the successful use of these strategies which not only improves students' affective states, but also their academic achievement (e.g. Conati & Zhou, 2002; Reilly et al., 2001; Lester et al., 1999a) In addition, Lazarus and his colleagues' longitudinal studies (e.g. Folkman & Lazarus; 1986; Folkman et al., 1986; Folkman & Lazarus; 1988) provide empirical support for the premise that people use both emotion-focused strategies and problem-focused strategies when coping with a problematic environment.

2.5 The effect of positive emotions on learning

The ability to momentarily broaden the scope of cognition is the first advantage of a positive emotional state. It allows an individual to become more creative, flexible, and efficient (see Fredrickson, 1998 for a review). Fredrickson (2003) argues that these characteristics allow an individual to build an array of enduring personal resources and, in consequence, initiate an upward spiral towards an increase in the state of well-being (Fredrickson & Joiner, 2002; Wauch & Fredrickson, 2006). Evidence from the study conducted by Isen and colleagues shows that people experiencing positive emotions display patterns of thought that are notably unusual, flexible and efficient (Isen, 1990; Moore & Isen, 1990; Isen, Daubman & Nowicki, 1987; Isen, 2000 as cited in Tugade & Fredrickson, 2004).

In another experiment, Fredrickson & Branigan (2005) conducted a study to examine the relationship between positive emotions and thought-action repertoire. In their study, participants were experimentally induced to either positive (i.e. joy and contentment), negative (fear and anger) or neutral emotions after which they listed all thoughts about what they would like to do right then (a measure of breadth in participants' thought-action repertoire). They found that individuals in a positive emotional state listed significantly more things than those in the negative or neutral emotional state.

Broadening students' scope for action is the second advantage of students being in a positive emotional state. Renninger (1992) studied children's reactions when playing with objects that elicited interest. He found that children in a positive emotional state showed a wider range of types of play, more variations of action within play types and longer play episodes when dealing with elicited interest objects. In other experimental studies, Master, Barden & Ford (1979) and Yasutake & Byran (1995) report that students in a positive emotional state tended to show significantly faster mastery of a learning task.

Finally, positive emotions have the ability to correct, restore, and undo the after-effects of negative emotions (Cabanac, 1971; Fredrickson & Levenson, 1998; Lazarus, 1991). It is hypothesised that positive emotions restore autonomic quiescence following a negative emotional arousal (Fredrickson & Levenson, 1998). In one experiment, Fredrickson & Levenson (1998) measured the time elapsed from the start of a randomly assigned film until the cardiovascular reactions induced by the negative emotion returned to baseline levels. They used four cardiovascular reaction measurements; 1) the interval of heart beat period, 2) the pulse transmission time to the ears, 3) the pulse transmission time to the finger and 4) the amount of blood in the tip of the finger (see Fredrickson & Levenson, (1998) for details of the study). They reported that participants in a positive emotional state exhibited faster recovery. This finding indicates that positive emotions have the ability to reduce a negative emotional arousal.

In another experiment, Fredrickson et al. (2003) conducted a survey to examine the relationship between positive emotion and people's resilience. In this study, participants' resilience, affectivity traits and life satisfaction were measured in early 2001 and again in the weeks following the September 11 attack. The result indicated that positive emotions buffered the resilient people against depression.

Pekrun et al. (2002) suggest that positive emotions are worthy of investigation. They postulate:

> *" .. emotions help to envision goals and challenges, open the mind to thoughts and problem-solving, protect health by fostering resiliency, create attachment to significant others, lay the groundwork for individual self-regulation, and guide the behaviour of groups, social system , and nations " (p 149)*

There is also evidence to show that positive emotions play a pivotal role in educational settings (e.g. Goetz et al., 2008; Pekrun et al., 2002). For example, Pekrun et al. (2002) highlighted the relevance of positive academic emotions with regard to self-regulation, strategy use, motivation and activation of cognition resources in students. Likewise, Aspinwall (1998) argues that positive emotions can effectively contribute to the self-regulatory process in students. More specifically, positive emotions have been found to positively relate to students' involvement in terms of motivation for further success (Ireson & Hallam, 2008), career aspirations, and occupational choices in specific domains (e.g. Goetz et al., 2008; Wigfield & Jacquelynne, 2002). For example, Wigfield & Jacquelynne (2002) found that students who experienced negative emotions in learning mathematics were less likely to pursue a career in this domain.

Nevertheless, there is also research on dysfunctional of positive emotions (e.g. Tiba & Szentagoi, 2005; David et al., 2004). For example, Tiba & Szentagoi (2005) argue that uncontrolled strong positive emotions such as pride, joy and contentment can influence individual behaviour to deploy unrealistic expectation (Efklides & Volet, 2005), cognitive bias leading to inappropriate action and strategies (Pekrun, 1993), reduce creativity in decision-making (Ashby et al., 1999), and appraisal components (Lazarus, 1991). In high level sport such as the Olympic Games, positive emotions are perceived as dysfunctional. Positive emotion states such as calm, relaxed, satisfied or too confident can be detrimental to the athlete's performance (Hanin, 2000).

In a learning context, positive emotions may also sometimes require regulation. For example, getting the correct answer to a difficult question could elicit positive emotions such as joy and pride, but lead to inappropriate learning activities if too much attention is given to the elicited emotions. Without regulation, excessive positive emotions can direct the student to focus on the euphoria and underestimate the effort needed to attain a good result (Efklides & Volet, 2005). Consequently, they become overconfident and less likely to increase their effort in learning.

Taken together, the findings suggest that a careful approach on positive emotion regulation should be considered in an affective tutorial system framework so that the positive emotion can be nurtured to optimise learning.

2.6 The effect of negative emotions on learning

Negative emotions have been found to be associated with several cognitive and learning deficits. The first is a perceptual deficit. Students in a negative emotional state sometimes cannot recognize the exact emotions they are experiencing (Garder et al., 1990). This may lead to a student sometimes ignoring or denying his emotional state or mislabelling it as physiological. As a result, the student may fail to engage in adaptive strategies for regulating his negative emotions, thereby prolonging his distress.

The second deficit experienced by students in a negative emotional state is that they are inclined to misinterpret the causes of problems associated with their learning or may misinterpret who is responsible for altering their affect (Brickman et al., 1982; Bandura, 1997). As a result, this deficit may lead the students to seek inappropriate solutions to their problem or not to seek any solution at all, particularly if they believe that the cause of their problem is stable and unchangeable. They are more likely to wait for others to make them feel happy, rather than to initiate behaviour that will alter their negative feeling.

Knowledge deficit is the third potential disadvantage experienced by students in a negative emotional state. A student in this emotional state may have adequate knowledge but be unable to use it while in a negative emotional state. This knowledge deficit may be a result of never having learned effective strategies for managing negative affect. It is believed that students in a negative emotional state do not engage in effective solutions because they do not expect that the strategies will help modify their negative affect; they expect that engaging in such strategies will produce additional undesirable effects (Garder et al., 1990). They also believe that while experiencing negative affect, their skills are not adequate to implement regulation efficiently.

Finally, a student in a negative emotional state may experience enactment deficit. This is about the inability of the student to execute or exercise the necessary responses of his selected solutions of a problem (Coyne, 1970; Lewinsohn et al., 1980, as cited by Garber & Dodge, 1991, Garder et al., 1990). It is possible that even if students are aware of appropriate strategies, they will be less capable of implementing them because of a general skills deficit or a temporary deficit resulting from their negative affect (Garber & Dodge, 1991). Students with negative affect have been found to generate significantly more irrelevant strategies than students with positive affect, although they did not differ with regard to the total number of alternative strategies generated (Garder et al., 1990).

In contrast, there are times when the effects of negative emotions are useful (Margolis & McCabe, 2006; Kay & Loverock, 2008). Anxiety enables one to be vigilant for threat; shame can lead one to monitor others' options and to re-establish one's reputation (Barret et al., 2002). There is evidence to show that negative emotions enhance individual performance. For instance, Hanin (2002) reports that negative emotions such as fear, anxiety and tension enhanced athletes' performance. Likewise, musicians and actors need a certain level of anxiety arousal in order to perform well (Isen, 2005; Eysenck, 1998).

In the learning context, negative emotions such as test anxiety and mild stress or fear can foster students to be more careful and analytical to avoid making unnecessary errors (Isen, 2005). Furthermore, negative emotions provide a helpful warning that alert students to potential bad consequences so that preventive measures can be invoked and coordinated. Similarly, the affective dissonance associated with short term failure can be used as a catalyst to improve students' subsequent performance (Nietfeld et al., 2005). When allowed to explore and discuss the causes of their failure, students become more alert and determined to use the learning resources efficiently and devise better strategies in their future learning (Isen, 2005).

However, an excessive level of negative emotions (i.e. anxiety and fear) can inhibit students' performance. Repeated errors will create the expectation of mistakes that leads to increased of anxiety, leading to more mistakes until the student's performance collapses. Moreover, there is evidence that extreme levels of negative emotion may also affect self-perception capabilities such as self-confidence (Bandura, 1997; Pekrun, 2006; Goetz et al., 2007) and self-esteem (Gross, 2002) which increases the level of anxiety and other negative emotions (Isen, 2005). This suggests that the regulation of the negative emotions within learning environment is an important matter to explore.

2.7 Emotion and computation

Perhaps the first attempt to promote the idea of emotions and computation was undertaken by Sloman & Croucher (1981) at the University of Sussex. They promoted a theory of emotions as a reaction to complex processing of certain kinds of goals in a certain environment. Meanwhile, mainly in the mid 1980s, efforts were made to develop a computational emotion theory from a cognitive viewpoint (Fridja, 1986; Oatley, 1992; Ortony et al., 1988). In fact, some of them were inspired by the idea of computational concepts in developing their computational emotion theory. The OCC model (Ortony et al., 1988) and the communication theory of emotions (Oatley, 1992) are good examples of this situation.

The introduction of emotion theory which is based on computational concepts has inspired the possibility of integrating emotion and computation. For instance, Swagerman (Fridja & Swagerman, 1987), who was Fridja's student, developed the ACRES program (Artificial Concern Realisation System) that integrated Fridja's model of emotion in complex and unpredictable environments. ACRES's primary tasks were the diagnosis of a situation over time, generating an emotion, and choosing a meaningful action in these circumstances. Elliot with his Affective Reasoner (Elliot, 1992), which was based on the OCC model (Ortony et al., 1988), is another example of how a program can be used to model the generation of emotions. The Affective

Reasoner demonstrates how modelling personalities of agents and their social relationships could interact with the generation of emotions.

Bates et al. (1992) at the University of Carnegie Mellon developed a different model of emotional and computational functions. They used various synthetic cartoon characters that influenced their audience powerfully as if they were real (Bates, 1994). Their proposed emotion generator architecture called ‘Em’ integrated not just emotions, but also rudimentary perception, goal directed behaviours and language. ‘Em’ was based on an adaptation of the OCC model, and hence emphasized a cognitive appraisal to generate emotions.

Inspired by Elliot’s and Reilly’s work on emotion and behaviour, Gratch (2000) extended their research by promoting the significance of emotion with regard to events and agents. His work illustrates a complementary relationship between classical planning methods and models of emotion processing. By building on classical planning methods, his model clarifies earlier accounts of emotional appraisal and extends these accounts to handle the generation and execution of complex multi-agent plans.

Following Gratch’s (2000) framework, Gratch & Marsella (2001) created a general computational model of the interplay between affect, cognition and behaviour. They explain how emotions arise from an evaluation of the relationship between environmental events and an agent’s plans, goals and the emotional impact on behaviour.

In their later experiment, Gratch & Marsella (2004) introduced a domain independent framework for modelling emotion. With appraisal theory, they include coping as one important element in the cognitive process. Consequently, the beliefs, desires, and intentions (known as the BDI architecture) of an agent have a strong relationship in the general computational model. These elements occur in the appraisal process before emotion is identified.

Extending the BDI architecture, Pereira et al. (2006) introduced the emotional-BDI architecture (EBDI), with the addition of three new components; namely, the Sensing and Perception Manager, the Effective Capabilities and Effective Resources revision function and the Emotional State Manager. The Sensing and Perception Manager extracts and provides information directly from stimuli captured by an agent's sensorial machinery. Effective Capabilities and Effective Resources revision function revises and updates the resources and capabilities that are available for an agent to use. The result is then forwarded to the Emotional State Manager for the agent to perform adaptively to its environment (see Figure 2-2).

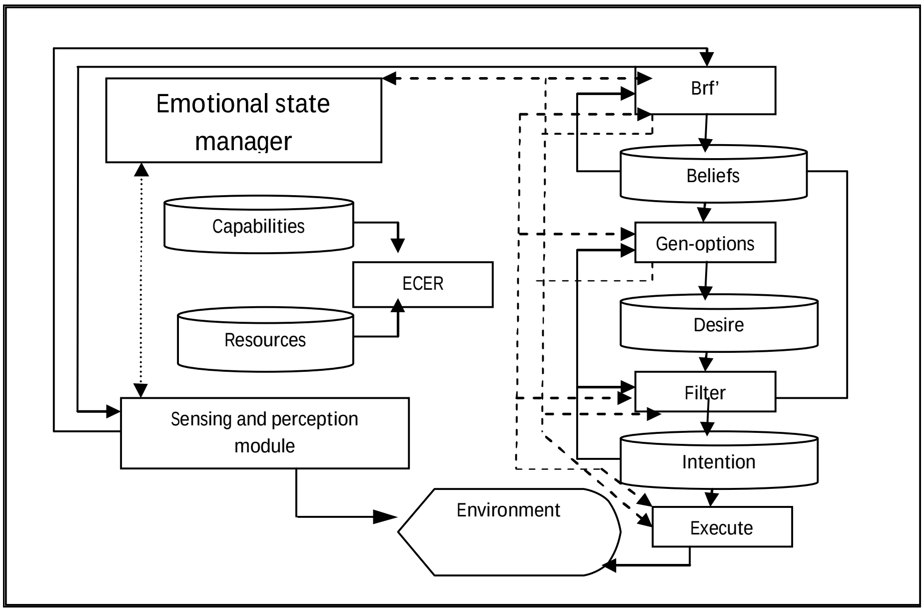


Figure 2-2: The Conceptual Emotional-BDI Architecture. Adapted from Pereira et al. (2006)

In another attempt, Jiang &Vidal (2006) extended the EBDI architecture by adding the influence of primary and secondary emotions into the decision making process of a traditional BDI architecture. They add possible belief candidates directly from communication and contemplation. To improve the balance between being committed to and over-committed to one's intentions, which is the major problem in the BDI agent, they left the control of reconsideration in the design of the plan execution function, since the solution of this depends more on the specific agent type and agent's strategy. They devised an experiment using the *Tileworld* system, as a platform to investigate the behaviour of various meta-level reasoning strategies since they can access the success of alternative agent strategies in different environments by tuning the environmental parameters.

In another experiment, Broekens et al. (2008) use cognitive appraisal theories which describe human emotions as a result of the subjective evaluation of events. They argue that if cognitive evaluation of events in relation to the agent's goals is sufficient for emotion, then the addition of such evaluation of events related to the beliefs, desires, and intentions of an artificial agent is sufficient for computing emotions.

Underpinning the development of emotion and computation are the Cognitive appraisal theories (i.e. Ortony et al., 1988; Fridja, 1986; Oatley, 1992; Lazarus, 1991). The tenet of these theories is that emotion is perceived as a result of an agent's appraisal of the environment. Consequently, individual goals, needs, beliefs, and desires influence the appraisal by virtue of the emotional factor an individual has towards the environment. To gain a better understanding of the cognitive appraisal process, we review the cognitive appraisal model most often used within the computational community, the OCC model (Ortony et al., 1988).

2.8 The cognitive appraisal model of emotions

In 1988, Ortony, Clore and Collins (OCC) published their book, entitled "The Cognitive Structure of Emotions", which set forth a model for the cognitive appraisal of emotion. This model attempts to lay the foundation for a computationally tractable model of emotion. In other words, they wanted to develop a cognitive appraisal model of emotions that could be used in an artificial intelligence system that would, for example, be able to reason about emotion (Ortony et al., 1988).

Their theory of appraisal assumes that emotions are elicited because of certain cognitions and interpretations. This model exclusively concentrates on cognitive elicitors that are either events, agents or objects. Emotions, from the OCC perspective, are the result of three types of subjective appraisal: 1) the appraisal of the pleasantness of events with respect to individual goals, 2) the appraisal of the approval of the actions of the agents or other agents with respect to a set of standards for behaviour, and 3) the appraisal of the liking of objects with respect to the attitude of the agents. They postulate,

> *"When one focuses on events one does so because one is interested in their consequences, when one focuses on agents, one does so because of their actions, and when one focuses on objects, one is interested in certain aspects or imputed properties of them qua objects.- (Ortony, Clore & Collins, 1988 , p 18)*

The distinction between reactions to events, agents, and objects gives rise to three basic classes of emotion: being pleased or displeased, approved or disapproved, and liked or disliked. These three basic emotion classes can in turn be differentiated into a number of distinct groups of emotion type. Reactions to events break into three groups: the first one, the Fortune-of-others group, focuses on the consequences for oneself of events that affect other people, whereas the other two, the Prospect-based and Well-being groups focus only on the consequences for oneself.

Reactions to agents are differentiated into four emotions of the Attribution group. Reaction to objects leads to an undifferentiated group called the Attraction group. There is also a compound group of emotions, the Well-being/Attribution compound, involving reactions to both event and agent simultaneously. The complete set of interactions are shown in Figure 2-3.

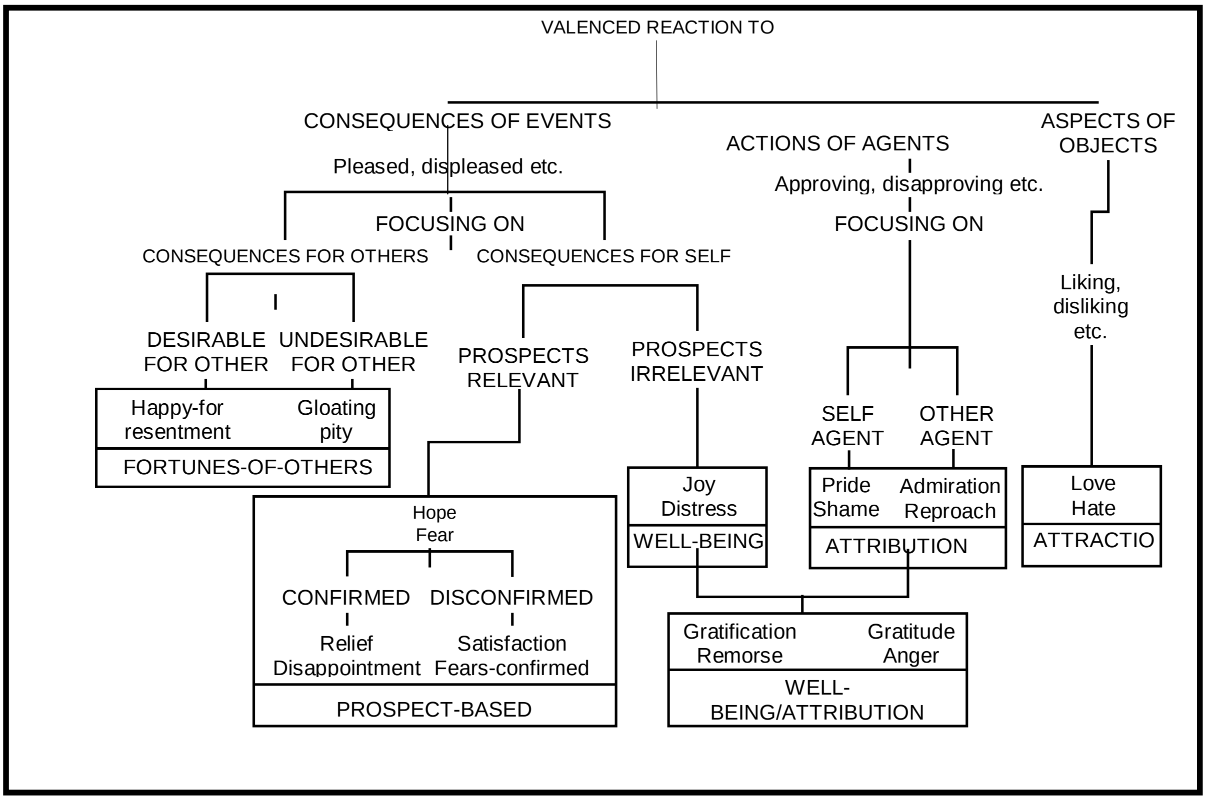


Figure 2-3: Structure of emotion types in the OCC model (adapted from Ortony et al., 1988)

The valenced reaction to the consequences of event is the most relevant reason for the elicitation of students' emotional state in a tutoring system learning environment. Depending on the students' desire, belief and goals, the appraisal of learning outcomes at the various learning stages (i.e. at the beginning, during and by the end of learning session) gives rise to a different emotional state. For example, a weak and low self-efficacious student who believes the upcoming lesson is difficult may experience a negative emotional state such as fear. In contrast, a highly self-efficacious student may experience a positive emotional state (e.g. confident, happy) if he feels that he can perform well in this next lesson.

Nevertheless, Ortony (2003), following a longitudinal study admits that the original OCC model is too complex to represent human emotional behaviour. He proposed to consolidate the classification of emotions into only two basic types of affective state: positive and negative emotion each of which consists of five specialised areas. He postulates:

" over the years Gerald Clore and I, together with some of our students, collected considerable empirical support for many basic ideas. However, for purposes of building believable artefacts, I think we might want to consolidate some of our categories of emotions. … I think it is worth considering collapsing some of the original categories down to five distinct positive and five negative specialization of two basic types of affective states – positive and negative." – (Ortony, 2003,p 193)

In line with the view, research by Pekrun et al. (2002) and Linnenbrink & Pintrich (2002) reveals that a range of emotions related to learning can be classified into two broad categories; namely positive and negative emotions. Likewise, it is still a challenge to determine specific emotions in computer based tutoring environments (e.g. Andre et.al. 1999; Lester et al. 1999c; Rickel, 2001; Conati & Maclaren, 2004). Poor results were reported in various studies; in facial expression analysis (Nkambaou, 2004), in agent behaviour (Jiang & Vidal, 2006; Gratch & Marsella , 2004; Chaffer & Frasson, 2004); and in prediction of frustration (Kapoor et al., 2007).

In fact, several developments are noted that use a positive and negative orientation in classifying students' affective or emotional states in computer based tutoring systems (del Soldato & du Boulay, 1995; Rebolledo et al., 2006; Kapoor et al., 2006; Jaques et al., 2002). For example, Kapoor et al. (2006) classify students' emotional states either as stuck (negative) or flow (positive). Likewise, Jaques et al. (2002) also use the positive and negative dichotomy in classifying students' emotional state in their research.

We therefore argue that emotions in an affective tutoring learning context can be viewed as the significant consequence of appraisal of the learning outcomes perceived by the students. This elicited emotional state is influenced by the students' beliefs and goals. Generally, in appraising a learning outcome, two possible emotions can be elicited; namely a positive or a negative emotional state.

2.9 Affective states and Intelligent Tutoring Systems (ITSs)

A growing band of researchers is concerned with embedding emotional state and motivation reasoning in Intelligent Tutoring Systems and Intelligent Learning Environments (e.g. Conati & Zhou, 2002; del Soldato & du Boulay, 1995; Reilly et al., 2001; Lester et al., 1999a). In this section, we present a review of affective ITS and ILE projects.

There are two main research groups in the area of affective tutoring system. The first group deals with motivational issues (e.g. del Soldato & du Boulay, 1995; de Vicente, 2002; Baylor et al, 2004; Qu & Lewis, 2005). The focus of this group is to enhance students' effort and persistence in learning through the adaptation of motivational techniques (e.g. Keller, 1987; Malone & Lapper, 1987; Bandura, 1997). The deployment of these techniques is not only aimed at improving students' ability to acquire and use the knowledge to achieve learning goals, but also to promote positive attitudes among students towards learning.

The second research group deals with emotional issues (e.g. Conati & Zhou, 2002; Conati & Maclaren, 2004; Reilly et al., 2001; Strauss et al., 2005; D'Mello et al., 2007). The objective of this group is to study the affect of emotions towards learning. This includes the development of suitable algorithms and tools to improve the accuracy of an ATS to detect student's emotional state while learning (e.g Conati & Maclaren, 2004; Strauss et al., 2005; D'Mello et al., 2007; Nkambou & Heritier, 2004). In addition, they are also concerned with the issue of how to regulate and use elicited emotions to enhance students' learning attitudes (including motivation) and academic achievement (e.g. Reilly et al., 2001; Lester et al., 1999a; Andre et al., 1999; Jaques et al., 2002).

2.9.1 The Learning Companion Project

We first review the Learning Companion by the Picard Group at the Massachusetts Institute of Technology. The aim of this project is to explore the relationship between emotions and learning, particularly observing, attending, adjusting and understanding the user's need within an educational context (Reilly et al., 2001).

In order to achieve their aim, they developed a four quadrant model which relates emotions and learning. In this model, they developed a space of possible emotions relevant to learning. Their learning theory proposes a circular and helical flow of emotions as shown in Figure 2-4.

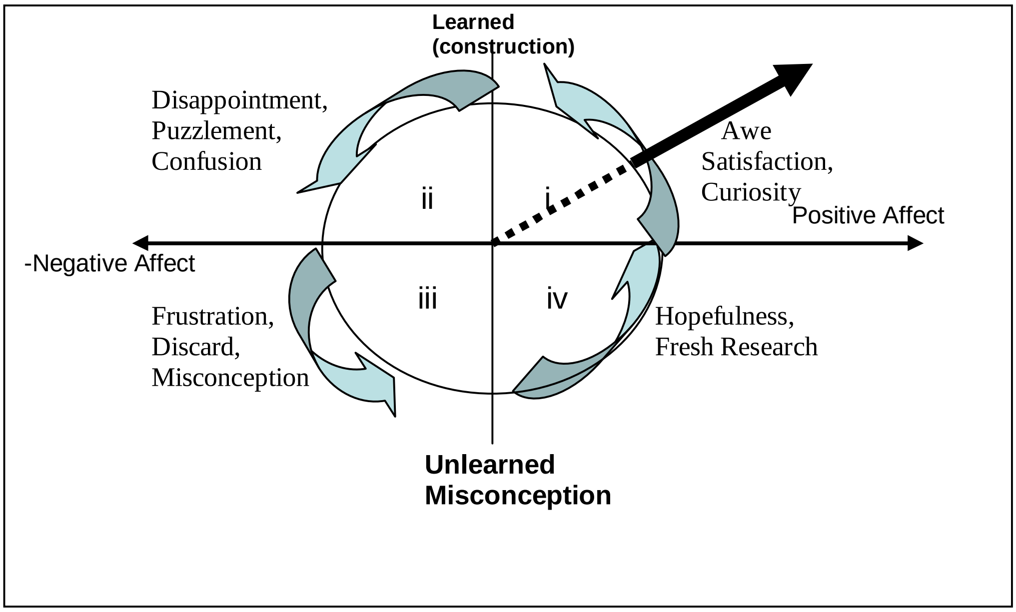


Figure 2-4: The four quadrant-learning model adapted from Reilly et al., (2001)

In this theory, students ideally begin in quadrant i or ii: they might be curious and fascinated about a new topic of interest (quadrant i) or they might be puzzled and motivated to reduce confusion (quadrant ii). The main educational aim according to this theory is to help them to keep orbiting the loop, teaching them how to propel themselves forward especially after a setback. They suggest that the model might be a useful to aid students learning about their meta-cognitive state, especially helping them to identify better ways to solve their learning problems (Reilly et al., 2001).

However, there is as yet little empirical evidence produced by this group to establish the four-quadrant model of learning. Rather, they have channelled their energy into developing a series of affective sensors and the consequent complex multimodal analysis that are able to detect a user's affective state and to react appropriately, such as the blue eyes camera (Kapoor et al., 2003, 2007), head tracking system (Mota & Picard, 2003), wireless Bluetooth skin conductance (Strauss et al., 2005; D'Mello et al., 2007) and video capture (Kapoor et al., 2004).

2.9.2 The MACES Project

The aim of the MACES (Multi Agent Architecture for a Collaborative Educational System) system is to develop a Collaborative Educational System (Andrade et al., 2001). One of the components of the MACES system is the Mediating agent, which is designed to help the student by considering her emotional state (Jaques et al., 2002). They postulate that by knowing the student's emotional state, appropriate reaction strategies can be deployed which contribute to the improvement of both the student's motivation and her engagement level during a lesson. They have developed a mediating agent framework which consists of two phases: an appraisal of the student's affective state phase; and a mediating phase that uses a set of instructional rules to adapt to the student's affective state (Jaques et al., 2002).

Using the OCC model, their mediating agent appraises the student's affective state according to three interaction variables namely: the duration of the lesson, the errors made by the student and the requests for help (Jaques et al., 2002). This model considers only two outcomes for learning events: satisfaction and dissatisfaction. In the second phase of this system, instructional support techniques are delivered by an animated agent to react to the student's emotional state. Unfortunately, due to the absence of an empirical study published by this group, it is difficult to assess the performance of the Mediating agent framework. Nevertheless, it is still a useful contribution especially in the area of modelling students' affective states in an interactive learning environment.

2.9.3 Emotions and education Games

Using cognitive emotion appraisal theory, Conati and her colleagues at the University of British Columbia have developed a student emotion model within an education game domain (Conati, 2002; Conati & Zhou, 2002; Conati & Maclaren, 2004). Their long-term goal is to devise a framework that is able to detect specific emotions and respond accordingly to the learner's needs. They used a probabilistic model based on a Dynamic Decision Network approach (Russell & Norvig, (1995) as cited in Conati & Zhou, 2002) to model the learner's emotional reactions. Using the OCC emotion theory, they developed the causal part of the network which appraises the learner's emotional state by encoding the learner's personality traits and goals, and his current game state.

Conati & Zhou (2002) use the education game, Prime Climb, as their test-bed. In this game, two players must cooperate to climb a series of mountains that are divided into numbered sectors. Each player can only move to a numbered sector that does not share any factors with the sector occupied by his partner. When a player makes a wrong move, he falls and starts swinging from the climbing rope. Some tools are available to help the players decide which sector to move to, including a pedagogical agent that acts as an advisor. The goal of this pedagogical agent is to provide tailored support to help the student learn about number factorization while maintaining a high level of engagement.

They conducted an empirical study to assess the performance of the probabilistic model among a group of 20 7th grade students (Conati & Maclaren, 2004). They measured how often the probabilistic model's assessment agreed with the student's self-reported emotions. Results of the study indicate that the accuracy of the assessment between the probabilistic model and student's self-reported emotional states (i.e. admiration, reproach, joy and distress) was in the range of 20-91% (Table 2-1).

Table 2-1: Emotional belief accuracy using data from 20 students (adapted from Conati & Maclaren, 2004)

	Accuracy %	
Emotion	Mean	Std Dev
Joy	68.63	2.49
Distress	91.67	14.43
Combined (J/D)	**80.15**	
Admiration	20.61	3.39
Reproach	81.67	22.91
Combined (A/R)	**51.14**	

2.9.4 Other emotion and learning studies

Chaffer & Frasson (2004) and Razek et al.(2006) propose a framework that uses a sequence of three colours as an alternative to online self-report questionnaire in assessing the learner's emotional state in an affective tutoring system. This framework consists of three stages. The first stage is the perception module which is used to detect the student's current emotional state using a decision tree based on a sequence of colours (Figure 2-5). The decision tree was developed from the results of a study in which 322 students were asked to map their current emotional state using a sequence of colours. Using Shannon's algorithm (see Chaffer & Frasson, 2004 and Razek et al., 2006 for details), they used these responses to classify and develop a decision tree (Figure 2-5). For example, the system will infer a student to be in a state of surprise if he/she chooses a sequence of blue, yellow and purple colours.

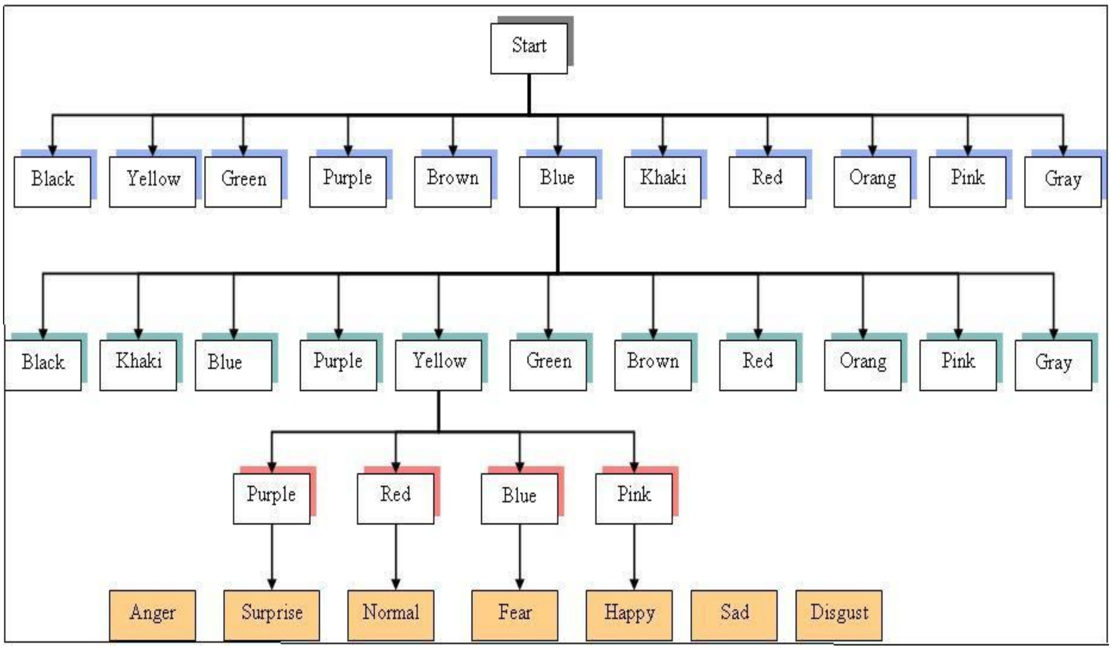


Figure 2-5: Sample of a decision tree (adapted from Chaffer & Frasson, 2004)

The second stage is the control module, which appraises the student's emotional state according to the outcomes of his learning goals (i.e. a positive outcome elicits a positive emotional state, and a negative outcome elicits a negative emotional state). The third stage of the proposed architecture is the action module. In this module, the student's optimal emotional state for learning is induced based on the student's personality. They proposed to use guided imagery vignettes, music and images for the induction of the student's optimal emotional state.

However, no empirical study has yet been conducted to establish the effectiveness of the proposed architecture. Without empirical evidence, it is difficult to estimate the practicality of this architecture.

In another study, Beal et al. (2005) studied the effectiveness of a self-report approach in assessing the student's motivational and mood while working with an ITS system. The study involved 47 students and was conducted in two high schools during geometry classes in Southern California, USA. They concluded that the students' mood (affective state) was a significant predictor for the outcomes of their test scores.

Using a different approach, Nkambou & Heritier (2004) developed a framework (Emilie-2) that detects the student's emotional state based only on facial expression analysis. This Emilie-2 framework consists of three modules: 1) capture and extract the facial image into its classification 2) analyse and diagnose the learner's perceived emotional state and 3) react according to the learner's emotional state.

Emilie-2 was developed using a neural network approach which classified the learner's face image into six basic Ekman (1978) facial expressions. However, based on their experimental study, the performance of Emilie-2 in detecting the learner's emotional state was quite low; only a 10 - 45 % accuracy level was achieved. Nevertheless, it is still a useful contribution for the progress of emotion-related studies within the affective ITS community.

2.9.5 Motivation and affective learning

The work by del Soldato & du Boulay (1995) represents a starting point for the consideration of motivational issues in ITSs. They developed a framework called MORE (Motivational Reactive plan) which was implemented for a simple Prolog debugging tutoring system. The MORE framework extended the traditional domain-based ITS framework by introducing motivational state modelling and planning. In general, the MORE framework consists of two phases: 1) detecting the student's motivation state and 2) reacting to the student's motivational state.

In the detecting of the student's motivational state phase, this framework used three methods that were adopted from existing motivation work (e.g. Malone & Lepper, 1987; Keller, 1987) which were: 1) communicating with students during the interaction, 2) monitoring students' request for help and perseverance to complete a lesson, and 3) asking for the students' self-evaluation of their motivational state during the interaction.

The MORE framework modelled the student's motivational state using three parameters: Effort, Confidence, and Independence. Effort is defined as the degree of engagement that the student displays to accomplish a task. Meanwhile, Confidence is defined as the student's belief in their ability to perform the task and Independence is defined as the degree that students prefer to work without asking for help. These motivational parameters together with sets of rules then generate the student's performance model and motivational state (del Soldato & du Boulay, 1995).

In the reaction phase, the MORE framework suggested strategies to react to the student's performance and the student's motivational state. These strategies were proposed by two planners: the domain planner whose main objective was to help students master their lesson and the motivation planner whose aim was to increase or maintain students' motivation state. However, in the case of disagreement between these two planners; the strategies suggested by the motivation planner overruled the domain planner strategy.

The work of del Soldato and du Boulay (1995) on motivation and ITS was extended by de Vicente (2002). He developed a framework called MOOD which could be used as an engine to diagnose a student's motivational state within an affective ITS system. The MOOD framework modelled the student's motivational state according to traits (i.e. sense of control, fantasy, challenge and independence) and states (i.e. satisfaction, confidence, effort, cognitive interest and sensory interest).

Central to the MOOD framework are the motivation diagnosis rules. These are an extension of the instructional planner rules developed by del Soldato & du Boulay (1995). The diagnosis of the student's motivational state was conducted according four factors: namely the student's performance, the student's interaction history, the student's motivational model and the student's feedback.

The evaluation of the MOOD framework's performance was carried out by comparing the system's motivational inferences with human teachers' diagnoses (de Vicente, 2002). Results from the evaluation study showed some evidence that motivational diagnosis techniques of the MOOD framework provided a reasonable level of accuracy in detecting a student's motivational state.

There is also progress reported by du Boulay and his students at the University of Sussex, UK, in their study on motivation and ITS systems. Rebolledo et al. (2005) for instance, developed a motivational ITS system (M-ECOLAB) which aims to provide motivational scaffolding via on screen character called Paul. This motivational model was added to an ITS system (ECOLAB) (Luckin & du Boulay, 1999). In M-ECOLAB, the student's motivational state was modelled using three variables: effort, independence and confidence (Rebolledo et al., 2005).

M-ECOLAB provided its feedback to the student through the alteration of a screen agent, Paul's, voice tone and facial expression at two learning stages: pre- and post activity. An empirical study was conducted among 19 students to evaluate the performance of the M-ECOLAB. Results from the study indicated that a positive effect was observed especially for the de-motivated students who registered higher learning gains after using the M-ECOLAB (Rebolledo et al., 2006).

The work of Martinez-Miron et al. (2004) is another attempt to study the relationship between motivation and an ITS system. Unlike Rebolledo et al. (2006), they were looking at the influence of the student's goal orientation (i.e. mastery and performance) on motivation. They developed two versions of a motivational system that were tailored to the student's goal orientation (either mastery or performance) and added these as modules to the ECALOB II system (Luckin & Hammerton, 2002).These systems are aimed at providing adaptive feedback based on the student's goal orientation so that the student can be kept in a positive motivational state.

In this study, the student's goal orientation was measured using the PALS questionnaire (Midgley et al., 2000 as cited in Martinez-Miron et al., 2004). Furthermore, similar to the Rebolledo et al. (2006) approach, they used the same three interaction variables in modelling the student's motivational state. However, based on their empirical study, they reported that no significant correlation was observed between the student's goals orientation and their motivational outcomes.

In a similar vein, Baylor et al. (2004) conducted a study to investigate the impact of an animated agent that provided motivational support to a student while learning. In this study, 67 general education community college students were presented with one of four animated agents, differing by motivational support (present/absence) and emotional state (positive/negative). The agents' motivational support was modelled based on a visual persuasion model (Bandura, 1997 as cited in Baylor et al., 2004). Results from the study showed that the presence of the agent with motivational support had a significant positive impact on students' self-confidence and their perception of the agent.

In another study, Qu & Lewis (2005) developed a framework to assess the learner's motivational state in an interactive system. They inferred the learner's motivational state according to three interaction variables: namely confidence, confusion and effort. These variables are modelled according to the learner's attention, the learner's current task and the duration of a lesson. Based on an empirical study, a recognition accuracy of more than 75% for the learner motivational state variables was recorded (Qu & Lewis, 2005).

2.9.6 Animated pedagogical agents

Animated pedagogical agents are another important area of research in dealing with students' affective states. Several applications using animated pedagogical agents have been developed to promote the integration between students' affective state and education (Johnson et al., 2000). Steve, an animated pedagogical agent, for instance, is designed to interact with students in a networked immersive virtual environment, and has been applied to naval training tasks such as operating the engines aboard US navy surface ships (Johnson et al., 1998). Adele, on the other hand, is designed to run in a student's web browser as an electronic learning aid (Shaw et at., 1999).

Lester et al. (1997), meanwhile, have developed three programs using pedagogical agents in a learning environment: Herman the Bug (Lester et al., 1999c), Cosmo and WhizLow (Lester et al., 1999b). Andre et al. (1999) have successfully implemented an animated pedagogical agent in an online help instruction project, called the PPP-Persona.

Lester et al. (1999c) and Andre et al. (1999) have found, in their separate experiments, that the use of animated agents can improve students' performance in post-tests and enhance student performance in complex problem solving. They argue that it is due to the Persona effect, the presence of a lifelike character, which improves the student's affective state, and thus, improves their engagement in learning. Lester et al. (1999a) reported that the Persona effect in an interactive learning environment could have a strong effect on the learner's perceptions of that environment and, thus enhance their performance.

In spite of these positive effects, the current implementations of animated agents do not consider the student's affective state in much detail in their design. Rickel et al. (2001) acknowledged that without emotions an animated agent can hinder the effectiveness of the learning process. They point out, in the case of Steve, that Steve's performance has two major limitations as a result of the absence of emotions. First, it is emotionally flat, and thus is not motivational. Steve, for instance, is unable to distinguish mundane instructions from important ones. Second, Steve is unrealistically rational as a team-mate. Steve's lack of emotion hampers his performance as an instructor and team-mate and, of course, it also makes it less engaging for interactive applications.

We have addressed and reviewed issues related to emotions in ITS environments. In the following sections, we examine architectures and the strategies used to regulate the student's affective state.

2.10 Analysis of current ITS systems

Current affective ITS research can be categorised into two kinds; a) the first is working with students' motivational issues and, the second with students' emotional issues. The first group deals with the student's motivational state in learning (e.g. del Soldato & du Boulay, 1995; de Vicente, 2002). They adopt motivational tactics and techniques derived from Keller's (1987) and Malone and Lepper's (1987) work in developing their individualised student's affective model.

The second group deals with the student's emotional state in learning (e.g. Conati & Zhou, 2002; Picard et al., 2002; Nkambou, 2006; Kapoor et al., 2004). Most of the members of this group use the OCC (Ortony et al. 1988) emotion appraisal theory to develop their individualised student's affective model. The underlying principle of these models is appraisal theory, in which emotion is generated as the consequence of evaluation of events related to the individual's beliefs and goals.

Across the literature, the architecture of affective ITS systems can be characterised as operating a two-phase approach. The first phase is the detection or appraisal of the student's affective state and the second phase is about responding or reacting using strategies adapted to the user's affective state.

Four appraisal methods have been used within the ITS community. Questionnaires are the first method used to appraise students' affective states (e.g. Matsubara & Nagamachi, 1996; Whitelock & Scanlon, 1996; de Vicente, 2002). de Vicente (2002) for instance, employed this method to diagnose several motivational factors including creativity, tiredness and boredom. In another example, Klein (1999) developed dialogue boxes with a radio button to assess the student's frustration level in dealing with the system.

The second method used to appraise the student's affective state is self-reporting (e.g. del Soldato & du Boulay, 1995; de Vicente & Pain, 2002). It involves the design of an interface with a mechanism that allows students to report their subjective reading of their affective state. For instance, de Vicente & Pain, (2002) used 'sliders' that represent the students' belief about the influence of several motivational factors on their affective state.

The third method to appraise the students' affective state is through a dynamic system (e.g. Conati & Zhou, 2002). They developed a system to appraise the user's affective states using a Dynamic Belief Network. They applied their model to educational games and it can determine six of the 22 emotions defined by the OCC theory: joy, distress, admiration, reproach, pride and shame.

The fourth method used by researchers to appraise the user's affective state is sentic modulation. This method is derived from the work of Picard and her colleagues at MIT. Sentic modulation is the physical assessment of the changes in a person's emotional state via sensors such as cameras, microphones, strain gauges applied to mouse buttons, special wearable devices, and other indicators that register physical modulation produced by emotional states (Picard, 1997). They have developed and tested several wearable devices in their labs such as a the Blue eyes camera[1] (Kapoor et at., 2003), head tracking system (Mota & Picard, 2003), wireless Bluetooth skin conductance (Strauss et al., 2005) and video capture (Kapoor et al., 2004).

Appraising the user's emotional state is often difficult due to its complex nature (Picard, 1997; Ortony et al., 1988). Therefore, most of the current affective systems categorise the outcomes of the appraisal process into four possible outcomes: a high or low positive affective state and a high or low negative affective state. (e.g. del Soldato & du Boulay, 1995; Reilly et al., 2001; Lester et al., 1999a; de Vicente & Pain, 2002; Jaques et al., 2002).

Just as in the appraisal phase, there are two general (problem-focused) strategies used in the reaction phase of current affective ITS systems. The first is the provision of help according to the user's current mastery and affective state. This is a common feature of an affective system (e.g. del Soldato & du Boulay, 1995; Rebolledo et al., 2006; Conati & Zhou, 2002). The second strategy is the organization of the students' work. Unlike the ordinary ITS system, the student's current affective state is an important factor in determining the student's next task (e.g. Reilly et al., 2001; Conati & Zhou, 2002; del Soldato & du Boulay, 1995).

---

[1] The Blue Eyes Camera is software that uses infrared (IR) sensitive camera to automatically detect human facial features like eyes, eyebrows and other facial parts in real time. For further information see (http://www.almaden.ibm.com/cs/blueeyes)

2.11 Conclusion

There are two significant differences observed between theory and the practical implementation of an emotion regulation framework. The first lies at the level of the appraisal phase. According to emotion regulation theory (Gross, 1999; Lazarus 1991), there are two appraisal phases involved in the self-regulation process namely: the primary and the secondary. The first should be conducted before an event becomes fully activated and the second comes after the event has been fully activated. Within an educational context, the first appraisal should be conducted before the start of a lesson, while the second is normally expected to be conducted after the lesson is completed. However, current affective ITS frameworks consider only one level of appraisal process which is during the lesson through this may happen several times during the lesson (e.g. Conati & Zhou, 2002; del Soldato & du Boulay, 1995; Reilly et al., 2001; Lester et al., 1999a).

The second gap between theory and the practical implementation of the emotion regulation process within an affective framework concerns the strategies deployed in the reaction phase of the emotion regulation process. Results from empirical studies (e.g. Lazarus, 1991, Folkman & Lazarus, 1985; Folkman et al., 1988) have provided strong evidence that individuals use both domain-dependent and domain-independent adaptive strategies as their reaction to regulate or modulate their overly intense affective state. In contrast, current affective ITS system concentrate very largely on the use of domain-dependent strategies as the means to regulate the student's affective state.

Therefore, there is a need to explore the value of using domain-independent strategies alongside domain dependent ones. This extension should allow users to enjoy the maximum benefit of the emotion regulation process.

Chapter 3

The affective tutoring system (ATS) framework

In this chapter the affective tutoring system (ATS) framework is presented. This chapter starts with a discussion of the theoretical background that underpins the formulation of the two stages of the ATS framework (i.e. the primary and secondary appraisal and reaction phases). It is then followed by a discussion of each aspect of the system together with some initial empirical work to calibrate the system.

3.1 The theoretical background of the ATS framework

As mentioned in the literature review, Salovey and Mayer (1990) proposed the concept of emotional intelligence which emphasises the individual's ability to perceive and express emotion, understand and reason with emotion, and regulate emotion. This concept has led to a better understanding of the personal emotional components and characteristics which improve the chance of having a better life (Mayer & Salovey, 1993). Picard (1997) argues that the adoption of the emotional intelligence concept within an affective computing environment may improve computer-human interaction by providing a better mechanism for recognising, understanding and regulating the user's affective state. Consequently, this should help students to improve their self-perception (e.g. self-confidence, self-esteem) thus leading to a better learning performance.

Picard (1997) further proposed that the architecture of an affective framework should include the three major characteristics of the emotional intelligence concept. The first is the ability to recognise a user's affective state. This includes the ability to appraise and deduce the user's current affective state through the human-computer interaction. The second characteristic is the regulation of the user's affective state itself. This involves the use of appropriate strategies in ways which influence the user's affective state. And the final characteristic is the utilization of the student's affective state such as by improving the user's self motivation.

Following the Picard (1997) architecture, we propose an affective ITS framework which uses the emotional intelligence concept as its underlying theory. We refer to this framework as an affective tutoring system (ATS) framework. The ATS framework has two phases. The first phase is the appraisal of a user's affective state which corresponds to the recognition of user's affective state as proposed by Picard (1997). The second phase of the ATS framework is the reaction phase. It represents the regulation and the utilization of individual's affective state processes (i.e. the second and third characteristic in Picard's architecture). In sum, the broad architecture of the proposed ATS framework is illustrated as in Figure 3-1.

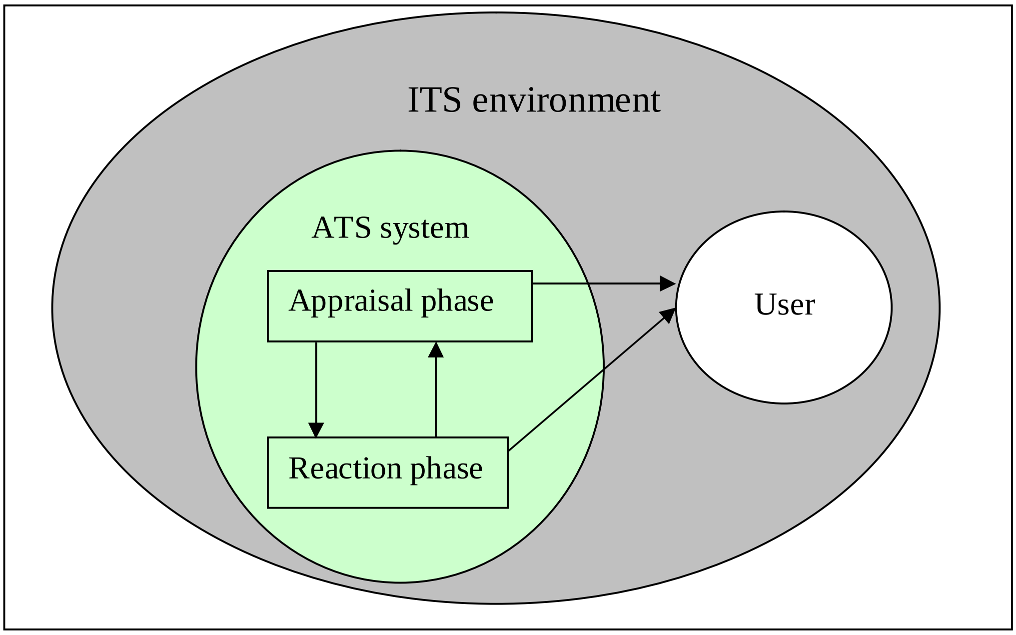


Figure 3-1: The broad architecture of the ATS framework

However, this framework does not fully represent how individuals regulate their affective state when dealing with daily events. According to the emotion regulation model (Gross, 1999; Lazarus, 1991), there are two appraisal and reaction processes at two different stages in an individuals' emotion regulation. The first appraisal and reaction phases should be conducted before the event and the second appraisal and reaction phases come after the event has been fully activated.

Within an ITS environment, it is hypothesised that the first appraisal and reaction phases should take place before the start of a lesson, at the outset of the potential emotional situation. And the second appraisal should take place during the learning session itself. So, the high level interactivity of ATS framework is presented in Figure 3-2 below.

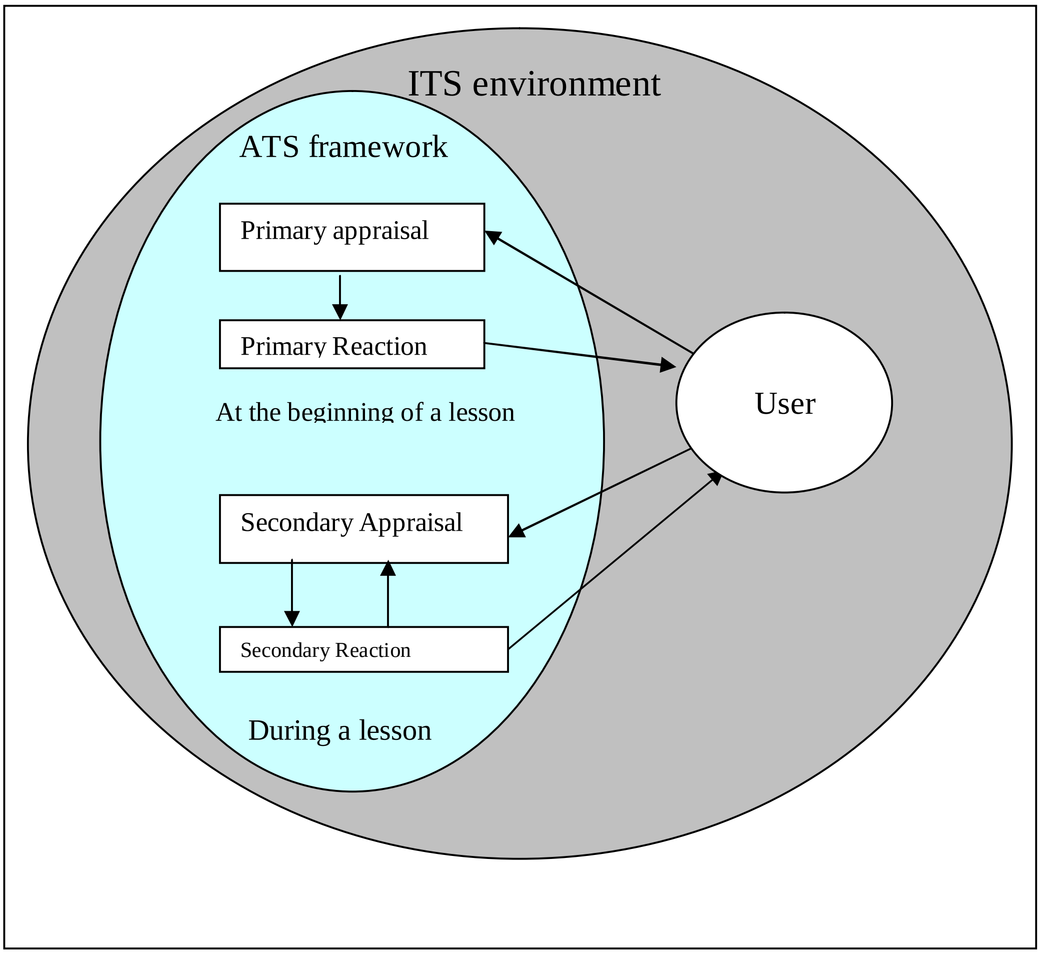


Figure 3-2: The high level interactivity of the ATS framework

3.2 The ATS appraisal phases

Within the ATS framework, self-report instruments are used as the primary method in appraising the student's affective state. These instruments are also commonly used by many researchers in tutoring system environments (e.g. de Vicente, 2003; Reilly et al., 2001; Conati & Zhou, 2002; D'Mello et al., 2007; Kapoor et al., 2007; Ahn & Picard, 2006). However, prior to a discussion of the specific self-report instruments of ATS, some of the issues in using self-report measures to appraise a student's affective state within a tutoring system environment are highlighted.

Perhaps the main advantage of self-report measures is that they offer a direct self-evaluation and meaningful appraisal of student's affective state which by its nature cannot be directly observed (Kort et al., 2001; Conati & Maclaren, 2004). This allows the system to capture participants' self-judgments on the changes in their affective state in a more consistent way while using the system. In addition, self-report instruments may be used in a variety of settings with minimal time and effort. This has facilitated the adoption of the self-report approach within the ATS domain.

Nevertheless, self-report instruments have several limitations. Self-reports can be inaccurate if respondents are unable to understand the language of the questions (Bradburn & Sudman, 1988). Most self-report instruments require the respondents to be literate in the language of the test (i.e. the PANAS questionnaire). This is relevant to our study as most of the students were not English native speakers. For example, students had a problem to understand the word "Hostile" which was not commonly used to describe a "hostile" emotional state in Malaysian culture. Furthermore, direct translations without considering the content and context are often insufficient. As a result, students may incorrectly interpret the word which, in turn, causes an incorrect assessment of their state.

Another limitation of self-report is the social desirability effect. This refers to the tendency of students to answer in such a way as to deliberately or unconsciously represent themselves in a favourable light (Howard, 1994). This may be due to the influence of the setting in which the research is conducted or the belief of the students about the purpose of the study. For instance, a good student who is afraid to "look less capable" may give an incorrect assessment during a learning episode. However, this kind of response is not necessarily a deliberate behaviour; it may also reflect an unconscious tendency to create a positive impression, to avoid criticism or gain positive approval (Howard, 1994).

Careful attention was given to the issues of the use of the self-report instruments for apprising students. In the next section, the instruments to appraise students' affective state (i.e. primary and secondary appraisal phases) are discussed. Subsequently, discussion of two exploratory studies is presented.

3.3 The primary appraisal process

The Positive and Negative Affect Scale (PANAS) questionnaire is used to appraise the user's initial affective state in the primary appraisal phase of the ATS framework. The PANAS questionnaire is reliable and valid statistically (Watson, Clark & Tellegen, 1988). Reliability refers to the internal consistency among individual items in the instrument (O'Connor 2006; Field, 2005). It is a measurement of the degree to which a set of test items can be treated as measuring a single latent variable. In addition, it is also about the extent to which the measures are free from random errors (Strenier & Norman, 2003).

The most widely use statistical reliability scale is Cronbach's alpha. A higher value of the alpha score implies that the items of the scale are more unified and hence better suited to form the scale. By convention, the widely-accepted social science cut-off value for Cronbach alpha for a set of items in a scale is 0.70 (e.g. Strenier & Norman, 2003; Norusis, 2005; O'Connor 2006; Field, 2005). Nevertheless, for an explotary study, according to Hair et al. (1998), a value of 0.6 is acceptable.

The PANAS questionnaire consists of 20 items on a Likert type scale of 1 to 5 that measures students' positive and negative affective states (see Appendix A for the PANAS questionnaire). It has a value of 0.85 for the Cronbach's alpha, for both positive and negative affect, which represents a significant reliability test value. As for the validity measurement, the PANAS questionnaire is highly correlated with its corresponding regression factor scores. Its convergent correlations range from 0.89 to 0.95, while its discriminate correlations are low, ranging from -0.2 to -0.18 (see Watson, Clark & Tellegen, 1988 for a detailed statistical analysis). Moreover, the PANAS questionnaire has been tested using over 3000 respondents and produced a consistently high score on related affective state measurements over time (Watson, Clark & Tellegen, 1988).

The PANAS questionnaire has been successfully used for measuring subjects' affective states in a broad array of research disciplines; social behaviour (Shrier et al., 2005); sport science (Gaudreau & Blondin, 2002); customer behaviour (Winkielman et al., 2006); emotions in the workplace (Schaubroeck & Jones 2005); medical clinical studies including measuring the affective state of advanced cancer patients (Voogt, et al., 2005); and depression, stress and fatigue research (Denollet &De Vries, 2006).

The PANAS questionnaire posits affective state as two independent dimensions: the negative affect and the positive affect. During the primary appraisal phase, users are asked to self report how they feel via 10 positive and 10 negative affective state items, each on a 5-point Likert-type scale. A score of 1 represents having that facet of the affective state slightly or not at all and a score of 5 represents an extreme feeling of the affective state (see Appendix A).

In order to get a single overall score, Bradburn (1969) argues that "general well-being" is a better indicator for personal satisfaction level coping with daily life. He develops a model called *Affect Balance Scale* (ABS) which measures an individual's state of general well-being (see Bradburn, 1969, for the complete review of the model). In this model, an individual's *Affect Balance Scale* (ABS) (i.e. general well-being) is measured by subtracting the averaged negative affect scale scores from averaged positive affect scale scores:

ABS = Average Positive affect – Average Negative affect ……………Eq 3.1

*Note: ABS refers to Affect balance scale

The ABS method has been used in measuring subjects' affective states in several disciplines; i.e. social psychology (e.g. Kehneman, 1999; Kempen, 1992; Liang, 1985); college students (Bolin & Dodder, 1990) and mental health (Harding, 1982). Furthermore, the ABS is statistically reliable. Namazi et al. (1989) for instance, reported that the ABS Cronbach's coefficient scale (alpha) was 0.62. In another study, Anderson (2001) reported that the ABS Cronbach's coefficient scale (alpha) was 0.79.

Following Bradburn's (1969) model, we used the ABS equation in order to measure a student's affective state within the ATS environment. The ABS scale ranges between 4 to - 4. A student who obtains a positive score on the ABS scale is considered to be in a state of positive well-being. In contrast, a student with a negative score on the ABS scale is considered to be in a state of negative well-being.

Nevertheless, we acknowledge that the practicality of using the primary appraisal and reaction phase of the ATS framework before the start of a lesson had not yet been tested. So, in order to check this, an exploratory study was conducted. The aim of the study was to explore the range of students' affective states before the start of a lesson. The details of the exploratory study are presented in the next section.

3.4 Student's affective state exploratory study

The study was designed to explore students' affective states before the start of a programming lesson. This study was carried out in February 2004. 18 unpaid undergraduate students took part in this exploratory study. All of the students were from a Java programming class at Sussex University, UK.

3.4.1 Objective

The objective of this study was to explore the baseline and range of the students' affective states before the start of a programming lesson.

3.4.2 Material

A shorter version of PANAS questionnaire consisting of 18 items was used. Two of the items (e.g. hostile and jittery) were excluded from the scale as these two were anticipated to be less relevant in learning. Admittedly, this raised the issue of the validity of the assessment. However, as this was only an exploratory study, the impact was not severe. Moreover, in the main experiment (discussed in Chapter 9), the complete PANAS questionnaire was used.

In this study, students were asked to indicate "how do you feel at the present moment" by rating each of the items using the five-item Likert-type scale, where 1 represented *slightly or not at all* of X (where X is an item of the PANAS questionnaire), while 5 represented an *extreme* level of X (see Appendix A for details).

3.4.3 Method

The survey was conducted in a Java programming laboratory. The questionnaires were distributed before the start of the lab session and they were given 30 minutes to complete the survey.

3.4.4 Results and discussion

Results from the study indicated that students experienced a certain degree of affective arousal (both positive and negative) prior to the programming lesson as shown in Table 3-1 below. There was also a reasonable spread of responses.

Table 3-1: Analysis of students' affective state

	Mean	Std D	N
Positive Affect	3.0	0.68	18
Negative Affect	2.1	0.64	18

In general, students in this study experienced higher positive affect (M = 3.0, SD = 0.68) compared to negative affect (M=2.1, SD = 0.64) at the beginning of the programming lesson. So, their average general well-being state using the ABS measure was + 0.9. The results of the study have provided some data on the baseline values of students' affective state.

3.4.5 Conclusion of the affective state exploratory study

Although in this study, the diagnosis of the students' affective states is far from complete, it has provided some insight into students' affective state baseline at the beginning of a lesson.

3.5 The ATS secondary appraisal phase

The secondary appraisal phase is conducted after the student has completed a lesson. The materials for the programming lessons were taken from the author's personal question bank, lecturer notes and tutorials which are part of the University of Tenaga Nasional's Data Structures course for undergraduate (the author has more than five years experience in teaching this course). These materials are a combination of easy and difficult topics which present sufficient learning challenges to elicit an emotional reaction from the user. There are four learning topics available for the user to choose from: the recursive, the linked list, the stack and the tree (see Appendix D). According to UNITEN's data structures syllabus, the recursive is considered an easy topic, the linked list is considered a moderate topic and the stack and the tree are considered difficult topics.

Following the cognitive appraisal model (Ortony et al., 1988; Ortony, 2003; Lazarus, 1991) the ATS framework appraises students' affective states according to their reactions to learning events. Students' reactions to learning events are categorised into two affective states: a state of positive well-being and a state of negative well-being. A state of positive well-being is produced after a desirable learning outcome is obtained such as when a student completes a lesson successfully. By contrast, an undesirable outcome of a learning event, such as when a student fails to complete a lesson on time, elicits a state of negative well-being.

Adapted from the OCC model (Ortony et al., 1988), three variables are used in modelling the factors which may influence the <u>intensity</u> of the positive or negative well-being. They are: S*elf-confidence,* which represents the student's personal belief about their ability to complete the learning task, *Independence* and the *Number of attempts* at a solution which together represent the student's effort working on that task. Within the ATS framework, the intensity of the student's state of well-being is measured on a single dimension scale of -3 to 3. Further details of this secondary appraisal phase are presented in Chapter 4.

3.6 The ATS framework reaction phase

In the ATS framework's reaction phase, both domain-dependent and domain-independent strategies are used as a response to the student's elicited affective state. These responses are tailored to both the student's mastery level and his/her affective state.

3.6.1 Domain-dependent strategies

There are three domain-dependent strategies implemented within the ATS learning environment:

a) The analysis of the student's answer and consequential feedback for each question during a lesson.
b) The provision of lecture notes and examples of program code.
c) The organization of the student's next task which adapts to the student's current affective state.

Details of the implementation of the domain-dependent strategies are presented in Chapter 4.

3.6.2 Domain-independent strategies

In contrast to the traditional affective ITS framework that typically considers domain-dependent strategies for coping with the student's affective state, the ATS framework incorporates domain-independent strategies as a complimentary method for dealing with the student's affective state.

The use of the domain-dependent and domain-independent strategies is intended to mirror the way in which individuals regulate their own affective states (e.g. Folkman & Lazarus, 1985; Folkman & Lazarus; 1988; Lazarus, 1991). However, there had been little attempt to study the use of the domain-independent strategies within the affective tutoring system community. So, in order to gather more evidence, a study was conducted aimed at identifying the specific strategies used by students when dealing with problems within an educational context. This exploratory study was used to determine the nature of the strategies deployed by the Malaysian students in regulating their affective state and subsequently was integrated into the reaction phase of the ATS architecture. Details of the study are presented in the next section.

3.7 Students' coping strategies: an exploratory study

This study explored the strategies used by Malaysian undergraduate students in dealing with affective problems, such as their reaction to a difficult programming assignment or an examination and was carried out in November 2004. In this study, 43 unpaid students from the Data Structures class of the College of Computer Science and Information Technology, University Tenaga Nasional, Malaysia took part.

3.7.1 Objective

The study was aimed at determining a ranking of Malaysian students' coping strategies based on the groups proposed by Folkman et al. (1986) and Lazarus (1991).

3.7.2 Material

The Ways of Coping questionnaire (WCQ) (Folkman et al., 1986, see Appendix B) was used in this study. This questionnaire consists of 66 different possible strategies containing a wide range of thoughts and acts that student might use to deal with the internal and/or external demands of specific stressful encounters. Each strategy is presented in a scale of 0 to 3. A scale of 0 means the strategy is not used by the student, 1(somewhat) means the strategy is used 1 to 2 times a day time, a scale of 2 (quite a bit) means the strategy was used 3 to 4 times a day and a scale of 3 (used a great deal) means the strategy was used more than 4 times a day.

The Ways of Coping questionnaire has demonstrated good reliability and validity (Folkman & Lazarus, 1980; Folkman, Lazarus, 1986; Folkman & Lazarus, 1988). In recent years, many researchers (e.g Lundqvist & Ahlstrom, 2006; Yip & Rowlinson, 2006) have reported reliable findings in the use of the WCQ questionnaire in assessing individual coping strategies in various disciplines (i.e. medicine, sport science and education).

Folkman et al. (1986) used the Ways of Coping questionnaire to conduct a comprehensive study of university students' coping strategies for dealing with potentially affect-eliciting events such as examinations. Using factor analysis, they identified eight groups of coping strategies. (See Folkman et al., 1986 for the theoretical and experiments details)

i. Problem-focused coping
ii. Wishful thinking
iii. Detachment
iv. Focusing on the positive
v. Seeking social support
vi. Self-blame
vii. Tension reduction
viii. Keep to self

In this study, we used these groups as the initial coping strategy groups.

3.7.3 Procedure

The questionnaire was distributed to the students at the beginning of their lesson. No time limit was imposed in this study. Students were asked to hand in the questionnaire as soon as they had completed it.

3.7.4 Results and discussion

The Malaysian student data set (i.e. 66 items) was classified into the eight coping groups proposed by Folkman et al. (1986). Subsequently, we analysed the reliability coefficient value (Cronbach alpha) of each coping strategy group proposed. Following the convention for an exploratory study (Hair et al., 1998; O'Connor 2006; Field, 2005), a value of 0.6 was set as the reliability coefficient acceptance level. Based on this acceptance level, three initial coping strategy groups were excluded; these were *Self-blame, Tension reduction strategy* and *Keep to self*. The reliability coefficients of these strategies were 0.138, 0.243 and 0.412 respectively.

Five coping strategy groups were accepted as the coping strategies by Malaysian computer science students. The complete description of the groups, their reliability coefficient (Cronbach alpha) values and components are presented in Table 3-2 below.

Table 3-2: The Malaysian student coping strategies groups and their components

Group	Mean	Std. Deviation	Reliability coefficient (Cronbach alpha)	Items of the group
1 Problem focus-coping (PFC)	1.82	0.50	0.61	1. Stand my ground and fight for what I want. (M = 1.69 , SD = 0.87) 2. I try not to act too hastily or follow my first hunch. (M = 1.51 , SD = 1.00) 3. I make a plan of action and follow it. (M = 1.97 , SD = 0.77) 4. I try to keep my feelings from interfering with other things too much. (M = 2.02 , SD = 0.80) 5. Change something so things will turn out all right. (M = 2.02, SD = 0.83) 6. I try to analyze the problem in order to understand

				it better. (M = 2.18 , SD = 0.74)
2. Detachment (D)	1.15	0.55	0.66	1. Try to forget the whole thing. (M = 1.06 , SD = 1.00) 2. Go on as if nothing is happening. (M = 0.92 , SD = 0.86) 3. I wait to see what will happen before doing anything. (M = 1.09 , SD = 0.99) 4. Go along with fate; sometimes I just have bad luck. (M = 1.06 , SD = 0.82) 5. I feel that time will make a difference (M = 1.02 , SD = 0.91) 6. Accept it, since nothing can be done. (M = 1.30, SD = 0.96) 7. Go away from it for a while; try to rest or take a vacation.(M = 1.39 , SD = 1.04) 8. I jog or exercise. (M = 1.41 , SD = 1.05)
3.Wishful Thinking (WT)	1.72	0.71	0.72	1. Wish that I can change what is happening or how I feel. (M = 2.09, SD = 0.86) 2. Wish that the situation would go away or somehow be over with. (M = 1.83 , SD = 1.02) 3. I daydream or imagine a better time or place than the one I am in. (M = 2.00 , SD = 1.29) 4. Have fantasies or wishes about how things might turn out. (M = 1.69 , SD = 0.96) 5. Hope a miracle will happen. (M = 1.50 , SD = 1.23)
4. Focusing on the Positive (FOP)	1.85	0.67	0.62	1. I'm changing or growing as a person in a good way. (M = 1.97 , SD = 0.80) 2. I am inspired to do something creative. (M = 1.76 , SD = 1.01) 3. Look for the silver lining, so to speak; try to look on the bright side of things. (M = 1.88 , SD = 0.96)
5. Seeking Social Support (SSS)	1.98	0.48	0.65	1. Talk to someone about how I'm feeling. (M = 1.93 , SD = 1.03) 2. Talk to someone who can do something concrete about the problem. (M = 2.30, SD = 0.87) 3. Ask a relative or friend I respect for advice. (M = 1.93 , SD = 0.96) 4. I pray. (M = 2.70 , SD = 0.87)
Average	1.70	0.58	0.65	

The findings suggested that the five coping strategy groups selected were suitable to be used as the basis for the development of suitable reaction strategies for the students within the ATS system. In order to get more details on the items of the selected coping strategy groups, the classification of the items of these strategy groups was examined.

Using Lazarus' (1991) definition, each item of each coping strategy group was analysed and categorised as either a domain-dependent or a domain-independent strategy. We noted that most of the Detachment group (D) (e.g. "*Go away from it for a while; try to rest or take a vacation*" and "*I jog or exercise*") and Wishful Thinking group (WT) (e.g. "*Wish that I can change what is happening or how I feel*" and "*Wish that the situation would go away or somehow be over with*") should be classified as domain-independent strategies. In a similar vein, items from the Focus on Positive (FOP) coping strategy such as *"I am inspired to do something creative"* and *"Look for the silver lining, so to speak; and try to look on the bright side of things"*) should also be categorised as domain-independent.

By contract, items of the Problem Focus Coping group (PFC) were more inclined toward a domain-dependent strategy. Items such as "*I make a plan of action and follow it*", "*Change something so things will turn out all right*" and "*I try to analyze the problem in order to understand it better*" indicated adaptive efforts to improve the situation encountered. Following Lazarus (1991), these were considered as domain-dependent strategies.

Seeking Social Support group (SSS), however, could be considered as being both a domain-dependent and domain-independent strategy. For instance, items such as "*talk to someone who can do something concrete about the problem*" and "*ask a relative or friend I respect for advice*" can be considered as domain-dependent strategies. But items like "*Talk to someone about how I'm feeling*" and "*I pray*" can be classified as domain-independent strategies.

The classification of coping strategies provided some initial evidence that Malaysian computer science students used both the domain-dependent and domain-independent strategies while coping with potentially affect eliciting events. The findings were important because they served as the foundation for the development of suitable domain-dependent and domain-independent strategies within the affective tutoring system (ATS) framework (discussed in Chapters 4 and 5).

However, the results did not provide evidence for the relationship between these two broad strategies which is the core assumption of emotion regulation theories; they claim that individuals who use the domain-independent would also deploy the domain-dependent strategies in managing stressful situation (Lazarus, 1991, Gross, 1999; Fridja, 1986). Thus, to examine the relations between strategies used by Malaysian students, a correlation test among the coping strategy groups was conducted.

Table 3-3: Correlations among the coping strategies

Strategy	(D)	(PFC)	(WT)	(FOP)	(SSS)
1 Detachment (D)	1	0.141	0.192	0.036	0.059
2. Problem focus-coping (PFC)	0.141	1	0.053	0.691(**)	0.321(*)
3. Wishful thinking (WT)	0.192	0.053	1	0.328(*)	0.082
4. Focusing on the positive (FOP)	0.036	0.691(**)	0.328(*)	1	0.272(*)
5. Seeking social support (SSS)	.059	.321(*)	0.082	0.272(*)	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 3-3 above shows the correlation analysis among the coping strategies used by Malaysian students. It is interesting to note that a strong correlation can be observed between the *Focusing on the Positive* (FOP) and the *Problem-Focus Coping* (PFC) groups. This implies that those who said that they used the *Focusing on the Positive* (FOP) strategy (mostly domain-independent) were most likely to also use the *Problem-Focus Coping* (PFC) strategy (mostly domain-dependent).

Similarly, the significant correlation between the *Problem-Focus Coping* (PFC) and the *Seeking Social Support (SSS)* and, between the *Problem-Focus Coping* (PFC) and the *Focusing on the positive (FOP)* provided more evidence that Malaysian students reported that they deployed both domain-dependent and domain-independent strategies in managing their affective state.

However, the *Detachment (D)* coping strategy was noted to be not significantly correlated with any other coping strategy group. Perhaps it was due to the nature of the items of this strategy. For example items like "*Go away from it for a while; try to rest or take a vacation*" and "*I jog or exercise"* required physical activities which prevented them to simultaneously deploy other coping strategies.

Although five groups of coping strategies, (i.e. *Detachment (D*), *Problem Focus-Coping (PFC), Wishful Thinking (WT), Focusing on the Positive (FOP) and Seeking Social Support (SSS)*) were accepted as Malaysia coping strategies, some of these strategies could not be implemented within and ATS learning environment. For example, activities such as "*praying"*, "A*sking a relative for advice", "Hope a miracle will happen*", and "*I'm changing or growing as a person in a good way*" were beyond the scope of learning activities in the ATS. There were also some activities, such as "*jogging"* and "*doing exercise"* that needed to be altered to suit and integrate into the ATS learning environment.

3.7.5 Limitation of the study

The first limitation of the study concerns the temporal frequency of the study. Standard questionnaire design principles require data on behaviour (especially to collect data on individual's regular behaviour) to be collected over a period of time (e.g. every day or once a week). By contrast, this study was conducted as a one-off event. However, in this study, students were required to report their past experiences (not present) dealing with stressful encounter. Note that others have also used a one-off approach in measuring individuals' past experience (e.g. Lundqvist & Ahlstrom, 2006; Yip & Rowlinson, 2006).

The second concern is about the use of a narrow scale range (0-3) in the WCQ questionnaire. Such a severe range tends to inflate the size of bivariate correlation and hence indicates that a higher threshold value than 0.60 should be used for the reliability coefficient. However, the scale range is a part of the standard WCQ questionnaire which is regarded as one of the most widely used coping strategies apparatus (Wong et al., 2006). As such, the use of similar scale range is important so that the results of our study can be compared to other studies. Moreover, in an exploratory study, a threshold value of 0.60 the reliability coefficient is accepted (Hair et al., 1998; O'Connor, 2006; Field, 2005).

3.7.6 Conclusion of the second exploratory study

Using Lazarus' (1991) definition, most of the items of three coping strategy groups namely the Detachment (D), the Wishful Thinking (WF) and the Focus on Positive (POF) coping strategies were classified as domain-independent. By comparison, most of strategies the other two coping strategy groups (Problem Focus Coping group (PFC) and Seeking Social Support group (SSS) were classified as domain-dependent. The findings of the study also confirmed that Malaysian students' coping strategies conform to emotion regulation theories (Lazarus, 1991; Gross, 1999, Fridja, 1986) which suggest that individuals use both the domain-independent and domain-dependent strategies in coping with affect-eliciting events.

3.8 Conclusion of the chapter

The (ATS) framework provides two major developments of current affective tutoring system architectures. First is the inclusion of two stages of both appraisal and reaction, and second is the integration of domain-independent strategies as another way of regulating students' affective state.

Chapter 4

ATS appraisal phase

The formulation of the ATS framework, which consists of two appraisal phases; the primary and the secondary, was presented in the previous chapter. Evidence derived from the exploratory studies gave some support to justify the integration of the two appraisal phases into an affective ITS framework. In this chapter, further discussion is presented of each appraisal phase which includes the approaches and strategies used.

4.1 The primary appraisal phase

The aim of the primary appraisal phase is to measure a student's affective state before the start of a learning session. Following the Bradburn (1969) approach, the student's affective state is measured using the *balance affect scale* formula. This formula assesses the student's affective state by subtracting the student's overall negative affect from their overall positive affect.

Within the ATS framework, the student's positive and negative affective states are measured using the PANAS questionnaire before the start of a lesson (Figure 4-1). His or her overall positive and negative affective state is calculated by averaging the aggregate scores of each of the positive and negative affect items in the PANAS questionnaire into a scale of 0 to 4.

Figure 4-1: The online PANAS questionnaire of the ATS framework

Therefore, the formula to measure student's affective state in an ATS framework is redefined as follows:

Well-being (WB) = Av (PP scores) – Av(PN scores) – Eq. 4.1

Note:

a) Av (PP scores) refer to average PANAS positive scores

b) Av (PN scores) refer to average PANAS negative scores

A student is considered to be in a state of positive well-being when his well-being (WB) score is positive and a negative well-being (WB) score means a student is considered to be in a state of negative well-being.

4.2 The secondary appraisal phase

VanLehn (1988) argues that the main goals of an ITS system is to develop effective strategies that are tailored to a student's current mastery level and to develop an individualised model to adapt those strategies to the student's needs. However, for an affective ITS framework, there is an extra dimension to be considered in constructing these strategies, which is the student's individualised affective model. An affective ITS system must not only track the student's mastery level, but must also include an individualised affective model that reflects the student's affective state.

The development of these models will allow an affective ITS system to make better inferences about the student's mastery and affective state level and therefore able to suggest more appropriate actions. For instance, Lester et al. (1999) reported a significant improvement in student' learning performance through the inclusion of a student's affective state model. Likewise, Andre et al. (1999) have demonstrated that the integration of students' affective model improved student post-test performance and enhanced their ability to solve complex problem solving.

An individualised student affective state model is a unique feature of an affective ITS system. It permits the system to appraise and store relevant information about the individual learner's affective state and knowledge. This essential information can be used to adapt the instructional content to the student's affective and cognitive needs (VanLehn, 1988).

However, adapting the instructional content to an individual's affective state is a difficult task due to the complex nature of the individual's learning episodes which involve the interplay between both the cognitive and affective dimensions (Kapoor et al., 2004). Hence, the success of an affective ITS system lies in its ability to model a student's affective state correctly. Across the literature, several approaches have been used in modelling students' affective states such as the Dynamic Decision Network approach (Conati & Zhou, 2002; Zhou & Conati, 2003), the facial recognition approach (e.g. Nkambou, 2006; Donato et al., 1999; DeSilva et al., 1997; Ekman, 1997), the self-reporting technique (e.g. del Soldato & du Boulay, 1995), and the sentic modulation approach (e.g. Strauss et al., 2005).

4.3 The ATS secondary appraisal model

Following the OCC model (Ortony et al., 1988), the ATS framework models the individual student's affective state according to her reactions to learning events. There are two possible outcomes of the students' affective state from the ATS secondary appraisal model (i.e. in a state of positive well-being or in a state of negative well-being). A state of positive well-being is elicited as the consequence of a desirable learning outcome, such as when students manage to complete a lesson successfully. Conversely, an undesirable outcome of a learning event, such as when students fail to complete a lesson on time, elicits a state of negative well-being.

However, students with different backgrounds, proficiency levels or cultures might set a different priority or standard for the same outcome of a learning event. Consequently, this may result in a different intensity for the elicited affective state. For example, a weak student may feel less worried if he fails to complete a lesson compared to a good student. According to the OCC model (Ortony et al., 1988), differences among students are due to their personal beliefs and judgments of their own ability. This is consistent with Lazarus's (1991) appraisal theory that argues that the intensity of the elicited affective state depends upon personal expectation, knowledge and preference.

Within the ATS framework, a personal judgment of ability is referred to as *self-confidence* and is used as the first factor that affects the intensity of the affective state. In addition, Ortony et al., (1988) introduced *effort* or attempts invested by individuals in solving a problem as the second factor which influences the intensity of personal affective state.

The intensity of a student's state of well-being is measured on a single dimension scale of -3 to 3 (Figure 4-2).

Very High	High	Low	Neutral	Low	High	Very High
-3	**-2**	**-1**	**0**	**1**	**2**	**3**

←— Decreasing —— Neutral —— Increasing —→

Figure 4-2: The well-being scale

4.3.1 Self-confidence

Within the ATS framework context, *self-confidence* is introduced as the first variable that affects the intensity of the student's elicited affective state. *Self-confidence* is a measure of students' expectation of their ability to accomplish their goals (Bandura, 1997). Although *self-confidence* is an important component of an individual's *self-efficacy*, they are not the same (Pajares & Schunk, 2002). *Self-confidence* refers to one's personal general belief about one's abilities (Hall & Ponton, 2002). This belief sometimes is not influenced by one's knowledge or resources for accomplishing a task. In contrast, self-efficacy refers to one's belief in one's capability to perform specific tasks and is tightly influenced by one's knowledge and other resources to accomplish that particular task (Bandura, 1997).

Bandura (1997) asserts that the personal expectation or belief influences the action and effort of an individual and often determines the outcomes before any action occurs. *Self-confidence* is also a critical force in influencing students' behaviour and emotional reactions (Pajares & Schunk, 2002). They assert that students with high self-confidence approach difficult tasks as challenges to be mastered which, in turn, create a feeling of serenity in approaching difficult tasks, increases optimism, lowers anxiety and increases effort and persistence.

Conversely, students with low self-confidence may believe that things are tougher than they really are, a belief that fosters stress, depression, and a narrow vision of how best to solve a problem. As a result, the same event can cause different affective state intensity levels. For example, when all other factors are equal, the intensity of the student's elicited negative affective state is naturally higher for a student of high *self-confidence* than for a student of a low *self-confidence* when both students fail to complete the same lesson. Students who doubt their academic ability often foresee low grades often even before they begin an examination. Students with high *self-confidence* are more confident of their ability and often set a higher standard of achievement than a student who is less confident in his ability**.** For example, Gore (2006) suggest that high *self-confidence* students often set higher self-set grade to achieve as compared to low *self-confidence* students.

However, there is concern about students who may not be able to perform an accurate diagnoses of their *self-confidence* state especially those with weak meta-cognitive skills (Olson and Wise, 1987; Conkie, 1990, as cited in Kort et al., 2001). Kort et al. (2001) also argue that students might be influenced by their self-awareness of what is expected of them to report. For example, a weak student who is afraid to be considered as "less clever than the other students" may give an incorrect *self-confidence* assessment during a learning episode. In order to tackle this problem, a secondary method was deployed in the form of a regression model to diagnose the degree of objectivity of the student's self-reported *self-confidence* assessment.

Colinwood (2006) classifies the self-judgment of a student's *self-confidence* when appraising the outcome of an event into three categories; optimistic, pessimistic and realistic. He describes optimistic perception as when someone believes that he is more likely to experience an event as more pleasurable than is actually the case. Pessimistic perception, on the other hand, is when a person tends to believe that a less pleasant situation is more likely to happen. Finally, a realistic perception is referred to when a person can objectively appraise the events according to his knowledge and resources. Across the literature, there is evidence that this classification is commonly used in research (e.g. Shultz, 2002; Timmermans et al., 2008; Collingwood, 2007; Vollman et al., 2007). For instance, Shultz (2002) used this classification (i.e. optimistic, pessimistic and realistic) in modelling the user's valence judgment about an event in a decision making process. In another study, Vollman et al. (2007) deployed the same classification to model social responses towards a stressful situation.

A study was undertaken in order to calibrate student judgements about their self-confidence in the domain of data structures. This was needed because the model underpinning the ATS suggests different system reactions for students who differ along the dimension of optimism, realism and pessimism. A regression model was derived from a study that involved 28 Malaysian students (see Appendix C for the details of the study). In the experiment, students were asked to select and answer two of four data structures topics; namely recursive, linked list, stack and tree. However, before they could start answering the questions, they were required to self-report on their level of *self-confidence*, indicating their self-judgment in solving the presented problem, using a scale of 1 to 3 (1 = not confident and 3 = very confident).

At the end of the experiment, three parameters were measured and analysed; namely 1) their prior self-confidence about correctly completing their lessons, 2) the time they actually spent to complete their lesson and, 3) the degree of correctness of their solutions. Subsequently, using these three parameters, a regression equation was developed which related the degree of student's stated prior self-confidence to the actual time taken in completing the task and the actual degree of correctness of their solution.

This regression model was used to provide the baseline relationship between the ATS system version and the earlier self-reporting version (described above) of the *self-confidence* level (Table 4-1). The analysis of the baseline relationship allowed the ATS framework to determine the state of student's self-judgement (i.e. optimistic, realistic or pessimistic). In general, the regression model of the state of student's self-judgment is presented as Eq. 4.2 below:

***Self-judgment (regression model)* = 0.8 + (-.05 * Time) + (0.7 *Quality)……Eq. 4.2**

In the implementation of the ATS framework, the same question (as in the study above) was used as the instrument to gauge a student's *self-confidence* and was presented before the start of the lesson. It required the students to indicate how confident they were about solving the presented problem on a scale of 1 to 3 (1 = not confident and 3 = very confident). The *self-confidence* question is presented in Figure 4-3.

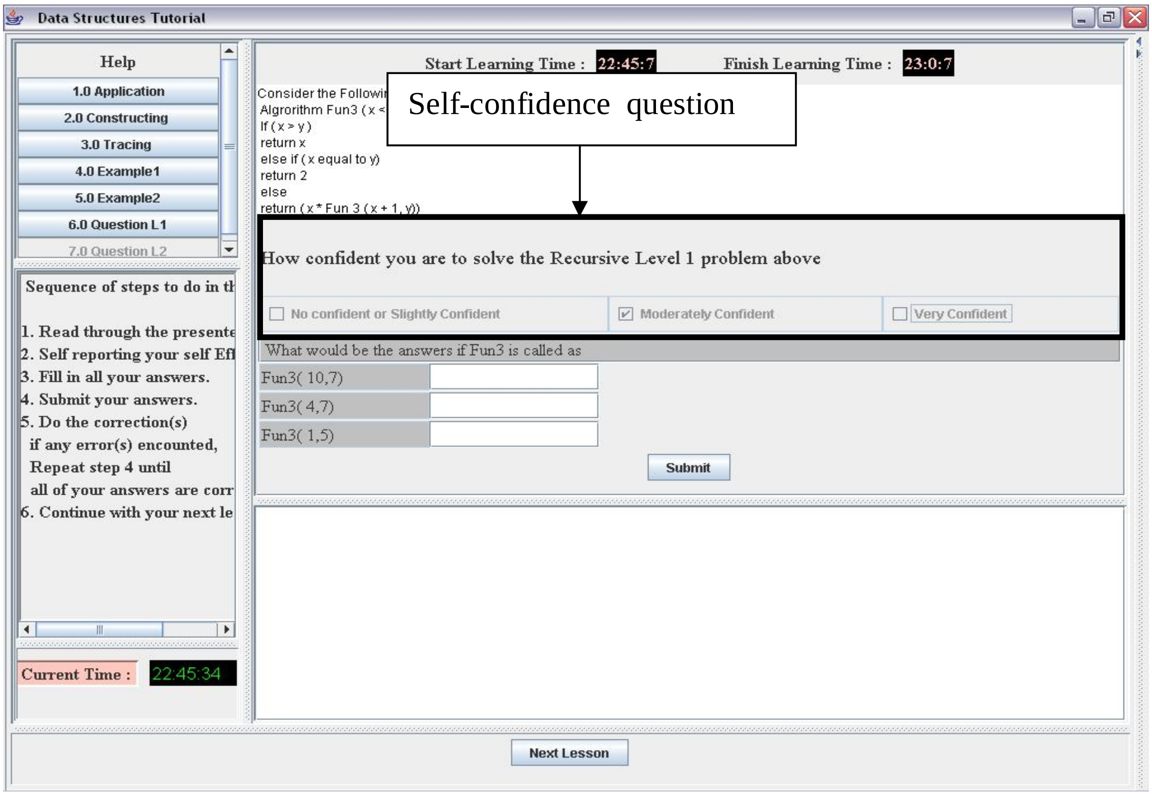


Figure 4-3: Example of *self-confidence* questionnaire in a lesson within the ATS learning environment

Likewise, the two other variables of the regression model (the time spent to complete the lesson and degree of correctness of his/her solution) were measured after they had completed a lesson. Subsequently, during the Pilot and Main studies (see Chapters 8 and 9), the regression model classified the students into his/her corresponding self-judgement group: "realistic", "optimistic" or "pessimistic". Essentially these were judgements that compared a student in the main study against the students in the study described above, taking the regression equation as expressing a standard for comparison purposes. Within the pilot and main experiments, realistic students are defined as those who perform accurate assessments of themselves. For instance, a non-confident or slightly confident student is considered to be "realistic" when the value of his or her *self-judgement (regression model)* is between 1.00 and 1.70. By comparison, a very confident student will be inferred to be "realistic" only when the value of his *self- judgement (regression model)* is over 2.40.

An "optimistic" student is one who performs below his computed *self- judgement (regression model)* value. For instance, a confident student is considered to be "optimistic" when the value of his *self- judgement (regression model)* is between 1.00 and 1.70. Likewise, a student is considered to be "pessimistic" if he performs above his own computed *self- judgement (regression model)* expectation. The complete set of rules for a student's *self-judgement (regression model)* assessment and its corresponding regression values and states are presented in Table 4-1.

Table 4-1: self-judgment (regression model) response rules

Student self-report questionnaire and its value	**Self- judgement regression value**	**The self-judgement response (value/state)**
Not confident or slightly confident (1)	1.00 - 1.70	0 (Realistic)
Not confident or slightly confident (1)	1.71 – 3.00	1 (Pessimistic)
Confident (2)	1.00-1.70	-1(Optimistic)
Confident (2)	1.71 – 2.40	0 (Realistic)
Confident (2)	2.41- 3.00	1 (Pessimistic)
Very confident (3)	1.01 - 2.40	-1 (Optimistic)
Very Confident (3)	2.41 – 3.00	0 (Realistic)

*Note: The confident optimists and very confident pessimist states were excluded as they were beyond the regression scope.

4.3.2 Effort

According to the OCC model (Ortony et al.,1988), *effort* is the second factor that affects the intensity of the elicited affective state. It can refer to physical or cognitive activities invested by the student to accomplish or solve a learning task. In general, when the *effort* in trying to achieve a desirable outcome is large, the negative affective state is stronger if the outcome is unsuccessful, and the positive affective state is stronger if the outcome is successful. For example, a hardworking student who manages to accomplish his lesson successfully will probably be in a state of higher positive well-being than the student who invests less effort.

Based on the preliminary study (see chapter 3 for details), two groups of coping strategies were identified as being used by the Malaysian students (to some extent) which can be regarded as their expression of effort when dealing with learning episodes. The first group is Seeking Social Support (SSS). "*Talking to someone who can do something concrete about the problem*" and "*Ask a relative or friend I respect for advice*" (see Table 3-2) are examples of this strategy. Within an affective ITS environment, it is common that the ITS instructional context and diagnostic rules play the role of a socially supportive partner. Conati & Zhou, (2002), for instance, use a Dynamic Decision Network approach to monitor the provision of hints and advice to the Prime Climb game's user. In a similar fashion, del Soldato & du Boulay (1995) through their MORE system's instructional rules, provide necessary hints and advice to students.

Problem-focused coping is the second group of coping strategies deployed by the Malaysian students in dealing with their learning events (see Table 3-2). This group of strategies involves students' actions or activities to directly solve the problem in a learning episode such as "*I try to analyze the problem in order to understand it better*" and "*I make a plan of action and follow it*" (see Table 3-2). It involves the process of analyzing the problem in detail, formulating a plan, and executing the plan of action.

In the ATS framework, two variables are introduced to measure *effort*. The first is *independence* which models student's requests for help from the system (as the more able partner) and the second is the *number of attempts* at a solution which monitors the student's action plan in solving a problem.

4.3.3 Independence

Similar to del Soldato & du Boulay (1995) the number of requests for hints and advice is modelled using the *Independence* variable. A low request frequency corresponds to a high level of *independence* and high request frequency means a low level of independence. Within the ATS framework context, the level of independence is derived from a measurement of the frequency of the student's requests for examples of code or lecture notes. A student is considered as a low in *independence* if he or she makes more then three requests for help during a learning session. Otherwise, he or she is considered as a high in *independence*.

4.3.4 Number of attempts

In the ATS framework, the *number of attempts* variable records the number of attempts made by a student in executing his plan of action in solving a learning task. In order to keep the learning sessions short, a student is allowed a maximum of six attempts to complete a problem. While a student who has made more than three attempts to solve the problem is considered as having a high *number of attempts*, those who make less than three attempts are considered as having a low *number of attempts* in solving the problem.

4.4 The ATS students' secondary appraisal model

Following the OCC model (Ortony et al., 1988), there are two possible outcomes in dealing with an event (i.e. learning episode); the desirable and the undesirable. In the ATS context, a desirable outcome is obtained when a student completes his lesson successfully. As a consequence, he is inferred to be in a state of positive well-being. Likewise, an undesirable learning outcome such as failing to complete a lesson after six attempts or during the allocated time elicits a state of negative well-being.

The OCC model (Ortony et al., 1988) also identified that the intensity of the elicited affective state (i.e. positive or negative state of well-being) is affected by two variables: the student's confidence level and the student's effort in solving the problem. Within the ATS framework, the student's confidence level is measured by the *self-confidence* variable and the student's effort is measured by the *independence* and *number of attempts* variables.

Therefore, as a result of the appraisal process during a lesson within the ATS environment, the student's affective state is modelled as a function of *self-confidence* (i.e. according to self-confidence regression model classification), *independence* and *numbers of attempts* (Eq. 4.3).

SAS = f (*self-confidence, independence, number of attempts*) [2]**…………… Eq. 4.3**

Note: SAS refers to Student's affective state

In order to make the SAS formula (Eq. 4.3) more specific, a set of rules linking the relationship between the three variables and the student's affective state was developed and is presented in Table 4-2 (desirable outcome) and Table 4-3 (undesirable outcome). For instance, when the outcome of a learning session is desirable, a *pessimistic* student with high level of *independence* and low level of *number of attempts* will be inferred to be in a state of very high positive well-being (rule 5). Likewise, a *realistic* student with high level of *independence* and a high number *of attempts* level will be inferred to be in a state of high negative well-being (rule 13) when he fails to complete his lesson successfully.

[2] Relationship between the quality of answers and numbers of attempts

Table 4-2: Rules of a student's affective state after a desirable learning outcome

Rules	Regression model Self-confidence classification (value)	Independence level (value)	Number of attempts level (value)	Appraised well-being state (value)
Rule 1	Realistic (0)	High (1)	High (1)	High positive well-being (2)
Rule 2	Pessimistic (1)	High (1)	High (1)	Very high positive well-being (3)
Rule 3	Optimistic (-1)	High (1)	High (1)	Low positive well-being (1)
Rule 4	Realistic (0)	High (1)	Low (0)	Low positive well-being (1)
Rule 5	Pessimistic (1)	High (1)	Low (0)	High positive well-being (2)
Rule 6	Optimistic (-1)	High (1)	Low (0)	Neutral (0)
Rule 7	Realistic (0)	Low (0)	High (1)	Low positive well-being (1)
Rule 8	Pessimistic (1)	Low (0)	High (1)	High positive well-being (2)
Rule 9	Optimistic (-1)	Low (0)	High (1)	Neutral (0)
Rule 10	Realistic (0)	Low (0)	Low (0)	Neutral (0)
Rule 11	Pessimistic (1)	Low (0)	Low (0)	Low positive well-being (1)
Rule 12	Optimistic (-1)	Low (0)	Low (0)	Neutral (0)

Table 4-3: Rules of a student's affective state after an undesirable learning outcome

Rules	**Regression model Self-confidence classification (value))**	**Independence level (value)**	**Number of attempts level (value)**	**Appraise well-being state (value)**
Rule 13	Realistic (0)	High (-1)	High (-1)	High negative well-being (-2)
Rule 14	Pessimistic (1)	High (-1)	High (-1)	Neutral state (0)
Rule 15	Optimistic (-1)	High (-1)	High (-1)	Very high negative well-being (-3)
Rule 16	Realistic (0)	High (-1)	Low (0)	Low negative well-being (-1)
Rule 17	Pessimistic (1)	High (-1)	Low (0)	Neutral (0)
Rule 18	Optimistic (-1)	High (-1)	Low (0)	High negative well-being (-2)
Rule 19	Realistic (0)	Low (0)	High (-1)	Low negative well-being (-1)
Rule 20	Pessimistic (1)	Low (0)	High (-1)	Neutral (0)
Rule 21	Optimistic (-1)	Low (0)	High (-1)	High negative well-being (-2)
Rule 22	Realistic (0)	Low (0)	Low (0)	Neutral (0)
Rule 23	Pessimistic (1)	Low (0	Low (0)	Low negative well-being (-1)
Rule 24	Optimistic (-1)	Low (0)	Low (0)	Low negative well-being (-1)

4.5 Conclusion

The approaches and strategies used in the primary and secondary appraisal phases have been presented. In the primary appraisal phase, the student's affective state is measured using the *well-being (WB)* formula which is derived from Bradburn's (1969) model.

In the secondary appraisal phase, the student's affective state is inferred according to the learning outcome. A desirable learning outcome elicits a positive state of well-being, and an undesirable outcome elicits a negative state of well-being. In order to measure the degree of positive/negative state of well-being, three variables; *self-confidence*, *independence* and *numbers of attempts* are used, which is based on the OCC model (Ortony et al., 1988).

Chapter 5

Domain independent strategies

"An anxious mind cannot exist in a relaxed body.' Jacobson, 1929

As discussed in Chapter 3, Malaysian students were found to employ both problem-focused strategies (domain-dependent) and emotion-focused strategies (domain-independent) as a reaction to their appraised state of well-being. These strategies represent their integrated cognitive, affective, and behavioural efforts in managing the external and internal demands from emotion-eliciting events (Crocker, Kowalski, & Graham, 1998; Lazarus, 1991). These results conform to the underlying emotion regulation theories of the ATS framework (Lazarus 1991; Gross, 1999). This chapter discusses domain-independent strategies. This includes a discussion of what constitute domain-independent strategies as well as justifications for the integration of these strategies into the ATS framework.

5.1 Domain-independent strategies

Analysis of Malaysian students' coping strategies indicated that the Detachment (D), the Wishful Thinking (WF) and the Focus on Positive (POF) coping strategies are domain-independent. These strategies are efforts that help people reinterpret, regulate and produce effective strategies to improve their affective state (Lazarus, 1991). They are not aimed at providing a solution or modifying the domain or environment, rather, they are self-oriented strategies aimed at maintaining the individual's psychological affective state (Flett et al., 1992).

Detachment is defined as the individual's attempt to minimize and regulate emotional impact by diverting their focus from the emotion-eliciting situation or events (Folkman et al., 1986). According to Lazarus (1991) activities such as relaxation exercises and meditation are examples of detachment strategies. This proposition is also supported by Holt & Dunn (2004). Through physical activities such as deep breathing exercises and progressive muscle relaxation, an individual can reduce his physiological affective state level. Moreover, many studies from across a wide research spectrum have also established a positive correlation between the relaxation exercise and personal affective state improvement (e.g. Borkovec & Sides, 1979; Bernstein & Borkovec, 1973; Clum et al., 1993; Rasid, & Parish, 1998; Barber, 1982; Matthews, 1983; Benson et al., 2000; Deckro et al., 2002). Thus, relaxation exercises are suitable to be a part of the domain-independent strategies of the ATS framework.

Central to the Wishful Thinking and Focus on Positive (FOP) strategies are the positive thinking and wishes about how an event would ideally be using positive affirmation statements. In this technique, students are advised to repeat particular positive sentences which are expected to improve their sense of awareness and control over the environment. This, in return, will help them to become more aware of their ability and of the available resources which will lead to better affective state management. Findings from various studies have shown that the use of a positive affirmation technique has enabled people to improve their positive affective state and reduce their negative affective state (e.g. Beck, 1988; Frey & Carlock, 1989; Dugan & Hock, 2000).

In summary, relaxation exercises and positive affirmation techniques were identified as possible components of the domain-independent strategies within the ATS framework. However, there have been very few attempts to study the effects of such strategies within a computer mediated environment, and in particular within the ATS community. Therefore, there was a clear need to review the use of these strategies within other research disciplines so that their findings and recommendations could be adapted within the ATS framework.

5.2 Relaxation exercises

The benefits of relaxation exercises, including reducing individuals' negative affective state and helping people cope with their psychological state, have long been established. The legacy of this relationship can be traced as back to the 1930s. Jacobson presented the idea in his book *progressive relaxation*, published in 1938. He believed that a person could reduce his negative emotional state by learning to make himself relax. He discovered that, by applying his *progressive relaxation* method of muscle tensing and releasing, a deep state of relaxation in those muscles could be achieved. Over the years, evidence from many studies has indicated that the use of *progressive relaxation* has helped treat a number of medical conditions such as high blood pressure and ulcerative colitis (Sultanoff & Zalaquett, 2000).

According to the *progressive relaxation* approach, a human's body is organised into four common physiological groups: 1) hands and arms; 2) head, neck, and shoulders; 3) torso, including chest, stomach and back; and 4) thighs, buttocks, legs, and feet. The method begins by asking the patient to lay or sit in a comfortable position. Following this, the patient is presented with the relaxation therapy for the first muscle group. This includes, asking the patient to tense those muscles, holding the tension for approximately five seconds, and then release and relax the same muscles for up to 30 seconds. This allows the individual to notice the contrast between the feeling of muscular tension and the feelings of muscular relaxation. The procedure is repeated with the next muscle in the group, and so on, until all the muscle groups have been treated.

The *progressive relaxation* session can be conducted either through guided verbal cues and scripts which can be memorized by the patient or provided on instructional audiotapes (Zalaquett & McCraw, 2001). Some individuals may prefer progressive relaxation that is prompted by a tape, because it allows them to completely clear their mind and just follow the cues allowing them to feel the difference between tensed and relaxed muscles easily. In his original idea, Jacobson (1938) developed a series of 200 different muscle exercises and a training programme that took one month to complete. Modern practitioners like Schultz & Luthes (1969) however, have abbreviated the session to only 15-20 basic exercises, which can be as effective as the original session. An example of the *progressive relaxation* procedure can be found in Appendix E.

Another prominent researcher in this area is Benson. In 1975, Benson published his groundbreaking work *The Relaxation Response*, which described in detail the stress-reduction mechanism in the body that short-circuits the "fight-or-flight" response[3], lowers blood pressure, relieves muscle tension, and controls heart rate (Zalaquett & McCraw, 2001). He claims

> *"The relaxation response is a physical state of deep rest that changes the physical and emotional responses to stress (e.g., decrease in heart rate, blood pressure, and muscle tension). If practiced regularly, it can have lasting effects when encountering stress throughout the day and can improve health. Regular elicitation of the relaxation response has been scientifically proven to be an effective treatment for a wide range of stress-related disorders. In fact, to the extent that any disease is caused or made worse by stress, the relaxation response can help."*
>
> *(*Benson-Henry Institute for Mind Body Medicine (MBMI), 2006, p.1)

The essence of Benson's method was to produce a simple and easy method to learn. Benson believed that his relaxation technique was preferable to other techniques because it is easy to administer and produces effects equivalent to those of more complex techniques (Greenwood & Benson, 1977). If one follows the simple steps necessary to elicit the *relaxation response*, the benefit to the body can be predicted reliably. These include: a decrease in blood pressure, diminished respiratory rate, lower pulse rate, and diminished oxygen consumption (Greenwood & Benson, 1977). An example of relaxation response procedure can be found in Appendix E

[3] The "fight or flight" response is a bodily reaction, which we experience due to stress, for example from internal worry or external circumstance. Originally discovered by the Harvard physiologist Dr. Walter B. Cannon (1871-1945), this response is hard-wired into our brains and represents genetic wisdom designed to protect us from bodily harm (Neimark, 2001).

Many benefits have been reported to be associated with relaxation exercises. Some of the general benefits include a reduction of general anxiety, prevention of cumulative stress, increased energy, improved concentration, reduction of some physiological problems, and increased self-confidence (Bourne, 2000). Neimark (2001) has identified the five major benefits of relaxation therapies if incorporated into daily life:

"

- *You will gain increased awareness of whether you are tense or relaxed.*
- *You will be more "in touch with your body."*
- *You will be better able to relax when you become stressed.*
- *You may reduce the resting level of your autonomic nervous system.*
- *Your concentration may improve. (By repeatedly bringing yourself back to the meditative state you are strengthening the part of your mind that decides what to think about)." -* *Neimark (2001, page 2, para 5)*

At present, *progressive relaxation* and *relaxation response* are the most commonly relaxation techniques used in various research disciplines. However, there are also several other hybrid or alternative methods, such as cue-controlled relaxation and cognitive relaxation, which are extensions of these two techniques.

Most of the early evidence for the successful application of relaxation exercises is found in medical research. This is however, not surprising since the relaxation exercises were first developed by medical practitioners as an alternative treatment for several illnesses (e.g. Jacobson, 1938; Benson, 1975). One area where relaxation exercises have been found particularly useful is in the treatment of clinical anxiety. There is substantial evidence that relaxation techniques are highly efficient in reducing the patient's anxiety levels and thus producing long-term health benefits (e.g. Borkovec & Sides, 1979; Bernstein & Borkovec, 1973; Clum et al., 1993; Rasid, & Parish, 1998). In a similar vein, Deffenbacher & Suinn (1982) used relaxation exercises to help treat their outpatients' anxiety levels with success.

In another experiment, Deffenbacher et al. (1990) attributed the ability of patients to control their hostile and aggressive behaviour to the relaxation exercises sessions that the patients undertook. There is also evidence that relaxation exercises are clinically effective in treating headaches. For instance, Blanchard et al. (1979) found that relaxation exercises help to reduce between 40% and 80% of the tension headaches that patients suffered. Similar results were found in studies by Primavera & Kaiser (1992) and Mehta (1992).

Relaxation exercises were also believed to be more effective in controlling mild hypertension (Agras et al,1983). Relaxation exercises alone, however, were not as effective as antihypertensive medication in reducing blood pressure (Jacob et al.,1986). The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure recommended relaxation exercises to be used as treatment for mild hypertension in 1998. In addition, there is evidence that deep-slow breathing can reduce blood pressure without the use of drugs (Deffenbacher et al., 1990).

In a similar vein, relaxation exercises have been successfully used to treat the side effects of cancer therapy, by, for example, decreasing the duration and severity of post treatment nausea (Morrow, 1986). There have also been positive results on the application of relaxation techniques in improving cancer patients' immunization systems (Lekander et al., 1997). Other research areas where relaxation exercises were reported to be effective includes clinical asthma treatment (Vazquez & Buceta, 1993), smoking and substance abuse (Kushner et al., 1990) and Fibromyalgia (Parker, et al., 1998).

Relaxation exercises are also believed to be strongly effective in reducing negative emotions such as stress and depression levels in the work place. For example, Toivanen et al. (1993) studied the relationship between relaxation exercises and depression levels amongst a group of hospital cleaners. During the experiment, which took place over 3 weeks, the subjects were given a 15 minute relaxation session, 3 times a week, conducted by non-qualified trainers. Results from this experiment suggested that relaxation exercises significantly reduced physiological tension, particularly neck-shoulder stress, in the experimental group.

In another study, Tsai & Swanson-Crockett (1993) investigated work stress levels of a group of nurses working in a hospital. In this study, subjects were presented with relaxation exercises twice a week, with each session lasting for 90 minutes. Their stress levels were measured at the end of the first session and at the end of a follow up session 5 weeks after, using a general health questionnaire. The findings revealed that there was indeed a significant decrease in work stress levels observed between the experimental and the comparison groups. They also observed that greater reductions in participants' work stress levels were observed when longer relaxation exercises sessions were administered.

Ortiz & La Grange (2006) conducted a study of the relationship between progressive relaxation techniques (Jacobson, 1938) and the performance of female recreational golfers. There were 18 subjects in the study (9 in both the experimental and the comparison groups) which was conducted over a 3-month period. The dependent variables included the scores per 9-hole round, the number of putts per round, and the number of greens hit in regulation. The level of improvement observed in the experimental group was greater, thus suggesting that progressive relaxation exercises technique appears could enhance female recreational golfers' performance.

5.3 Relaxation exercises in education

We identify three prominent research objectives of studies applying relaxation exercises techniques within the learning environment: improving the students' psychological state, the students' physiological state or the students' academic achievement. While some studies have focused on all three aspects (e.g. Barber, 1982; Matthews,1983; Benson et al., 2000; Deckro et al., 2002), there are also studies which have looked at one or two of the identified objectives (e.g. Johnson, 1982; Britton and Virean, 1999).

Several studies have suggested that there is a positive relationship between relaxation exercises and students' performance within the classroom environment. Barber (1982) reported that relaxation sessions in a college management class led to some academic acceleration, improved morale in students' daily lives. Johnson (1982) found that short term relaxation exercises training improved 6th grade children's spelling scores. The same pattern was observed by Gamble et al. (1982), who studied the effects of relaxation and music upon creativity in adults. They found that the experimental group exposed to both music and relaxation exercises showed the greatest improvement in creativity when compared to the comparison group and the music only experimental group.

Similar outcomes were observed in Matthews' (1983) study. The study consisted of 532 grade seven students in 10 elementary schools who each received 15 minutes of relaxation training every day for a period of nine months. He concluded that there was a positive correlation between relaxation exercises as the independent variable and children's self-concept, discipline and achievements. In another study, Britton and Virean (1999) demonstrated that relaxation and positive affirmation intervention significantly decreased test anxiety in college students. A slightly different approach has been used in a Hollywood school in the USA. They incorporated yoga instruction into the physical education class as a means to ease tension in stressed-out children (Marshall, 2002). It is reported that students in these classes obtained better grades.

More comprehensive experiments which have also lead to encouraging results can be found in several of Benson's and his colleagues' empirical studies. In one experiment, Benson et al. (1994) studied the relationship between a positive psychological characteristic: the student's self-esteem and their perceived locus of control, and relaxation exercises. Using a randomised strategy, students in the experimental group were exposed to a relaxation exercises curriculum which was added to the general health curriculum whereas the comparison group received no relaxation exercises. Exposure to the relaxation exercises curriculum resulted in significant increases in self-esteem and locus of control scores. Furthermore, teachers' observations indicated a high degree of student acceptance of the relaxation exercises training. Hence, it seems that the incorporation of relaxation exercises into the curriculum may be a practical way to increase students' positive psychological attitudes.

In a later experiment, Benson et al. (2000) studied the relationship between the *relaxation response* curriculum and academic achievement amongst middle class students. Teachers were trained to teach the relaxation exercises curriculum and self-care strategies to their students. Four measures of academic outcome were analyzed: grade point average, work habits, cooperation, and attendance. The results of the study showed that students who had more exposure to the relaxation exercises curriculum showed an improvement in their grade point average scores, work habit scores and cooperation scores over the course of a two-year period (Benson et al., 2000).

Benson et al.'s (2000) findings were further explored by Deckro et al. (2002). In their study, they examined the effect of 6 weeks of relaxation exercise intervention on college students' physiological stress and anxiety levels. One hundred and twenty eight students were randomly assigned to an experimental group (n = 63) or a comparison group (n = 65). The experimental group received six 90-minute group training sessions using the *relaxation response* and cognitive behaviour skills. The Symtom-Checklist-90-Revised, Speilberger State-Trait Anxiety inventory, and the Perceived Stress Scale were used to assess the student's psychological state before and after the intervention. Ninety students (70% of the original sample) completed the post assessment measure. The findings of the study suggested that there were indeed significant reductions in psychological distress, state anxiety, and perceived stress between the experimental group and the comparison group.

Recently, there has been an attempt to develop commercial computer-based relaxation exercise software which has produced a positive result (TestEdge, 2003). TestEdge®, has developed the software which integrates positive-emotion focused and relaxation exercises techniques as a way to tackle and improve users' affective state anxiety levels. Results from a three week pilot study amongst groups of high school students, revealed that the students who used the software were observed to record a 35% improvement in math scores and a 14% improvement in reading scores.

Nevertheless, there have also been a substantial number of studies which have produced contrasting results. Stricherz and Stein (1980), for example, investigated the effect of relaxation, relaxation and musical background, a body awareness technique and a guided fantasy technique on a recognition task. They reported that none of these conditions were more effective than the control condition when students were tested after a period of 48 hours. In another study, they found that 12 progressive relaxation exercises sessions over a six week period failed to improve the reading scores among a group of disabled boys.

Using the Jacobson (1938) relaxation method on 48 undergraduate students, Job & Depamo (1991) studied the relationship between relaxation exercises and students' anxiety levels and learning performance. Results from this study revealed that there was no significant difference in anxiety level and learning gain between the control and the experimental groups. In a similar fashion, Gaines (2005) conducted a study to examine computer anxiety and its relationship to four interventions including relaxation exercises. They found that relaxation treatment was ineffective in reducing computer anxiety levels among subjects in the study.

In view of this inconsistency, Felix (1989) has suggested two explanations. Her first argument centred on the non-standardised procedure and the difficulty level of the task. She pointed out that while some of the studies required subjects to do one-off relaxation session (e.g. Depamo & Job, 1991; Gaines, 2005), others have used relaxation exercises in several repeated sessions, which provided extra practice for the subjects (e.g. Barber, 1982; Deckro et al., 2002). Consequently, the latter approach is more likely to produce a better result in improving participants' affective states. This is consistent with the findings by Benson et al. (2000) who pointed out that subjects in their studies enjoyed the benefits of relaxation exercises only after a fair amount of practice.

The second explanation for the difference in outcomes is due to the difficulty or complexity of the tasks. For example, Matthews (1983) looked at a simple recognition task, while others such as Depamo & Job (1991) applied the technique to a more complex and difficult task. It is therefore, plausible that an increase in a task's difficulty impacts on how far the students are able to improve in their learning performance.

A more comprehensive explanation of this issue is offered by the Houston Independent School District (Gaines, 2005). They have identified six potential problems with relaxation exercise studies:

1. There were too few training sessions. Due to this, they argue that the participants were unable to efficiently perform the relaxation session and this had a negative repercussion on the participants' affective states.
2. Little follow-up beyond treatment. They argue that the benefit of the relaxation exercise last only during the treatment session. However, in some of the studies, the measurement of relaxation exercises sessions were taken far beyond the treatment period where the effects of the relaxation exercise has become less valuable.
3. No longitudinal examination of the cumulative effects of different relaxation training strategies used in the relaxation studies.
4. Insufficient description of the relaxation procedure used in the studies. Consequently, without a detailed description, it is hard to draw conclusions

about the relaxation session because different researchers may have provided different treatment under the rubric of the same procedure.

5. Lack of clear rationale for the participants. In some experiments, voluntary participants sometimes felt there was no reason to improve their performance. As a consequence, a certain level of emotional state failed to be elicited and this may also have decreased the effectiveness of relaxation exercises session.
6. Examining the average effect of relaxation exercises of the group rather than the individual within the group. This approach, they argue, meant that the researchers were unable to record important information about how individuals reacted to the relaxation session.

In summary, a substantial amount of research on the application of relaxation exercises across a wide spectrum has been presented. There is significant evidence to support the premise that relaxation exercises can be useful in reducing participants' negative affective state (e.g. Barber, 1982; Matthews, 1983) and in enhancing their academic achievement (e.g. Benson et al., 2000; Deckro et al., 2002). Nevertheless, there are also several studies which report the failure of relaxation exercise in improving participants' affective state or in enhancing their academic achievement (e.g. Stricherz and Stein, 1980; Depamo & Job, 1991).

5.4 Positive affirmation

Burnett (2003) and Sasson (2001) view positive affirmation as positive sentences which are repeated many times in order to transform dysfunctional thinking into positive action. According to Seligman (1991), people who practice positive affirmation will have a greater sense of self-control or self-awareness over their ability and resources. As a result, they are expected to be better in managing their affective state (Gross, 1999; Love, 2005).

Furthermore, Canfield (2006) and Henshaw (2005) have pointed out a further benefit of positive affirmation. They believe that positive affirmation is a powerful tool for building a sense of worthiness and self-concept. In an educational context, the improvement of self-concept has often been associated with better academic achievement. For example, Hansford and Hattie (1982), when analysing 128 experiments involving more than 200,000 participants, concluded that overall that there is a significant positive relationship between self-concept and academic achievement.

In a more recent study using 3100 British participants, David and Brember (1999) found a significant, though weak, positive relationship between self-concept and academic performance. Similar results were also reported by Bowles (1999), whose study has shown that self-concept was correlated at 0.29 with students' most recent semester grades in Mathematics and English. In another study, Rosenberg et al. (1989) also found a significant positive correlation between self-concept and academic grades.

Moreover, empirical studies have been also been conducted on the relationship between positive affirmation and relaxation exercises, and academic achievement. For example, Britton & Virean (1999) found in their study that relaxation and positive affirmation significantly decreased test anxiety amongst the repeat students of the Texas Academic Skills Program Mathematics Laboratory. In another experiment (Penchina & Hoffman, 2001) conducted in 1990 in the US (at the St Clement Elementary School in Somerville, Massachusetts), positive affirmation and relaxation exercises were included in a curriculum called *"I am a good person"*. Students who undertook this curriculum were found to have greater self-concept, better classroom concentration and grade average scores. In a more recent study (Henshaw, 2006), conducted in the US (North Miami Beach, Florida), positive affirmation and relaxation exercises were used as additional techniques to treat addiction. Results showed that those who subscribed to this method reported greater improvement in their self-concept, stayed longer in recovery and had generally a better quality of life.

There have also been a numbers of studies investigating the use of positive affirmation in other areas, in particular in sport science (e.g. Mahoney & Avener, 1977). For example, Finn (1985) and Weinberg (1983) found that positive affirmation reduced anxiety, increased effort, and enhanced self-confidence in sport. In a similar fashion, Brewer et al. (1995) studied the relationship between positive affirmation and dart-throwing task performance. He found that the subject who used positive affirmation performed significantly better. The finding is also supported by another study conducted by Dagrou et al. (1992).

However, there are also studies which have produced contrasting results. Kendall (1984), for instance, found that positive affirmation was not effective in improving personal psychological well-being. The same results were observed in several other studies (e.g. Kendall & Hollon, 1981; Philpot et al., 1995). In a more recent study, Philpot & Bamburg (1996) found the use of positive affirmations failed to increase subjects' self-concepts test scores.

5.5 The components of domain independent strategies

Summing up, we have identified two kinds of domain-independent strategy for the ATS framework: namely relaxation exercises and positive affirmation. The use of domain-independent strategies is hypothesized to help people to improve their state of well-being (Lazarus, 1991; Gross, 1999). As a consequence, they should be able to regulate their affective state better, which would lead to better performance, i.e. academic achievement and problem solving. The literature reveals many positive results of the use of these strategies in improving both the users' affective state and their performance. However, there were also some studies which were unable to confirm this notion.

These results suggested that a cautious approach should be taken when applying and implementing relaxation exercises and positive affirmation strategies as the domain-independent component of the ATS framework environment. The best way to move forward was by conducting exploratory studies. These studies were aimed at exploring and gathering information to increase the likelihood of success when these strategies were integrated into the ATS framework. For this reason, a pilot study using a user-centred approach was appropriate. The idea was that this would enable us to improve our understanding of what a suitable design and approach might be applied within the Malaysian student environment.

Across the literature, upper limb muscles (i.e. neck, shoulder and arms) have been identified as the common body-part effected by computer related-injuries (e.g. Cook et al., 2000; Blatter & Bongers, 2002; Ming et al., 2004; Sharma et al. 2006). Repetitive and extensive computer activities such as typing at the keyboard and dragging the mouse for a long period of time are some of the causes of the upper limb muscle injuries (Cook et. al. 2000; Ming et al., 2004). There are several studies which documented the relationship between the upper limb muscle injuries and the duration of working with a computer. For instance, Hakala et al. (2006) have reported that the frequent use of computer-related activities is a significant contributor for neck-shoulder and low back pain.

In another study, Sharma et al. (2006) observed that 73% of computer related health problems among their subjects were related to upper limb muscles. In a similar fashion, Peper and Gibney (1998) reported that 96.8% of the college students studied reported discomfort in their upper limb muscles (i.e. neck and shoulder and arms) after using a computer for a long period of time. Therefore, in the user centred study, domain independent strategies were developed to tackle the upper limb muscles (i.e. neck and shoulder and arms) problem.

5.6 Testing the domain independent strategies

In the following sections, we present the results of two user-centered design studies conducted within a Malaysian student environment. The participants were students from the Collage of Computer Science and Information Technology, University Tenaga Nasional, Malaysia.

5.7 User centred design – study one

This study was conducted over a period of two weeks. Eight undergraduate students volunteered to participate and were not paid. At the end of the experiment, an interview was conducted.

5.7.1 Objective

The aim of this experiment was to investigate the following issues:

a) To invite feedback on the experimental design of the ATS framework.
b) To receive feedback on the suitability of the relaxation exercises and positive affirmation audio within a Malaysian learning environment.
c) To investigate any change in students' affective state before and after the lesson.

5.7.2 Material

The PANAS questionnaire was used to measure subjects' positive and negative affective states at the beginning and by the end of the learning session. The learning materials were questions which were taken from the author's data structure teaching bank. These materials were similar to those used in the first exploratory study (see Chapter 3 for details).

The domain-independent materials were adapted from the *progressive muscles relaxation* (Jacobson, 1938) and the *relaxation response* (Benson, 1975). However, in order to suit the ATS learning environment, a number of modifications to these techniques had to be made. For example, a shorter version of the Jacobson's technique was used which concentrated only on the upper limb muscles. Likewise, a shorter version of the Benson's relaxation response for the positive affirmation strategy was used. A sample of the domain-independent strategies script can be found in Appendix C.

5.7.3 Procedure

At the beginning, the participants were asked to answer the paper-based PANAS questionnaire followed by listening to a narrated relaxation exercises audio.

Subsequent to the relaxation exercise, participants were required to select two of their preferred lessons from the four Data Structure topics available before they started working with their first preferred lesson. To support their learning, materials such as lecture notes and examples were provided.

Immediately after completing the lesson, each participant was required to submit their answers to a tutor. While their answers were checked, the participants were presented with the narrated relaxation exercises audio again. This relaxation exercise could be repeated on the participant's request.

After the relaxation exercise session, participants engaged in a discussion with their tutor. During the discussion, the tutor explained which error(s) the participants made and provided suggestion(s) on how to correct the error(s). After this, participants were asked to do the correction(s) and resubmit their answer. The cycle of submission, discussion and resubmission activities continued until they finished the entire lesson.

Upon completion of the lesson, participants were required to self report their state of well-being again using the same PANAS questionnaire. This was followed by an interview. The experimental design of this study is summarized in Figure 5-1 below.

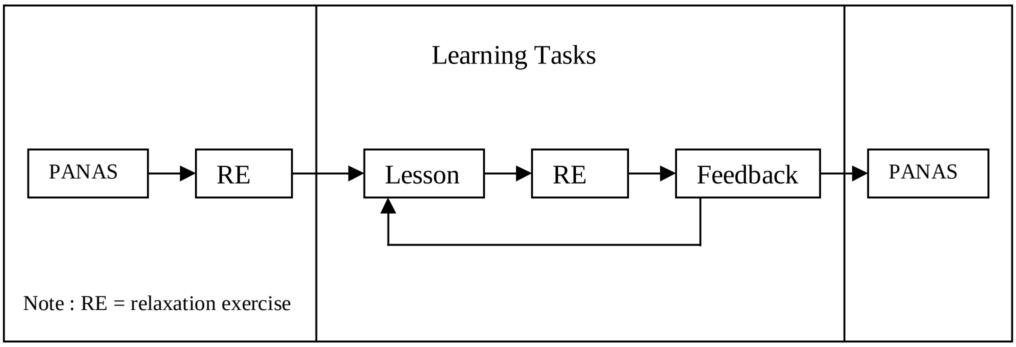


Figure 5-1: The experimental design of the study

5.7.4 Results

This section presents the results from the study. It is aimed to shed light on the three research issues raised in section 5.7.1.

b) Was the sequence of the procedure appropriate?

Generally, participants were happy with the sequence of the experimental tasks presented in the experiment. However, there were a few constructive comments made by the students about the experimental set up, which are summarised as follows:

1. Most of the participants commented on the need for a relaxation exercise training session. Without the session, they struggled to follow the narrated instruction. For example, they struggled to learn how to breathe correctly and how to carry out the relaxation exercises. Their comments were consistent with the literature review across a numbers of research areas. Researchers (e.g. Felix, 1989; Gaines, 2005) had attributed the lack of a training session as one of the major factors contributing to the failure of the relaxation exercise studies. In fact, there is evidence that a longer training session contributes to the effectiveness of a relaxation exercise regime in clinical studies (e.g. Groden et al., 1984).
2. Initially, the audio was designed to be played before the submission of students' answers. However, based on students' feedback, most of them preferred to do the exercises only after they had submitted their answers.
3. Some students suggested that the relaxation exercises were not practical for students when they were doing corrections.

c) Were the relaxation exercises and positive affirmation audio appropriate within Malaysian students' environment?

In general, participants gave positive feedback on the use of the relaxation exercises during the lesson as a means of helping them to manage their affective state. Nevertheless, there were constructive comments that should be taken into account in order to improve the system:

1. Level of loudness. Some students felt the background sound used in the audio was too loud. There was also a suggestion that a female narrator's voice should be used.
2. The duration of the exercises. Some students felt that the duration of these muscle exercises was too long. Some of them complained that the lengthy exercises had distracted them from focusing on learning.
3. A few students commented on the pace and the clarity of the instruction. They felt it would be better if the narrated audio was not so fast. They also suggested that their failure to follow the instruction was due to the lack of training.

d) Were there any changes in the students' affective state before and after the experimental tasks?

Table 5-1: Students' affective state at the beginning and by the end of the experiment as measured by the PANAS questionnaire

Student Affective State	**At the beginning (mean)**	**By the end (mean)**	**Analysis**
State of well-being	0.85 (SD 0.74)	1.74 (SD = 0.52)	Increased

Using the *well-being* formula (Eq. 4.1- see Chapter 4), student's affective state was measured both at the beginning and by the end of the learning. Results from the analysis indicate that the students' state of well-being increased by the end of the lesson (Table 5-1). However, due to small sample size (8 students), no-significant difference in the state of well-being was observed between the two learning.

5.7.5 Discussion

Generally, participants gave positive feedback on the experimental design of the ATS framework. There was also encouraging feedback on the use of the relaxation exercise session in improving participants' affective states. Despite this positive feedback, several weaknesses with regard to the relaxation exercise session were noted. The absence of a training session was the most noteworthy comment observed.

There is evidence that students who undertook this experiment had a better state of well-being by the end of the experiment. This provided some support for the usefulness of the ATS framework in improving a subject's state of well-being. Yet, these results need to be treated with caution. Although the participants who undertook the lesson reported improvement in their state of well-being, there is no evidence to suggest a positive causal relationship between the use of the domain-independent strategies and the improvement in the participants' state of well-being. This is in part due to the absence of a comparison group. For example, it might have been that doing the Data Structures exercises themselves that improved the participants' state of well-being.

5.8 User centred design study two

The study was completed over the course of a week. Five unpaid volunteer students participated in this study. These were students from the College of Computer Science and Information Technology, University Tenaga Nasional, Malaysia. At the end of the experiment, the participants were interviewed.

5.8.1 Objective

The objectives of the experiment were as follows:

a) To invite feedback on the prototype system.
b) To receive feedback on the use and the effectiveness of the positive affirmation audio when presented to the students during their learning session.

5.8.2 Material

For the purpose of this study, a computer-based tutorial system was developed that catered for only the *recursive* topic (see Figures 5-2 and 5-3). The learning materials used were identical to those used in the previous paper-based study. Student's answers for the *recursive* topic were classified into three categories: namely correct, minor error and major error as shown in Table 5-2.

Table 5-2: The classification of students' answers for the recursive topic

Question	Correct Answer	Minor Error	Major Error
1	SumOfNumbers	SumOfnumbers	Others
		sumofnumbers	
		Sumofnumbers	
		SumOf	
		SumofNums	
2	n	N	Others
		X	
		x	
		int	
		int X	
3	1	20	Others
		0	
4	1	20	Others
		0	
5	SumOfNumbers	SumOfnumbers	Others
		sumofnumbers	
		Sumofnumbers	
		SumOf	
		SumofNums	
6	x-1	X+1	Others
		x+1	
		N	
		N-1	
		N+1	
		n-1	
		X+1	
		x+1	
		int x	
		int n	

A positive affirmation audio was created corresponding to the quality of student's answer as summarized in Table 5-3.

Table 5-3: The positive affirmation phases and the corresponding answer category

Student's answer category	Positive affirmation phrase
Correct answer	Well done
Minor error	Never mind, keep on trying
Major error	Never mind, I know you can do it

5.8.3 Procedure

The participants were required to begin work on the recursive questions using the prototype system. To assist with their learning, materials such lecture notes and examples were provided. However, unlike the first study, students' answers were automatically evaluated by the system, and therefore they received feedback instantly. The feedback, which is considered as a domain-dependent strategy, comprised the identification of the potential error(s) and suggestions about how to correct the error(s) as shown in Table 5-4.

In addition, as the domain-independent strategies, they were offered a positive affirmation audio which was based to the quality of student's answer. The cycle of evaluating the answers, presenting the feedback and the positive affirmation phase were repeated until they got all questions correct. Examples of the interactions are shown in Figure 5-3. At the end of the study, during the interview session, participants were asked to give their comments on the evaluation, the error(s) suggestions and the positive affirmation design.

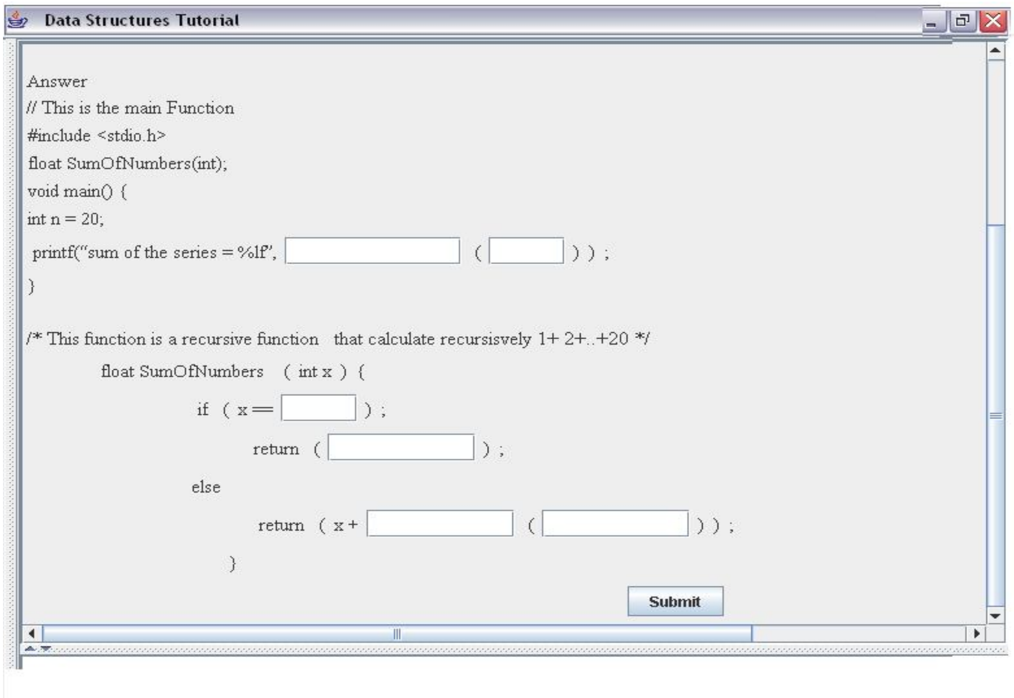


Figure 5-2: The prototype's main page

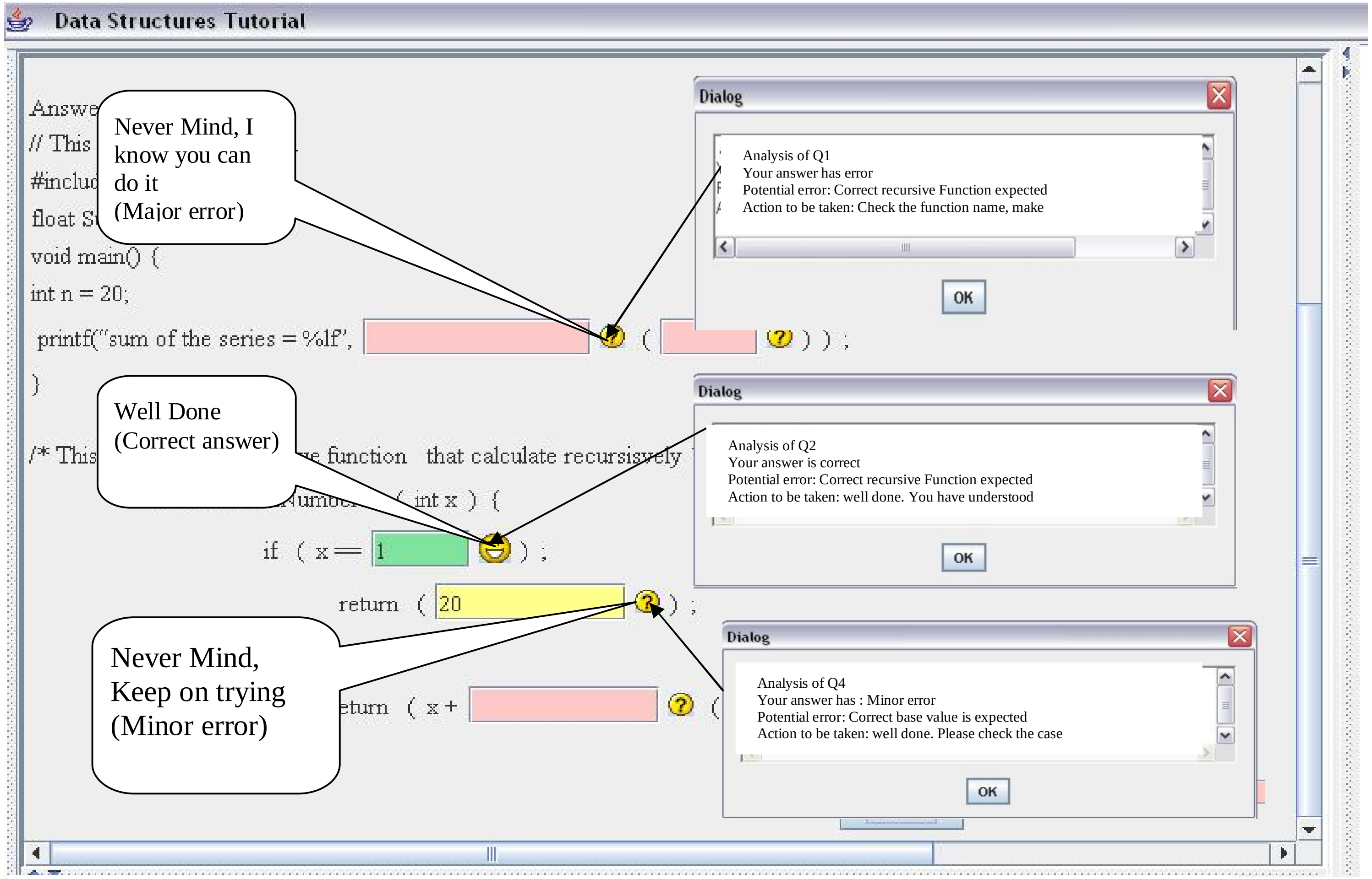


Figure 5-3: Example of the interactions

Question	Classification of answers	Phrase used
1	Correct answer	***Suggestion:*** Well Done. You have understood the recursive concept
	Minor error	***Potential error**:* Correct function was expected.
		***Suggestion**:* Make sure you called the correct function name
	Major error	***Potential error**:* Correct recursive function expected
		Suggestion: Check the function declaration, Make sure you have called the right function
2	Correct answer	***Suggestion:*** Well Done. You have understood the recursive concept
	Minor error	***Potential error**:* Correct variable was expected.
		Suggestion: Please check the assignment of variable used in the function
	Major error	***Potential error**:* Correct parameter was expected.
		Suggestion: Check the parameter of the function, Make sure you have referred to the valid parameter
3	Correct answer	***Suggestion:*** Well Done. You have understood the recursive concept
	Minor error	***Potential error**:* Correct case base value was expected.
		Suggestion: Please check the case base criterion
	Major error	***Potential error**:* Correct case base criterion was expected.
		Suggestion: Check the case base criterion; refer to what is a case base criterion note
4	Correct answer	***Suggestion:*** Well Done. You have understood the recursive concept
	Minor error	***Potential error**:* Correct case base value was expected.
		Suggestion: Please check the case base value again
	Major error	***Potential error**:* Correct case base value was expected.
		Suggestion: Please recheck the case base return value again , refer to how to identify a case base condition note
5	Correct answer	***Suggestion:*** Well Done. You have understood the recursive concept
	Minor error	***Potential error**:* Correct function name was expected. Please check the name of the function again
		Suggestion: Please check the name of the function again
	Major error	***Potential error**:* Correct recursive call was expected.
		Suggestion: Please check the function name again, refer to how to call the same function recursively note.
6	Correct answer	***Suggestion:*** Well Done. You have understood the recursive concept
	Minor error	***Potential error**:* Correct parameter that narrows the recursive scope was expected
		Suggestion: Please recheck the recursive function parameters again
	Major error	***Potential error**:* Correct parameter that narrows the recursive scope was expected
		Suggestion: Please ensure the recursive function parameters are correct, 'how to call develop a recursive solution" note.

Table 5-4: The potential error phrases and the suggestions as corresponding to a students' answer

5.8.4 Results and Discussion

a. Participant 1 (female, average student)

She was happy with the experimental set-up. She felt that the prototype system had improved her understanding of recursion. However, she commented on the phrases used in the feedback from the system. For instance, she suggested the use of the phrase "*Please refer to note 2.1 tracing*" instead of the phrase "*Refer to the note on how to trace a recursive solution*".

b. Participant 2 (male, good student)

He got all answers correct at the first attempt. He did not comment much on the phrases used in the feedback. He felt that the use of the audio had little impact on his state of well-being, although in general, to him this experimental task was well designed.

c. Participant 3 (male, average student)

To him, the use of audio in the domain-independent strategies was helpful in uplifting his affective state. He had no complaint about the sequence of the experimental procedure. He commented only on the use of some phrases which he thought were unclear. For instance, he suggested using the phrase "*Make sure you called the correct function name*" to replace the phrase "*please check the parameter used in the recursion*".

d. Participant 4 (female, average student)

In her comments, she said that the use of the domain-independent strategy was helpful in improving her negative affective state. However, she commented that some of the feedback had caused confusion. She suggested that more examples should be provided to the students before the learning session.

e. Participant 5 (male, a weak student)

In the interview, he said that the use of the domain independent strategy was very helpful to him to improve his negative affective state. As a weak student, he took the longest time to complete the experiment and he had to resubmit his answers more than three times. When asked about the feedback given, he said that some of the comments were unclear and he found it difficult to understand what was wrong with his answers. His suggestion was to clarify the phrases used in the feedback given to the students. Although he was the weakest of the students, he was very happy at the end of the experiment because he felt he had gained a lot from the system.

5.9 Conclusion

This section has set out the reasons for including relaxation exercises and a positive affirmation statement as the two domain-independent strategies used in the ATS framework. Two studies were deployed as to explore the suitability of the domain-independent strategies within an ATS environment. Results from the studies provide preliminary evidence that the relaxation exercise can improve students' state of well-being. Finally the feedback, comments and suggestion received from these studies were used in the formulation of the ATS framework reaction phase which will be discussed in Chapter 6.

Chapter 6

ATS Reaction phase

The formulation of the ATS framework which includes appraisal and reaction phases was presented in Chapter 3. In the following chapter (Chapter 4), the justification and rationale of the approaches and strategies used in the ATS appraisal phase were discussed. This chapter focuses on the reaction phase of the ATS framework. There are two reaction phases in ATS framework; namely the primary and secondary reaction phases. The primary reaction is carried out before the start of a lesson (i.e. after primary appraisal) and the secondary reaction phase is conducted at the end of a lesson (i.e. after secondary appraisal).

In line with individual coping theory (Lazarus, 1991) and emotion regulation theory (Gross, 1999), results of the preliminary study indicated that the Malaysian students used both domain dependent and domain independent strategies as their coping strategies when dealing with difficult learning events (Chapter 3). The current chapter is organised according to the students' coping strategies. First, a discussion of the approach and method used to model domain-dependent strategies at the primary and the secondary reaction phase is presented and this is followed by a discussion of the domain-independent strategies.

6.1 Domain-dependent strategies within the ATS framework environment

Domain-dependent strategies, according to Lazarus (1991), are attempts to deal with the cause of the problem through direct activities or strategies such as analysing the problem in detail and making a plan of action. Likewise, Gross (1999) refers to domain-dependent strategies as attempts to understand the situation which include attempts to resolve the cause of the problem within the domain. Successful outcomes of these strategies may improve the individual's affective state.

6.1.1 Primary reaction phase

The provision of examples of questions and their solutions is the domain-dependent strategy used before the start of a lesson (primary reaction). These materials were aimed at aiding students to prepare for their lesson and improve their mastery level. According to Bandura (1997), the improvement of students' mastery level is believed to improve their confidence level and hence make the students feel better (i.e. increases the student's state of well-being). An example of a screenshot of this approach is presented below (Figure 6-1).

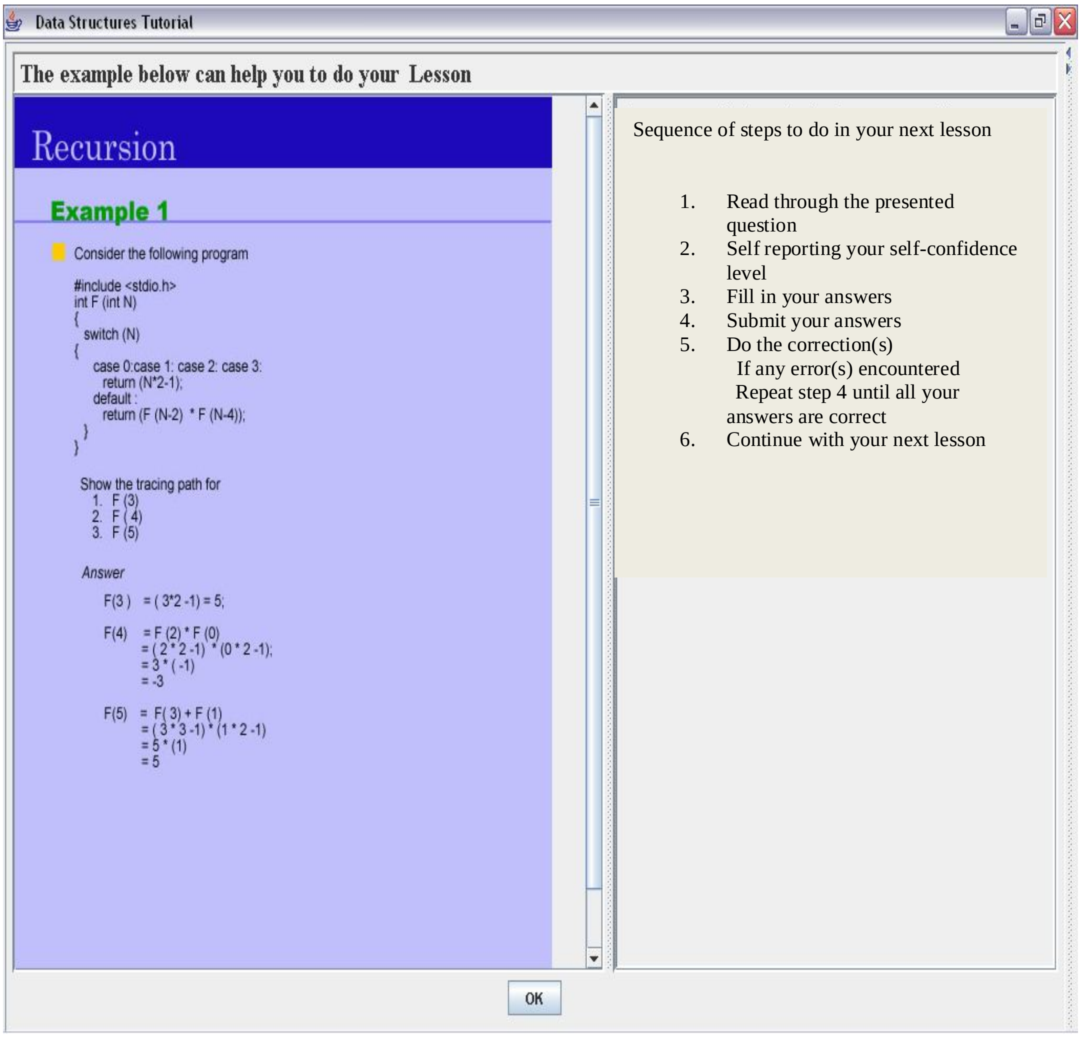


Figure 6-1: Example of a question and solution provided to student before the start of a lesson

6.1.2 Secondary reaction phase

There are three kind of the domain-dependent strategies used within the ATS framework at the secondary reaction phase as follows:

a) The analysis of the answer to each question from the lesson after each submission.

   Students' answers are analysed and categorised into one of three categories: answer with a major error, answer with a minor error, or the correct answer. To help students to debug their code, the ATS framework provides feedback which describes potential error(s) and suggestion(s) of what action should be taken to solve the problem, see Figure 6-2 below. (See appendix 6-1 for a complete description of the learning materials)

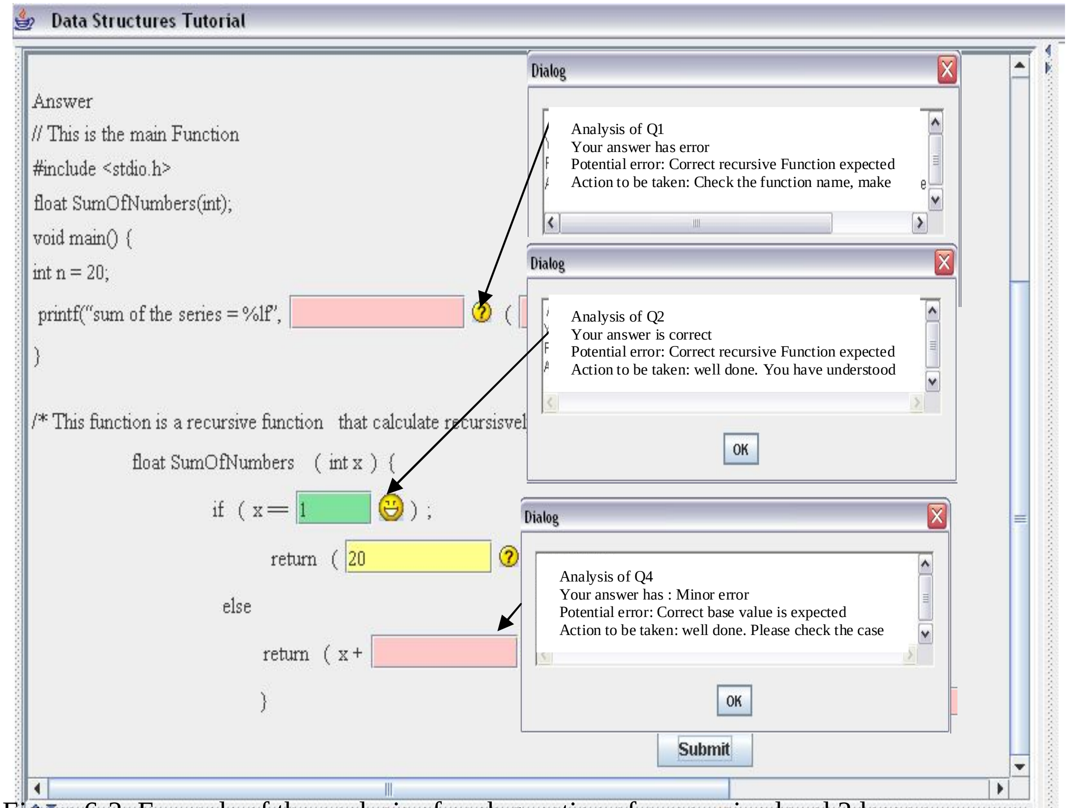


Figure 6-2: Example of the analysis of each question of a recursive level 2 lesson

b) The provision of lecture notes and examples of program code

In order to assist students, the ATS framework provides lecture notes and example code. Students can request the notes and examples of program code at any time throughout the session. Examples of the interfaces are presented in Figure 6-3 and Figure 6-4 below.

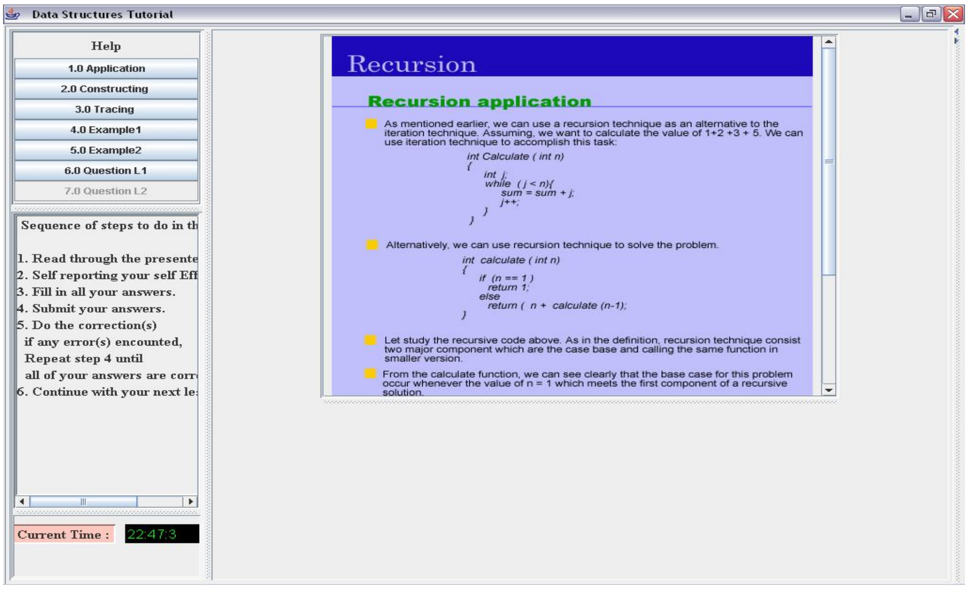


Figure 6-3: Example of lecture notes provided within the ATS environment

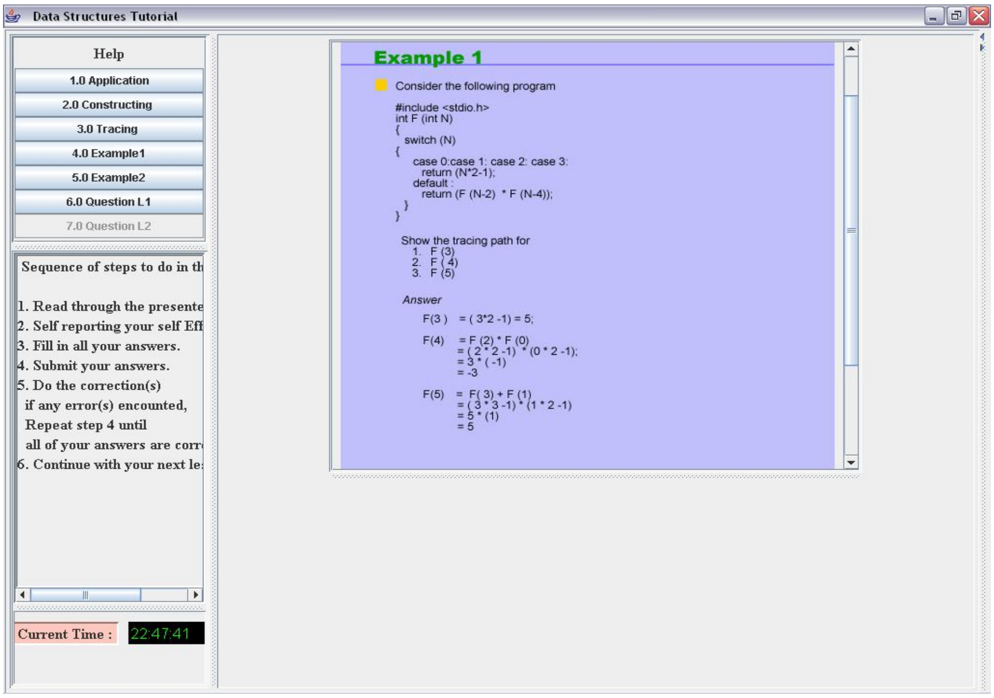


Figure 6-4: Example of program code provided within the ATS environment

c) The organization of a student's next task which adapts to the student's state of well-being.

By the end of each lesson, a student's state of well-being is appraised by the system on a scale of -3 to 3 (see Chapter 4 for details). In order to simplify the reaction process, this scale of well-being is divided into two ranges: high and low level (Figure 6-5). A student is considered to be in a state of high positive well-being when his well-being score is higher than 1.5 and low otherwise. Similarly, a student with well-being score below than -1.5 is considered to be in a state of high negative well-being and low otherwise.

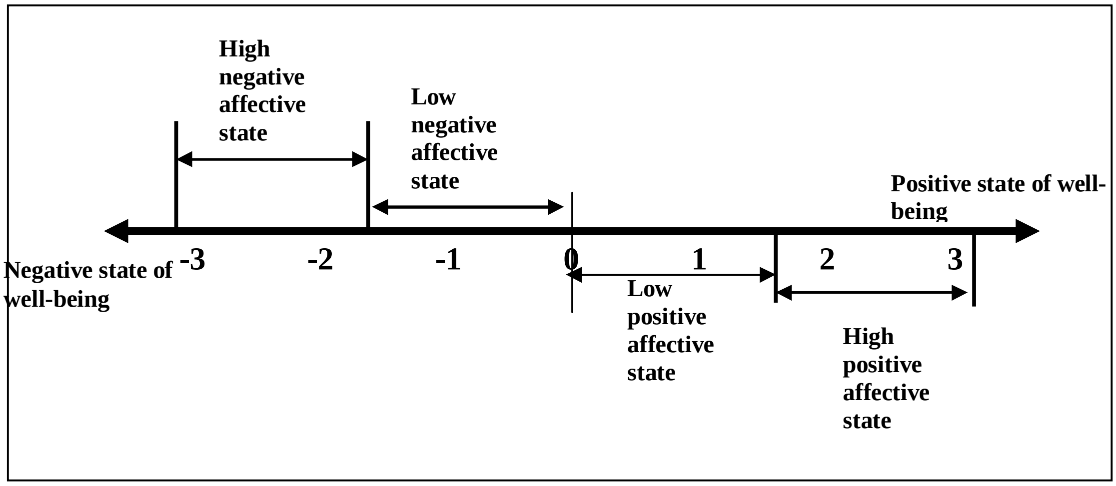


Figure 6-5: The classification of students' states of well-being in the secondary reaction phase

A student who is considered to be in a state of high positive well-being is offered a more challenging task as his next lesson. By contrast, a student who is inferred to be in a state of low negative well-being state is advised to redo the same task again. The adaptive strategies for the student's state of well-being are presented in Table 6-1 and Table 6-2 respectively.

Table 6-1: Adaptive strategies for students who are appraised to be in a state of positive well-being

<table>
<tr><th>Current Affective State</th><th>Current lesson level</th><th>Adaptive strategies</th></tr>
<tr><td>Positive well-being state (High)</td><td>Level 2</td><td>1. To do a more challenging task according the following rules
<table>
<tr><th>Current Level</th><th>Suggested Level</th></tr>
<tr><td>Tree Level 2</td><td>Stack Level 2</td></tr>
<tr><td>Stack Level 2</td><td>Tree Level 2</td></tr>
<tr><td>Linked List Level 2</td><td>Tree Level 2 or Stack Level 2</td></tr>
<tr><td>Recursive Level 2</td><td>Linked List Level 2 or Tree Level 2 or Stack Level 2</td></tr>
</table>
2. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
<tr><td>Positive well-being state (High)</td><td>Level 1</td><td>1. to do a more difficult task according the following rules
<table>
<tr><th>Current Level</th><th>Suggested Level</th></tr>
<tr><td>Tree Level 1</td><td>Stack Level 1</td></tr>
<tr><td>Stack Level 1</td><td>Tree Level 1</td></tr>
<tr><td>Linked List Level 1</td><td>Tree Level 1 or Stack Level 1</td></tr>
<tr><td>Recursive Level 1</td><td>Linked List Level 1 or Tree Level 1 or Stack Level 1</td></tr>
</table>
2. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
<tr><td>Positive well-being state (Low)</td><td>Level 2</td><td>1. to do a more difficult task according the following rules
<table>
<tr><th>Current Level</th><th>Suggested Level</th></tr>
<tr><td>Tree Level 2</td><td>Stack Level 1</td></tr>
<tr><td>Stack Level 2</td><td>Tree Level 1</td></tr>
<tr><td>Linked List Level 2</td><td>Tree Level 1 or Stack Level 1</td></tr>
<tr><td>Recursive Level 2</td><td>Linked List Level 1 or Tree Level 1 or Stack Level 1</td></tr>
</table>
2. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
<tr><td>Positive well-being state (Low)</td><td>Level 1</td><td>1. To do a more difficult task according the following rules
<table>
<tr><td>Current Level</td><td>Suggested Level</td></tr>
<tr><td>Tree Level 1</td><td>Tree Level 2</td></tr>
<tr><td>Stack Level 1</td><td>Stack Level 2</td></tr>
<tr><td>Linked List Level 1</td><td>Linked List level 2</td></tr>
<tr><td>Recursive Level 1</td><td>Recursive level 2</td></tr>
</table>
2. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
</table>

Table 6-2: Adaptive strategies for students who are appraised to be in a state of negative well-being

<table>
<tr><th>Current Affective State</th><th>Current lesson level</th><th>Adaptive strategies</th></tr>
<tr><td>Negative well-being state (High)</td><td>Level 2</td><td>1. To do an easier task according the following rules
<table>
<tr><th>Current Level</th><th>Suggested Level</th></tr>
<tr><td>Tree Level 2</td><td>Tree Level 1</td></tr>
<tr><td>Stack Level 2</td><td>Stack Level 1</td></tr>
<tr><td>Linked List Level 2</td><td>Linked List Level 1</td></tr>
<tr><td>Recursive Level 2</td><td>Recursive Level 1</td></tr>
</table>
2. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
<tr><td>Negative well-being state (High)</td><td>Level 1</td><td>1. to do an easier task according the following rules
<table>
<tr><th>Current Level</th><th>Suggested Level</th></tr>
<tr><td>Tree Level 1</td><td>Linked list level 1 or Recursive Level 1</td></tr>
<tr><td>Stack Level 1</td><td>Linked list level 1 or Recursive Level 1</td></tr>
<tr><td>Linked List Level 1</td><td>Recursive Level 1</td></tr>
<tr><td>Recursive Level 1</td><td>Recursive Level 1</td></tr>
</table>
2. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
<tr><td>Negative well-being state (Low)</td><td>Level 2</td><td>1. To continue working on the current lesson with 5 extra minutes and 3 more attempts.
2. Gives the explanation on the error(s) and provide suggestion(s) on how to solve the problem.
3. Provides an example of program code at the suggested level (to increase the likelihood of the student producing the correct answers)</td></tr>
<tr><td>Negative well-being state (Low)</td><td>Level</td><td>1. To continue working on the current lesson with 5 extra minutes and 3 more attempts.
2. To give the explanation on the error(s) and provide suggestion(s) on how to solve the problem.</td></tr>
</table>

6.2 Domain-independent strategies within the ATS environment

Bandura (1997) asserts that an active approach is more effective in improving students' self-confidence and their affective state. Within the tutoring context, students should be allowed to have more control over the emotion regulation process by allowing them to stop, repeat or quit the relaxation exercise session as they wish.

Although these features were available within the ATS system, the students of the pilot and main studies (described in Chapters 8 and 9) were not allowed to use them. Rather, they were required to finish the complete cycle of the relaxation session so that they all were presented with a similar domain-independent strategy. This allowed a reliable comparison to be carried out on the effect of the relaxation exercise sessions on the students. Furthermore, in order to improve the efficiency of the session, students are presented with a background of relaxing scenery. A snapshot of the relaxation session interface is shown in Figure 6-6

Figure 6-6: Relaxation therapy interface

6.2.1 Primary reaction phase

The ATS reaction phase uses a generic relaxation therapy (i.e. primary relaxation therapy) for all students before the start of a learning session. It concentrates on the use of a breathing exercise and positive affirmation techniques which were believed to improve the student's affective state. The script of the primary relaxation therapy is presented below.

> **"Make yourself as comfortable as possible** [pause for a few seconds]**, gently** [pause for a few seconds]**, close your eyes,** [pause for few seconds]**, feeling yourself relax,** [pause for a few seconds] **and more relaxed,** [pause for a few seconds]**. Now, take a deep breath,** [pause for a few seconds]**, breath in,** [pause for a few seconds]**, breath out,** [pause for a few seconds]**, again,** [pause for a few seconds], **breath in,** [pause for a few seconds], **breath out** [pause for a few seconds] **feeling the air slowly and deeply going through your nose,** [pause for a few seconds]**, enjoy the great feeling of relaxation,** [pause for a few seconds]**, relax,** [pause for a few seconds]**, relax,** [pause for a few seconds]**, relax,** [pause for a few seconds]**.**
>
> **As you stay calm and focused,** [pause for a few seconds], **you are going to find,** [pause for a few seconds], **you have the ability to produce your best performance on your coming lesson, because,** [pause for a few seconds], **I know you can do it,** [pause for a few seconds]**, say I can do it,** [pause for a few seconds], **yes you can do it!"**

6.2.2 Secondary reaction phase

The domain-independent secondary reaction phase classifies the student's affective state into two categories (i.e. in a state of positive well-being or in a state of negative well-being). Positive affirmation and breathing exercises techniques are deployed at the beginning of the secondary reaction phase (i.e. after the secondary appraisal phase has been completed). These positive affirmation statements are aimed at improving the students' state of well-being. A student believed to be in a state of positive well being is presented with the following statement:

"***Well done, you are doing great, as to keep up your momentum and make yourself relaxed, how about taking the relaxation exercise now?.***"

By comparison, a student believed to be in a state of negative well-being is presented with the following statement:

"Never mind, I know you can do it, I think it is a good time for you to take a break, how about doing the relaxation exercise now?"

[Note that the content of the affirmation statements was adjusted slightly from that used in the initial user studies]

Subsequently, students are presented with a secondary relaxation therapy session. Unlike the primary relaxation therapy, the secondary relaxation therapy uses muscle relaxation techniques in addition to breathing exercises and positive affirmation. There were two versions of the secondary relaxation therapy developed to suit either the students who are believed to be in a state of positive or those in a state of negative well-being. Although the scripts are slightly different, both are designed to relax the same body parts, the upper limb muscles. A student believed to be in a state of positive well-being is presented with the following relaxation therapy script:

“Make yourself as comfortable as possible [pause for a few seconds], **gently** [pause for a few seconds]**, close your eyes,** [pause for a few seconds]**, feeling yourself relax,** [pause for a few seconds] **and more relax,** [pause for a few seconds]**. Now, take a depth breath,** [pause for a few seconds]**, breath in,** [pause for a few seconds]**, breath out,** [pause for a few seconds]**, again,** [pause for a few seconds], **feeling the air slowly and deeply going through your nose,** [pause for a few seconds]**, enjoy the great feeling of relaxation,** [pause for a few seconds]**, relax,** [pause for a few seconds]**, relax,** [pause for a few seconds]**, relax,** [pause for a few seconds]**.**

Now, [pause for a few seconds], **gently,** [pause for a few seconds]**, tilt your head to your left shoulder,** [pause for a few seconds]**, hold it for a moment,** [pause for a few seconds], **let the tension go,** [pause for a few seconds]**, relax,** [pause for a few seconds], **now slowly roll over to your right side,** [pause for a few seconds], **hold it** [pause for a few seconds], **relax,** [pause for a few seconds], **relax,** [pause for a few seconds]**,finally, lift your head up to its natural position,** [pause for few seconds], **and feel the tension away,** [pause for few seconds]**, as you become relaxed,** [pause for few seconds]**, and more relaxed,** [pause for few seconds],

As your stay calm and your tension drained away, [pause for a few seconds]**, you are going to find,** [pause for a few seconds], **you have the ability to produce your best performance,** [pause for a few seconds]**, say I believe I can do it,**[pause for a few seconds], **again** [pause for a few seconds], **I can do it,** [pause for a few seconds], **yes you can do it ..”**

And a student believed to be in a state of negative well-being is presented with the following script:

> **“Make yourself as comfortable as possible** [pause for a few seconds]**, gently** [pause for a few seconds]**, close your eyes,** [pause for few seconds]**, feeling yourself relax,** [pause for a few seconds], **and more relax,** [pause for a few seconds]**. Now, take a depth breath,** [pause for a few seconds], **breath in,** [pause for a few seconds]**, breath out,** [pause for a few seconds], **again,** [pause for a few seconds], **feeling the air slowly and deeply going through your nose,** [pause for a few seconds]**, enjoy the great feeling of relaxation,** [pause for a few seconds]**, relax,** [pause for a few seconds]**, relax,** [pause for a few seconds]**, relax,** [pause for a few seconds]**.**
>
> **Now,** [pause for a few seconds], **Bring your shoulder up to as high as you can,** [pause for a few seconds], **hold it for a few moment,** [pause for a few seconds],**now release it gently and slowly,** [pause for a few seconds], **feel the heaviness of the muscles,** [pause for a few seconds], **as the tension drains away,** [pause for a few seconds], **and you become relaxed,** [pause for a few seconds], **and more relaxed,** [pause for a few seconds].
>
> **Again,** [pause for a few seconds], **Bring your shoulder up to as high as you can,** [pause for a few seconds], **hold it for a few moment,** [pause for a few seconds],**now release it gently and slowly,** [pause for a few seconds], **feel the heaviness of the muscles,** [pause for a few seconds], **as the tension drains away,** [pause for a few seconds], **and you become relaxed,** [pause for a few seconds], **and more relaxed,** [pause for a few seconds].
>
> **As your stay calm and your tension drained away,**[pause for a few seconds]**, you are going to find,** [pause for a few seconds], **you have the ability to produce your best performance,** [pause for a few seconds]**,because you are a fighter,** [pause for a few seconds]**, you can do it better this time,** [pause for a few seconds]**, say,** [pause for a few seconds], **I’m fully confident I can do it better this time,** [pause for a few seconds] **Yes, you can do it.”**

6.3 Conclusion

In this chapter, the specific domain-dependent and domain-independent strategies within the ATS reaction phases have been presented. These domain-dependent and domain-independent strategies were used as the foundation of the ATS system. The overall ATS system is presented in the following chapter.

Chapter 7

ATS System

This chapter presents an overview of the ATS system that implements the results gathered from the studies discussed in Chapters 4 and 6. This includes an overall flowchart and activities for each of the ATS framework stages. Furthermore, examples of interaction snapshots of the ATS system are also presented.

7.1 Overview of the ATS system

The ATS system was developed in Java using Eclipse version 3.1 and was compiled using Java 1.4.2. It took 6 months (Nov 2005 until April 2006) to complete the system. In total, there were 183 classes and 3 abstract classes in the ATS system. The complete list of the classes is presented in Appendix H.

7.2 The overall structure of the ATS system's interactions with the students

In general, the ATS interactions consist of seven activities presented in the following flowchart (Figure 7-1).

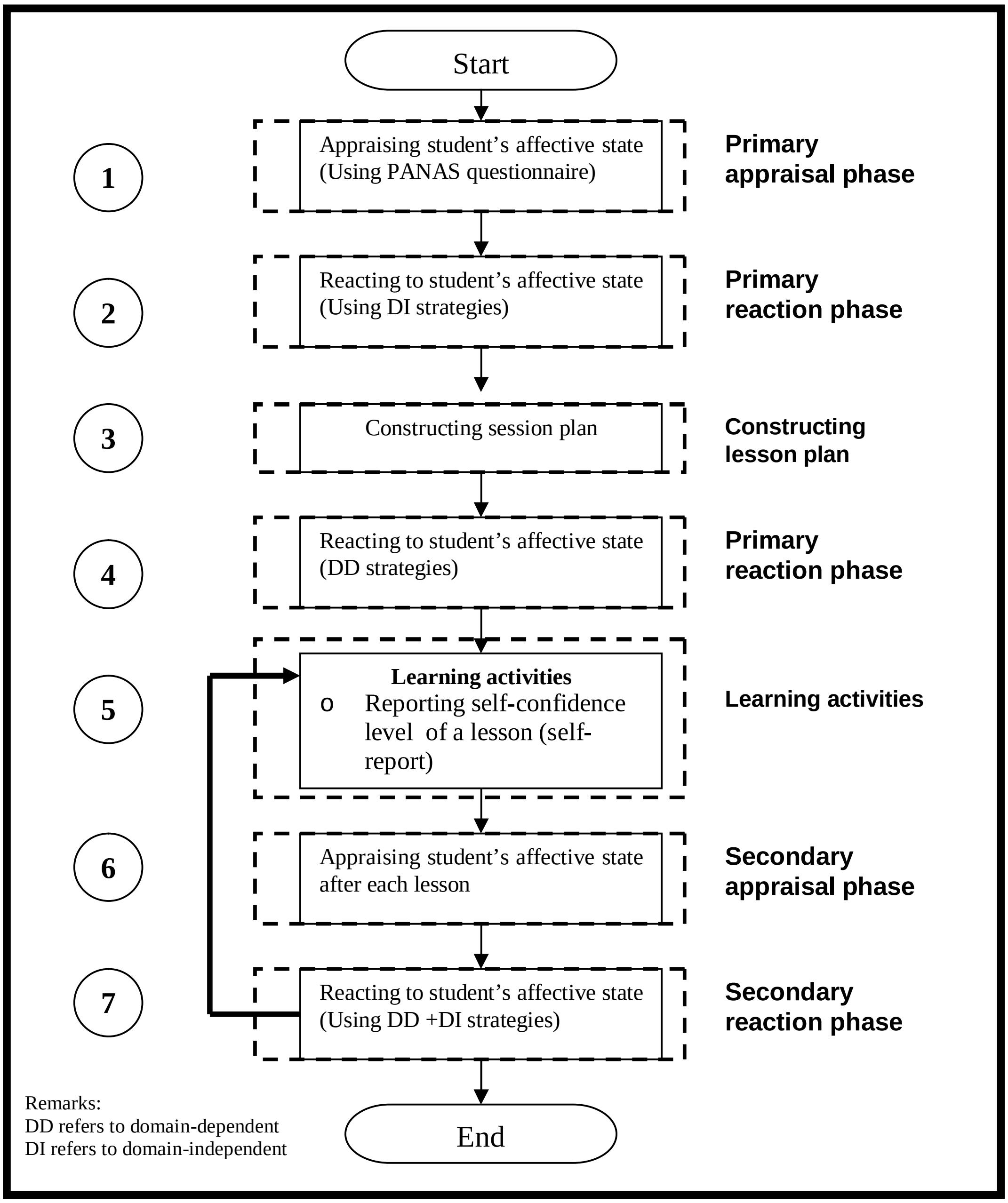


Figure 7-1: Flowchart of the ATS framework activities

7.3 Primary appraisal phase

Before the start of a lesson, the student's state of well-being is appraised based on the PANAS positive and negative components. An example of the interface for the PANAS questionnaire is shown in Figure 7-2. Readers are referred to Section 4.2 of Chapter 4 for the details of the appraisal mechanism.

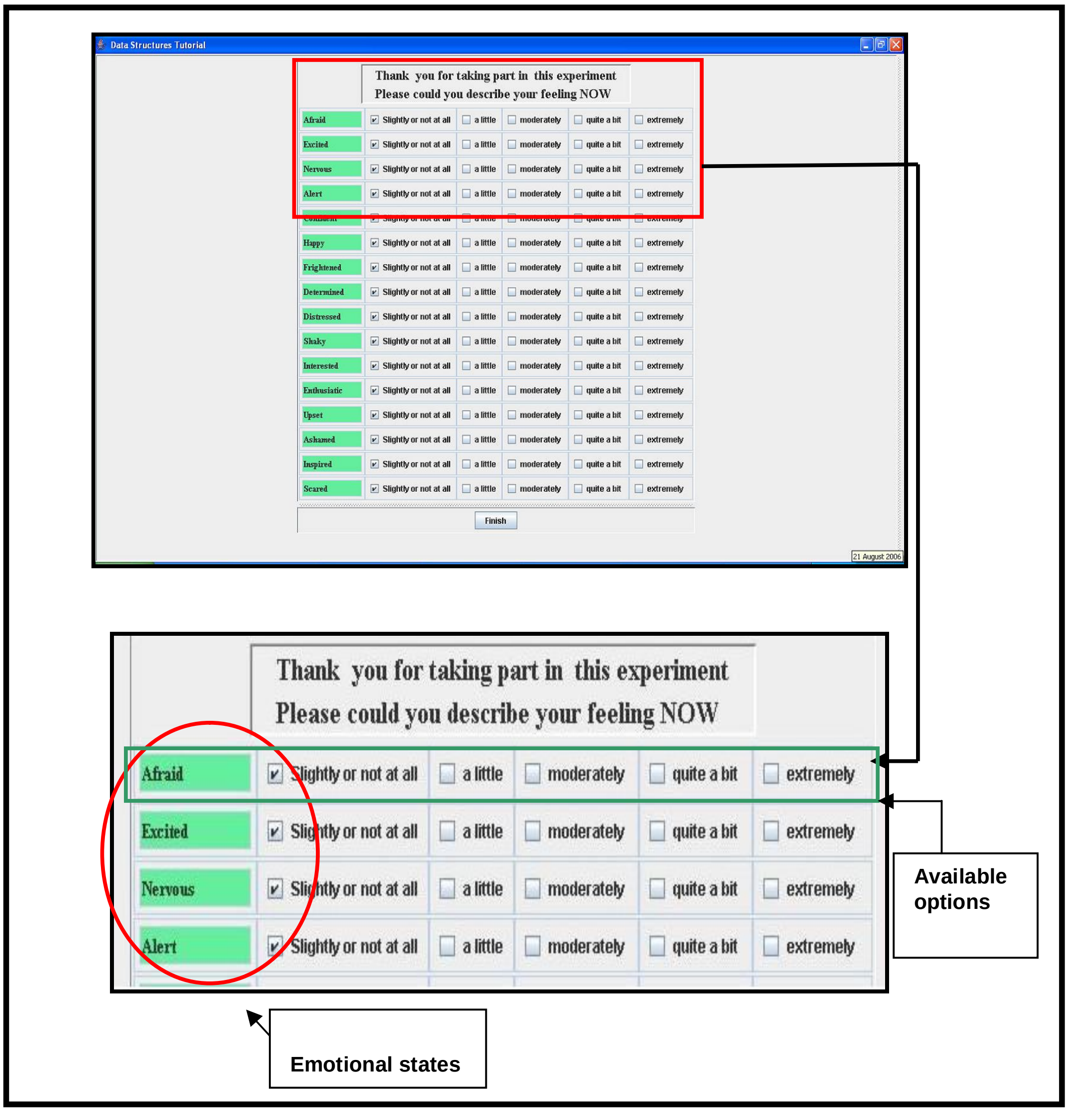


Figure 7-2: The PANAS questionnaire interface

7.4 Primary reaction phase

In the primary reaction phase, the student is presented with a relaxation exercise audio (i.e. breathing exercises and positive affirmations) (Figure 7-3).

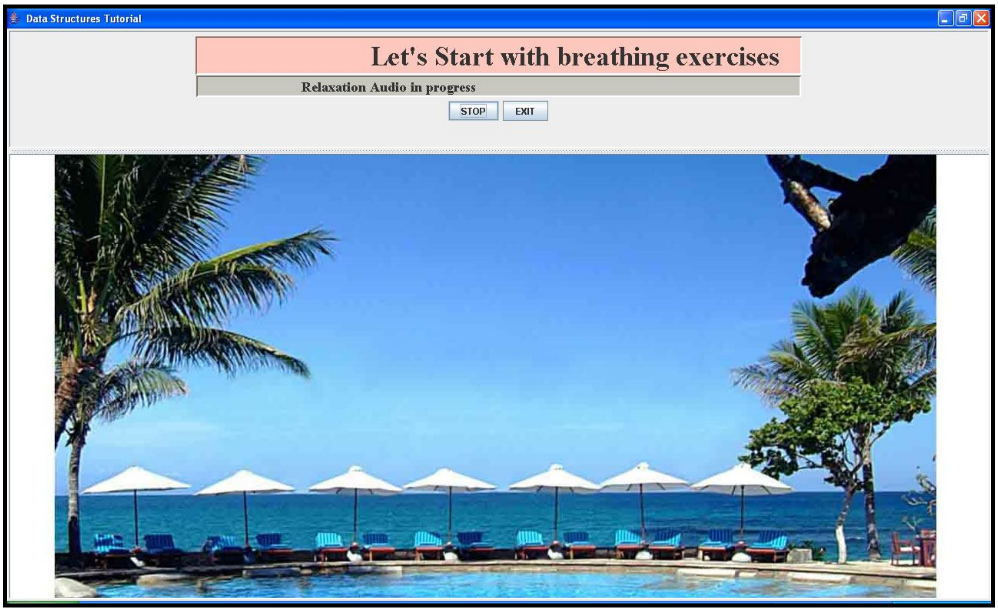


Figure 7-3: Relaxation exercises session (audio) page.

After the relaxation session, the student is required to self-report any change in his state of well-being on a scale from 'much worse' to 'much better' (Figure 7-4). The details of the approach deployed in this stage have been discussed in section 6.2 of Chapter 6.

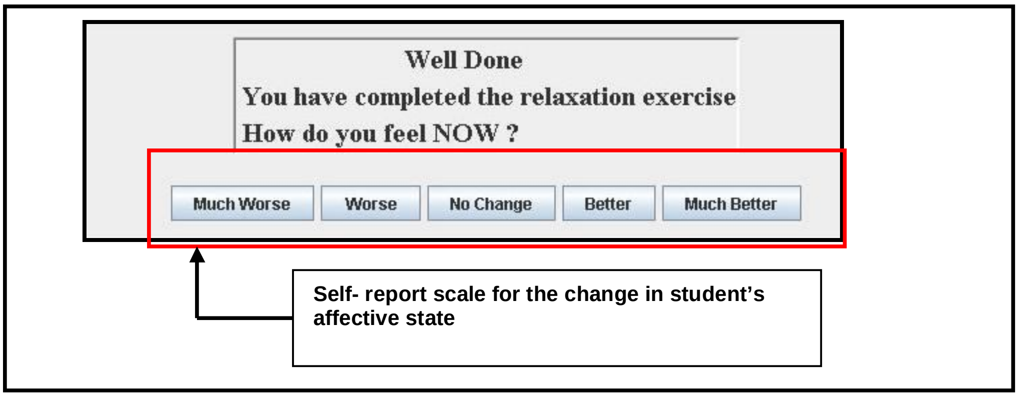


Figure 7-4: The self-report scale for the change in student's state of well-being.

7.5 Constructing the session plan

In the ATS system, the learning materials are designed to suit the Data Structures syllabus of the computer science course at the University Tenaga Nasional, Malaysia. Before the start of a learning session, the student is required to construct his session plan which consists of two learning topics (see Figure 7-5 for an example of the session).

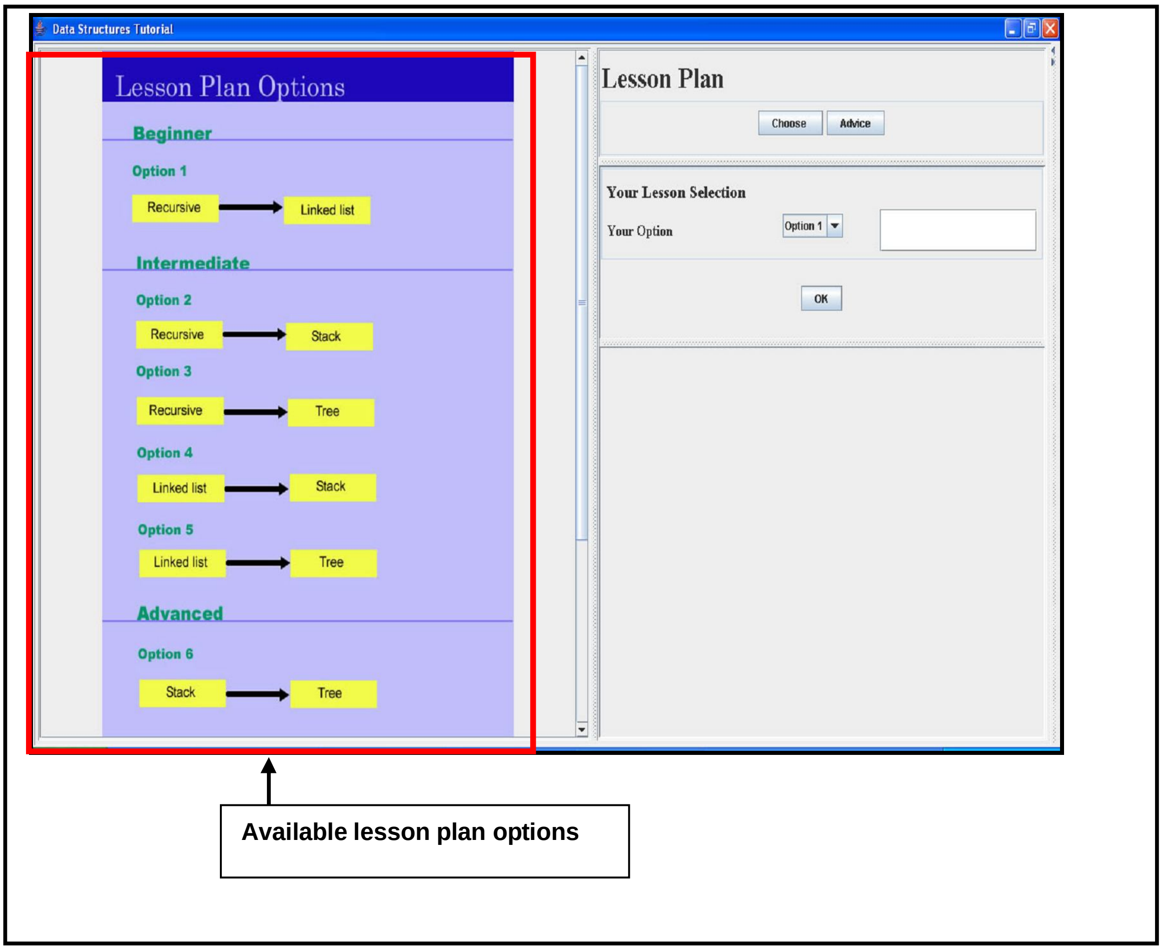


Figure 7-5: Interface of the lesson plan options provided to a student

7.6 Example of an upcoming lesson

Within the ATS system, the student is provided with an example of his upcoming lesson before the start of the learning activities (Figure 7-6). In addition, the student is also offered step-by-step instructions for the next lesson.

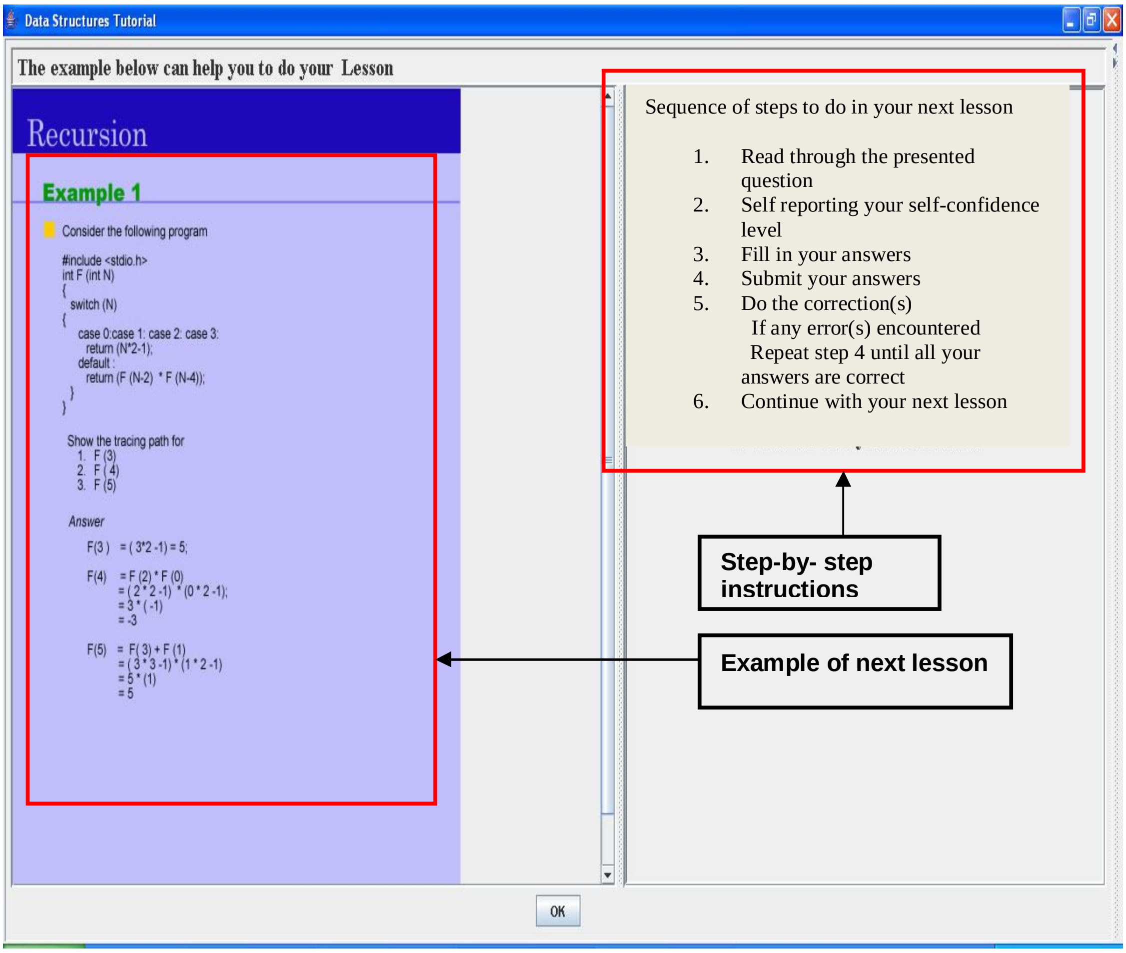


Figure 7-6: Interface of the example lesson and step-by-step instructions

7.7 Learning activities

At this stage, the student is presented with the learning activities interface (Figure 7-7). These include the notes, examples of code and the question itself. However, the student is required to self-report his self-confidence level before starting on the presented problem.

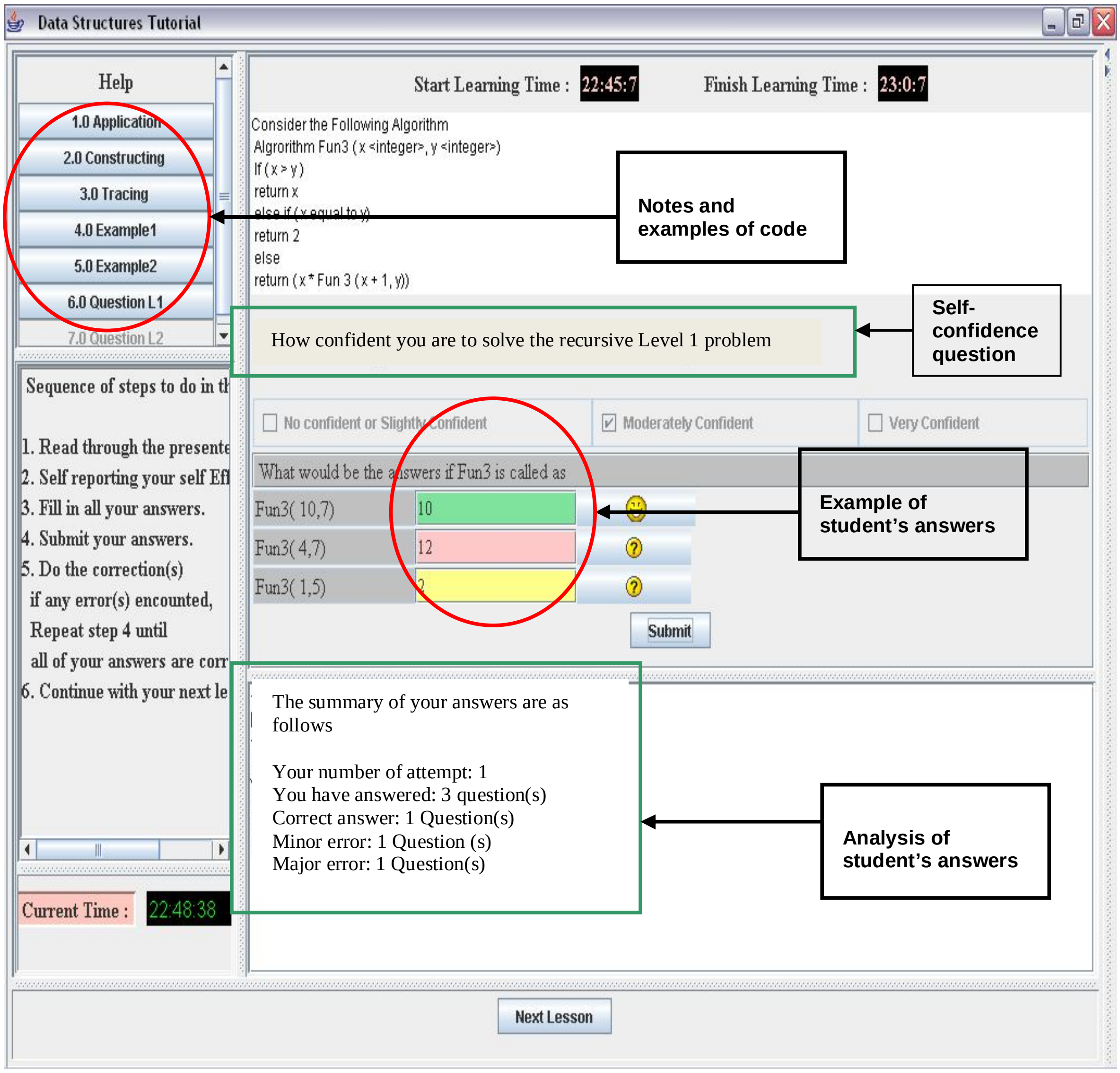


Figure 7-7: The ATS learning activities interface

7.8 Secondary appraisal stage

In the ATS secondary appraisal phase, the student's state of well-being is appraised using three variables: self-confidence, independence and number of solution attempts. The details of the appraisal process have been discussed in Chapter 4.

7.9 Secondary reaction phase

The ATS framework deployed both the domain-independent and domain-dependent strategies in coping with student's affective state; see Chapter 6 for the details of these approaches.

7.9.1 Domain-independent strategies

In the secondary reaction stage, the student is first presented with positive affirmations to accommodate to the student's affective state (i.e. in a state of positive well-being or in a state of negative well-being). The screenshot below (Figure 7-8) shows an example of a positive affirmation audio and statement presented to a student who is appraised to be in a state of positive well-being.

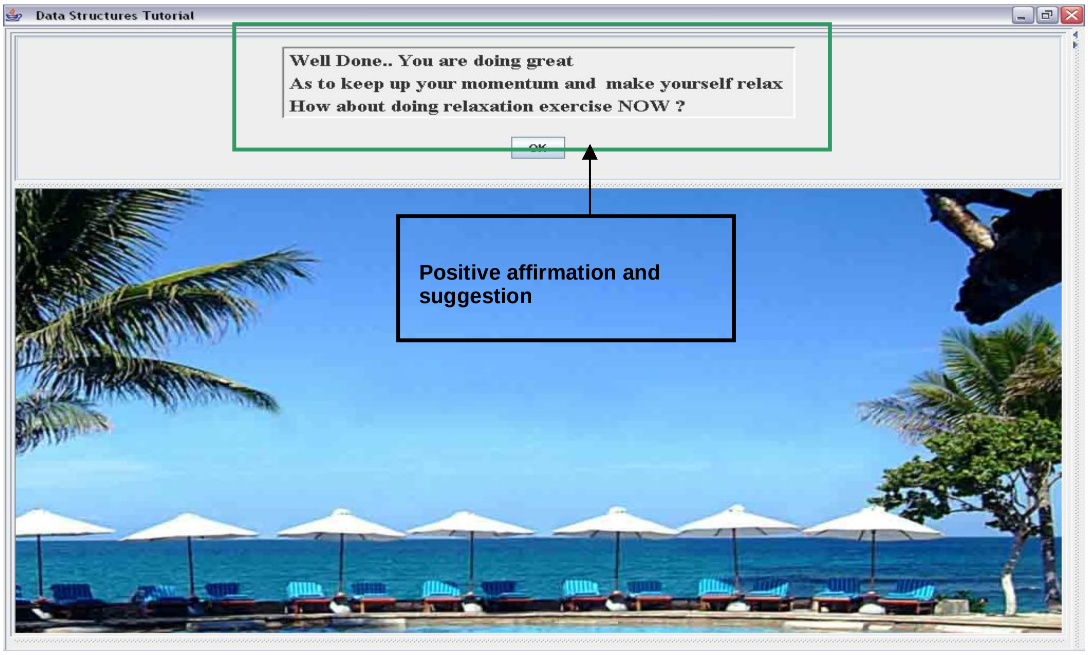


Figure 7-8: Interface for positive affirmation for student in a state of positive well-being

Figure 7-9 represents an example of a positive affirmation screen presented to a student who is appraised to be in a state of negative well-being.

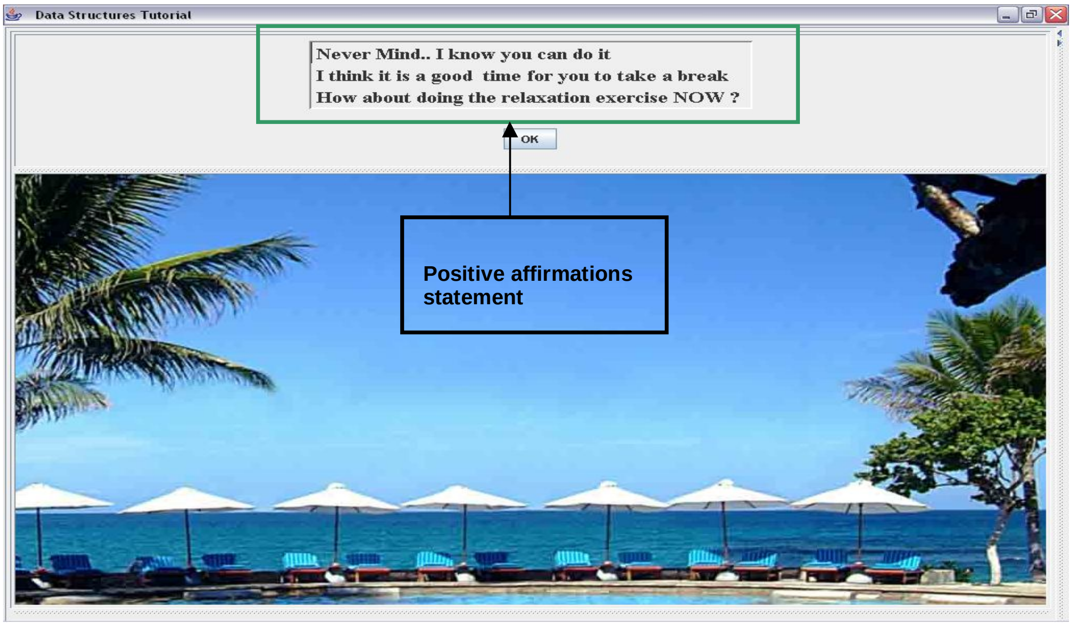


Figure 7-9: Interface of positive affirmation for student in a state of negative well-being

Subsequently, the student is allowed to start the relaxation exercise audio (Figure 7-10).

Figure 7-10: Interface of the relaxation exercise audio

After completing the relaxation exercise session, the student is required to self-report any change in his state of well-being (Figure 7-11).

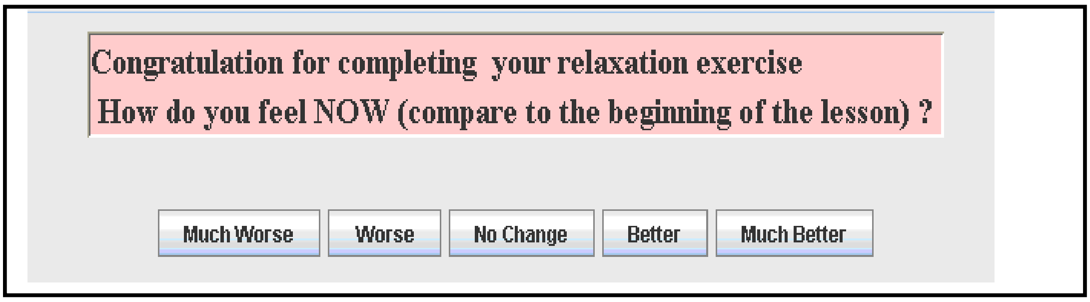


Figure 7-11: Interface of the question about any change in student affective state after a relaxation exercise session

7.9.2 Domain dependent strategies

In the ATS framework, the domain-dependent strategies are designed to suit the student's affective state. For example, Figure 7-12 presents a situation where a student has been appraised to be in a state of high positive well-being. As a response to his affective state, the ATS framework suggests that he progresses two steps ahead of his session plan (i.e. to Linked List Question 1).

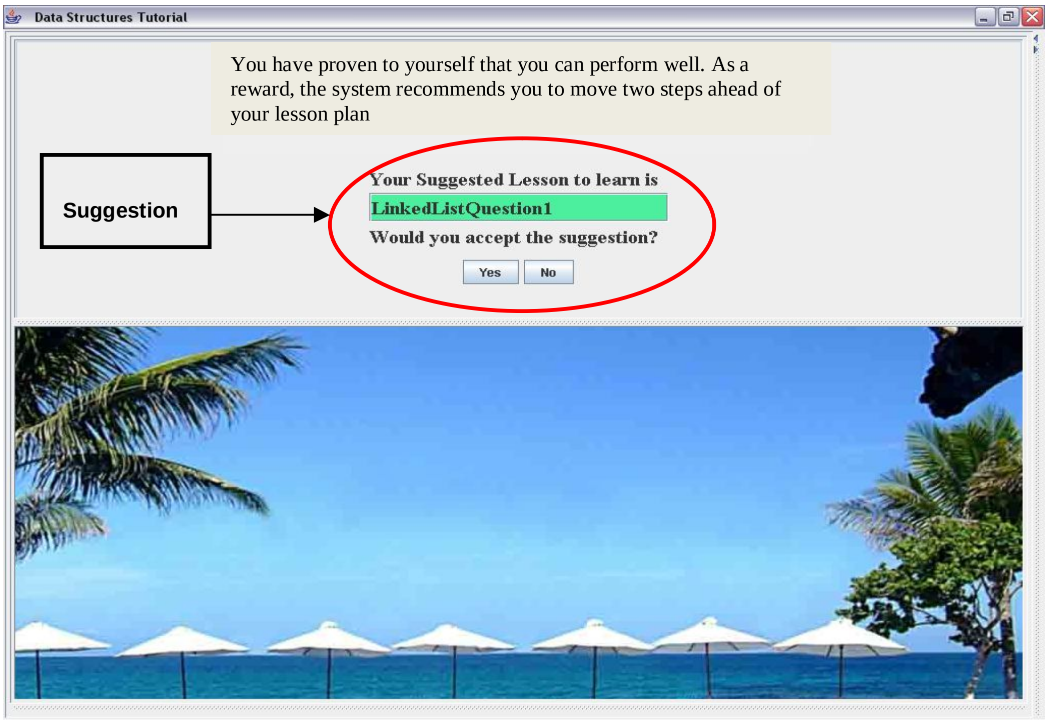


Figure 7-12: Interface of the domain-dependent strategies for a student in a satisfactory affective state

In comparison, the interface below (Figure 7-13) represents the reaction to a student who is inferred to be in a state of negative well-being. In this example, the ATS framework advises the student to re-do the linked list question. Details of the domain-dependent strategies were presented in Tables 6-3 and 6-4 of Chapter 6.

Figure 7.13: Interface of the domain-dependent strategies for a student in a state of negative well-being

7.10 Conclusion

This chapter has explained the activities of the ATS system (i.e. appraisal and reaction phases) and given brief details of its implementation. In order to investigate the effectiveness of the ATS system with regard to the research questions posed in Chapter 1, an experimental study was carried out. The design and results of the experimental study are presented in the next chapter.

Chapter 8

Pilot study

This chapter describes a pilot study to evaluate the system described earlier. We begin with the hypotheses of the study. Following this, in Sections 8.2 and 8.3, we discuss the participants' profiles and the materials used, including the pre- and post-tests and the relaxation methods. In Section 8.4, the experimental design is presented. Next, in Section 8.5, we look at the preparation of the data for statistical analysis. We tabulate the experimental findings and their discussion in sections 8.6 and 8.7. In Section 8.8, we present the conclusions of this study.

8.1 Objectives

The broad aim of this pilot study was to investigate two hypotheses;

a) *The integration of domain-independent strategies within an ATS-based environment can enhance students' performance in learning.*
b) *The integration of domain-independent strategies within an ATS-based environment can improve students' state of well-being.*

Derived from these two hypotheses, the two main research questions addressed in the pilot study were:

RQ1. Does the integration of the domain-independent strategies within an ATS-based environment improve students' learning performance?

and

RQ2. Does the integration of domain-independent strategies within an ATS-based environment improve students' state of well-being?

The experiment was conducted over a four week period between April 2006 and May 2006 in the Department of Computer Science, University of Tenaga Nasional in Malaysia. Because not all participants could attend at the same time, the experiment was conducted over four sessions. In total, 45 participants took part in the experiment including both lecturers and students. Of the participants, there were 40 computer science students and 5 computer science lecturers (all of them had taught Data structures).

The lecturers were selected with a view to getting feedback from experienced users on the ATS framework. Each of the students received RM 5.00 for their voluntary participation. The participants were randomly assigned to two groups; 23 participants used just the domain-dependent strategies (the DD group) while 22 participants used the full ATS system that used both domain-independent and domain-dependent strategies (the DD + DI group). As for the lecturers, three of them were assigned randomly to the DD group and the other two were attached to the DD+DI group. Details of the participants and the four sessions are shown in Table 8-1 below:

Table 8-1: The distribution of participants during the experimental sessions

Session	**Numbers of participants**	**Version**
1	14 (all students)	Domain-dependent and independent strategies (DD + DI)
2	13 (all students)	Domain-dependent strategies only (DD)
3	6 (3 students, 3 lecturers)	Domain-dependent strategies only (DD)
	4 (2 students, 2 lecturers)	Domain-dependent and independent strategies (DD + DI)
4	4 (all students)	Domain-dependent strategies only (DD)
	4 (all students)	Domain-dependent and independent strategies (DD + DI)

Of the 45 participants who took part in the experiment, three participants failed to complete their sessions for different reasons; two participants in the first session did not complete the learning tasks stage, and one of the second session participants failed to complete the post-test.. Thus, after all four experimental sessions, there were 22 participants (9 females and 13 males) who had completed the DD version with an average age of 24.1 years (SD = 4.1). By comparison, there were 20 participants (14 females and 6 males) who had completed the DD + DI version with an average age of 22.8 years (SD = 2.5).

8.2 Methodology

8.2.1 Pre-test and Post-test

The pre-test aimed to measure participants' initial proficiency with data structures. The questions were derived from the author's personal question bank for a course on Data Structures which follows the University of Tenaga Nasional syllabus (the author had taught this subject for 5 years). It covers four topics that represent a mixture of easy and difficult areas; the recursive, the linked list, the stack and the tree (see Appendix J). Of the four available data structure topics, participants were required to answer only the two topics of their preference. Each topic was marked out of 10, giving a maximum possible total score of 20 for the pre-test which then was normalised in a scale of 0 to 10. The post-test was identical to the pre-test and scored in the same way.

8.2.2 Relaxation training session

Based on preliminary studies (see Chapter 5), relaxation exercises and positive affirmation were identified as the components of the relaxation session of the affective tutoring system (ATS) framework**.** The user-centred trials (see Chapter 6) indicated that many participants were unable to follow the relaxation regime without prior training. So a relaxation training was incorporated at an early stage of the session to help them to follow the regime correctly.

Researchers across a broad array of disciplines have identified the fact that a comfortable environment is one of the key factors for the success of relaxation exercises (e.g. Mary, 2006; Tacken, 1989; Davis, 1992; Tusek & Cwynar, 2000). Two important factors were identified for making experimental room comfortable; the seating arrangement of the participants and the lighting. Each of the participants was provided with adequate space to avoid distraction from other participants and the lighting was subdued in the experimental room, see Figure 8-1.

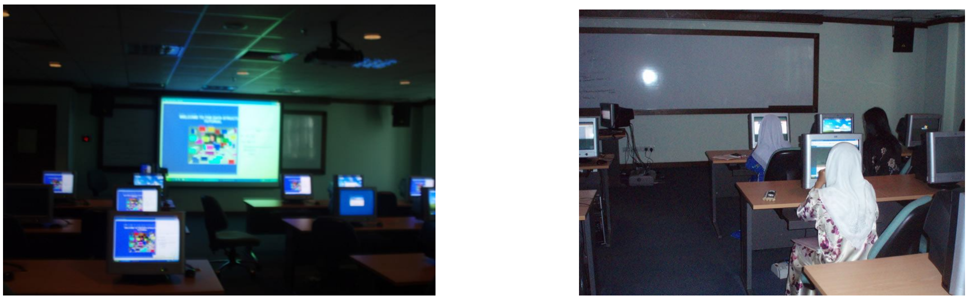


Figure 8-1: The pictures of the relaxation training session.

8.2.3 Procedure

This study used a between-subject methodology based on an experimental and a comparison group. The experimental group is referred as the DD + DI group and the comparison group is referred as the DD group. While the experimental group consisted of participants who were asked to use both the domain-dependent (DD) and domain-independent (DI) strategies to help regulate their state of well-being, the comparison group consisted of participants who were presented only with domain-dependent strategies to help regulate their well-being.

There were 14 stages in this pilot experimental study. These stages were further grouped into five sub-phases. The complete flow chart of the experimental design is presented in Figure 8-2.

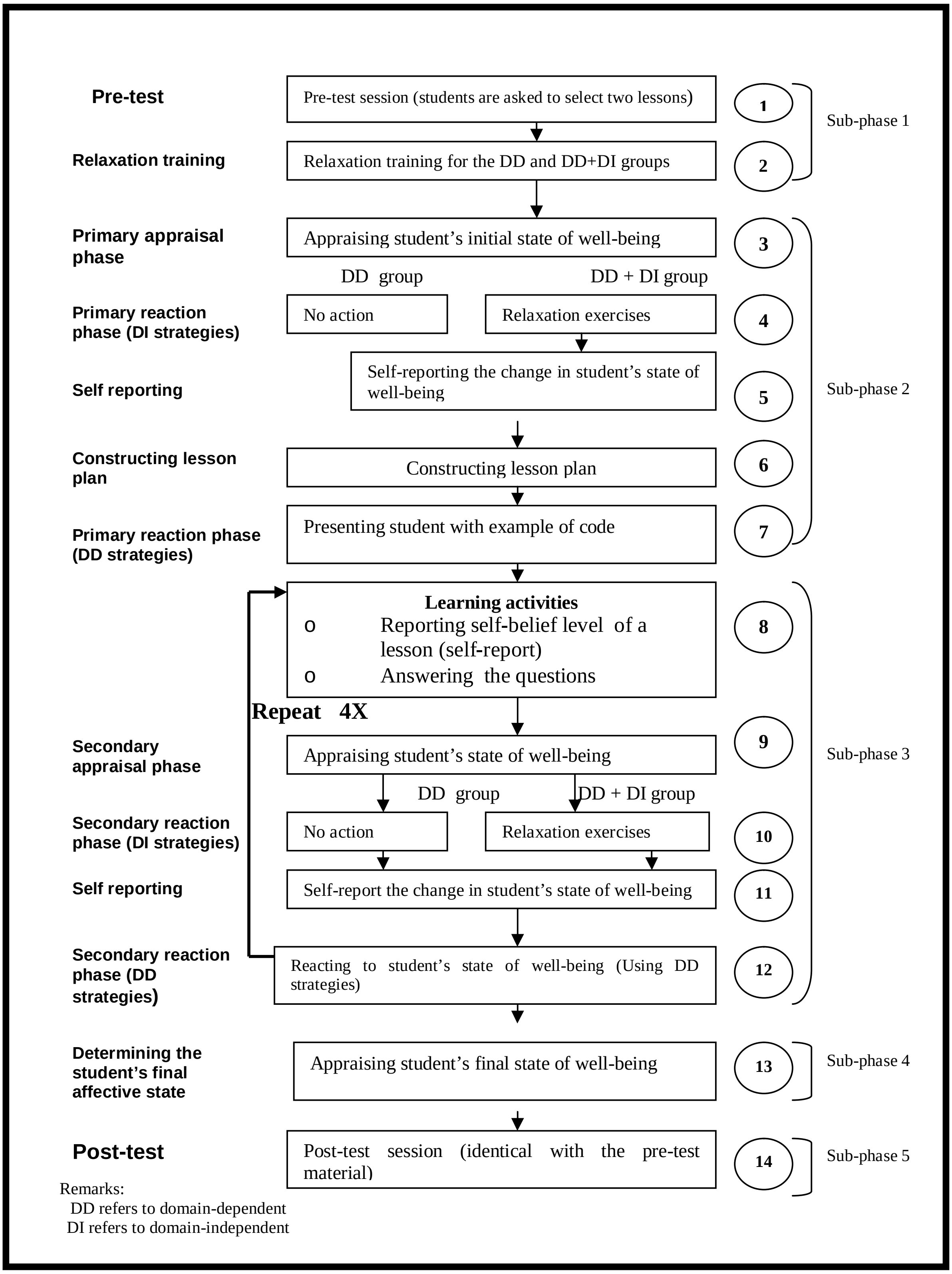


Figure 8-2: The complete experimental design flow chart

Participants were asked first to take the data-structures pre-test session (Stage 1). Using paper-based materials, participants were required to select and complete two of the four available Data Structures topics (i.e. recursive, linked list, stack and tree – see Appendix J for details). They were given about 20 minutes to complete both of their selected topics. No supporting materials such as notes or books were allowed or provided. Identical pre-test materials were used by both the experimental group and the comparison group (see Section 8.2.1 for details).

After the pre-test, all participants were presented with relaxation training (Stage 2). During this stage, they were asked to follow a narrated relaxation script which taught them the correct method of doing the relaxation exercise and the positive affirmation activity. Three identical relaxation training cycles were conducted to ensure the participants had mastered the relaxation skills. In order to create an identical environment for both groups, all participants were required to undertake the same relaxation training even though the DD group did not actually do the relaxation exercises later during learning.

Following relaxation training, participants started to work with the system itself. All participants were asked to self-report their initial affective states via an online version of the PANAS questionnaire (Stage 3). Using the *Well-being* formula (Eq. 4.1- see Chapter 4 for details), the participant's state of well-being was calculated. This was followed by the primary reaction phase (Stage 4). The primary reaction phase varied according to which group the participant was in. In the DD version, which was also the comparison group for the experiment, no activities were deployed as a reaction to the participants' affective state. In contrast, in the DD+DI version, the participants were asked to do the domain-independent strategies (i.e. breathing exercises and positive affirmation activity). At the end of the relaxation exercises, the DD+DI group were asked to report any change in their state of well-being (Stage 5).

Having completed the primary reaction sub task, all participants were then asked to construct a session plan; there were four topics (i.e. recursive, linked list, stack and tree) to choose from (Stage 6). Of the four available topics, they were required to select the same two topics they had chosen for the paper-based pre-test. Subsequent to the construction of a session plan, participants were provided with an example of an upcoming lesson and were also provided with step-by-step instruction for it (Stage 7).

The participants were then presented with the first of their four lesson[4] interfaces and their associated activities (Stage 8); i.e. the notes, examples and the problem itself which the participants were required to complete. However, before they could start to answer the questions, they were required to self-report on their level of self-confidence, to indicate how confident they were about solving the problem presented, using a scale of 1 to 3 (1 = not confident and 3 = very confident).

For each of the four lessons, participants were given 15 minutes and allowed six attempts to complete that lesson. They were allowed to use all the helpful features incorporated into the software environment. These included examples and notes and they were allowed to navigate freely within the environment (see Chapter 6 for details).

A secondary appraisal of the state of well-being of all of the participants' was carried out after they had submitted their answers (Stage 9). Each participant's state of well-being was computed based on three variables: their self-belief level, their independence level and the number of attempts they had made at solving the problem. They were inferred to be in a state of positive well-being if they had produced the correct answers for the problem in less than 15 minutes and with not more than 6 attempts. Conversely, participants who failed to complete the lesson within 15 minutes or had made more than 6 attempts in the problem were inferred by the system to be in a state of negative well-being. See Chapter 4 for details of the secondary appraisal mechanism.

Next, the secondary reaction phase of the ATS framework began (Stages 10, 11). The DD+DI group were again presented with the domain-independent strategies; i.e. relaxation exercise and positive affirmation before reporting any change in the state of their well-being. In contrast, the DD group's members were asked to self report any

[4] Each topic consists of two lessons

change in their state of well-being without doing the domain-independent (relaxation) strategies.

Next, both groups of participants were presented with similar domain-dependent strategies (Stage 12). For instance, if a participant was inferred to be in a high state of positive well-being, the system suggested that the participants move two steps ahead in his session plan. Likewise, the system advised a participant who was inferred to be in a state of negative well-being either to do an easier lesson for his next task or to redo the current lesson. The complete mechanism of the domain-dependent strategies is presented in Table 6-3 (for participants who were inferred to be in a state of positive well-being) and Table 6-4 (for participants who were inferred to be in a state of negative well-being) of Chapter 6.

The learning session cycle of the primary and secondary appraisal and reaction phases together with problem solving continued until the entire session plan was completed (each participant had four cycles to complete).

Upon the completion of all the learning sessions, participants were asked to again self-report their affective state using the online PANAS questionnaire. Finally before they left the lab, they were asked to take the paper-based post-test on Data structures. Identical materials to the pre-test were used for the post-test, and again with students being tested on the same topics they had been pre-tested on and had worked on with the system.

As for the qualitative data collection, six randomly selected participants from each of the DD and the DD+DI groups were interviewed at the end of the experiment (the interviews were carried out in the Malay language). These interviews were conducted using a semi-structured approach. The interview transcripts are presented in Appendix M.

8.3 Data preparation for analysis

The data analyses were performed using SPSS (version 13). In accordance with common practice in this type of research (Norusis, 2005; O'Connor 2006; Field, 2005), a significance level of 5% was adopted throughout the study. Note that not all graphs and Tables are included in this chapter but are included in Appendixes F and G.

8.4 Data normality

Trochim (2005) and Field (2005) identify four basic assumptions to be checked in experimental data; the normality of the data; the homogeneity of the data; the interval of the data and the independence of the data. However, as many statisticians agree (e.g. Field, 2005; Howell, 1997), the normality of the data is the most important assumption to check; it determines which statistical tests are applicable. As such, the Kolmogov-Smirnov (K-S) test was used to examine the normality of the data (Clark-Carter, 1997; Norusis, 2005; O'Connor 2006; Field, 2005). A significant K-S test value (less than 0.05) indicates a deviation from normality (Field, 2005). The K-S test produced a mixture of results and is presented in Appendix G.

To conduct further analysis, parametric tests were applied to the normally distributed data, and non-parametric tests were deployed for the non-normal data. Also, if the existence of both types of data were observed; a non-parametric test was used (Clark-Carte, 1997; Norusis, 2005; O'Connor 2006; Field, 2005).

8.5 Results

The results of this pilot study are organised around the two questions posed at the outset of the chapter (i.e. RQ1 and RQ2).

8.5.1 Did the integration of the domain-independent strategies within an ATS-based environment improve students' learning performance?

Results of pre-and post-test scores indicate that the DD+DI group appeared to have better scores compared to the DD group (Figure 8-3). However, inferential analyses indicated that no significant difference was observed between either the pre-test (Table I in Appendix F) or the post-test (Table II in Appendix F) of the two groups. To have better insight of their performance, students' learning again was measured. The learning gains for the two groups were measured using the following formula:

Learning gain ($g_x(i)$) = Post-test score (g_x (i)) - Pre-test score (g_x (i))------- (eq 8.2)

Where ($g_x(i)$) represents the experimental group.

Results of the learning gains of each group are presented in graph below (Figure 8-3).

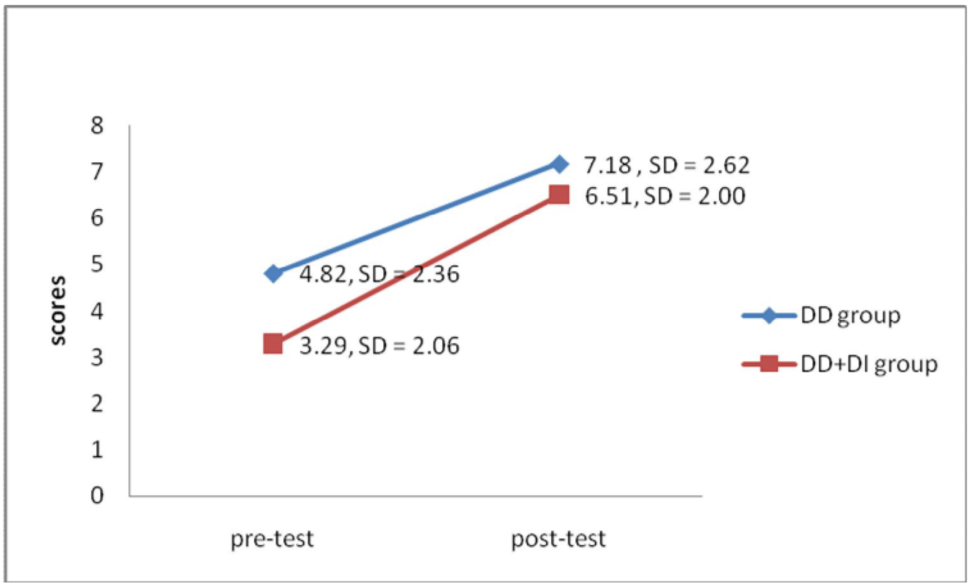


Figure 8-3: Comparison between the pre-test and post-test scores of the two groups

A descriptive statistical analysis revealed that the DD+DI group had better leaning gain scores, (M = 3.22, SD = 1.60) than the DD group (M = 2.36, SD = 1.56). These results indicate that the DD+DI group had recorded an improvement of 33% by the end of the lesson as compared to the 24% improvement by the DD group. In order to develop a more reliable insight into the data, an inferential analysis was conducted.

The results of the one tailed Mann-Whitney test (the learning gain data was not normally distributed) reveal that there was a significant difference between the two experimental groups with regard to their learning gain ($U = 142.5$, $p<0.05$, $r = -0.30$ see Table I in Appendix F). This means that the DD+DI groups had a greater learning gain by the end of lesson than the DD group.

Table 8-2: Summary of the pre and post -test scores analysis

Comparison	**Group**		**Inferential test results**
Pre-test scores	DD (22)	DD+DI (20)	U = 149.5, p>0.05, r = -0.27 (not significant) (Table 1- Appendix F)
	M = 4.82 SD = 2.36	M = 3.29 SD = 2.06	
Post-test scores	DD (22)	DD+DI (20)	t(40) = 0.81, p>0.05, df = 40) (not significant) (Table II- Appendix F)
	M = 7.18 SD = 2.62	M = 6.51 SD = 2.00	
Learning Gain	DD (22)	DD+DI (20)	(U= 142.5, p<0.05, r =-0.30) (significant) (Table I- appendix F)
	M = 2.36 SD = 1.60	M = 3.22 SD = 1.56	

In conclusion, the results from this section provide some evidence that the integration of the domain-independent strategies assisted students to improve their learning performance as compared to the students who were presented with only the domain-dependent strategies (Table 8-2).

8.5.2 Did the integration of domain-independent strategies within an ATS-based environment improve students' state of well-being?

The analyses of the change in students' state of well-being were conducted at two learning phases; from before the lessons till the end of the four lessons (i.e. well-being gain) and during each lesson itself.

8.5.2.1 Overall change in well-being within an ATS-based environment

As mentioned in chapter 4, the participants' initial state of well-being was measured by subtracting the average of their PANAS negative affect from the average of their PANAS positive affect (Eq 4.1 - see Chapter 4 for details).

Well-being (WB) = Av (positive affect) – Av(negative affect) ….. Reproduction of Eq 4.1

The mean of the initial state of well-being of the DD group was 1.02 (SD 1.23) and was 1.31 (SD = 0.95) for the DD+DI group (Table 8-3). T-test results, however, indicate no significant difference between the two groups ($t(40) = 0.25$, $p>0.05$, df = (40)) (see Table II in Appendix F for details).

Using the same procedure as for the participants' initial state of well-being (i.e. subtracting the average of their PANAS negative affect from their average PANAS positive affect), the participants' final state of well-being (Stage 13) was measured by the end of the overall learning session. No significant difference was noted between the participants' final state of well-being for the two groups (See Table II in Appendix F for the details of the analysis). The summary of the analysis is presented below (Table 8-3)

An analysis was conducted to study any changes in participants' state of well-being between the DD+DI and the DD groups. The change was measured using the following formula based on the scores in the reduced version of the PANAS questionnaire:

Well-being change (WBC)($f_x(i)$) = FWB state ($f_x(i)$) – IWB state (f_x (i))--------- Eq 8.1

Notes: IWB refers to initial well-being and FWB refers to final well-being
Where ($f_x(i)$) represents the experimental group.

The mean value of the participants' change in the state of well-being (WBC) for the DD+DI participants' was 0.36 (SD = 1.41) compared to -0.13 (SD = 0.91) for the DD group (Table 8-3). A one tailed T-test analysis revealed that there was a significant difference in the change of participants' state of well-being between the two groups by the end of the experiment (U= 139.5, p<0.05, r =--0.30 - Table I of Appendix F). This lent some evidence to support the view that the integration of the domain-independent strategies was useful in helping to regulate the student's state of well-being by the end of the four lessons.

Table 8-3: The inferential statistical results of the participants' initial state, final state and well-being gain analysis

Comparison	Group		Inferential test result
Participants' initial state of well-being	DD	DD+DI	(t(40) = 0.25, p>0.05, df = 40) (not significant) (Table II- Appendix F)
	M = 1.02 SD = 1.23	M = 1.31 SD = 0.95	
Participants' final state of well-being	DD	DD+DI	t(40) = 1.06, p >0.05, df(40) (Significant) (Table II- Appendix F)
	M = 0.89 SD = 1.43	M = 1.67 SD = 0.96	
Participants' well-being gain	DD	DD+DI	(U= 139.5, p<0.05, r = -0.30) (Significant) (Table I –Appendix F).
	M = -0.13 SD = 0.91	M = 0.36 SD = 1.41	

In conclusion, the results indicated that the integration of the domain-independent strategies provided a positive impact to the self-reported changes of students' state of well-being at the end of their lesson.

8.5.2.2 Change of the participants' state of well-being during the lessons

The participants reported any changes in their state of well-being at two learning stages: after the primary relaxation (Stage 4) and, for each lesson, after the secondary relaxation exercise (Stage 10) using a simple self-report mechanism.

8.5.2.2.1 Primary reaction (Stage 4)

The self-reported changes in the DD+DI group's state of well-being were measured at Stage 4 of the experimental design. (i.e. after the relaxation exercises and positive affirmations regime, see Chapter 6 for the details of the primary reaction mechanism). Participants were asked simply to self-report any change in their state of well-being after the relaxation exercise session, using a single online question with a simple scale of:

- Much worse (score = -2)
- Worse (score = -1)
- No change (score = 0)
- Better (score = 1)
- Much better (score = 2)

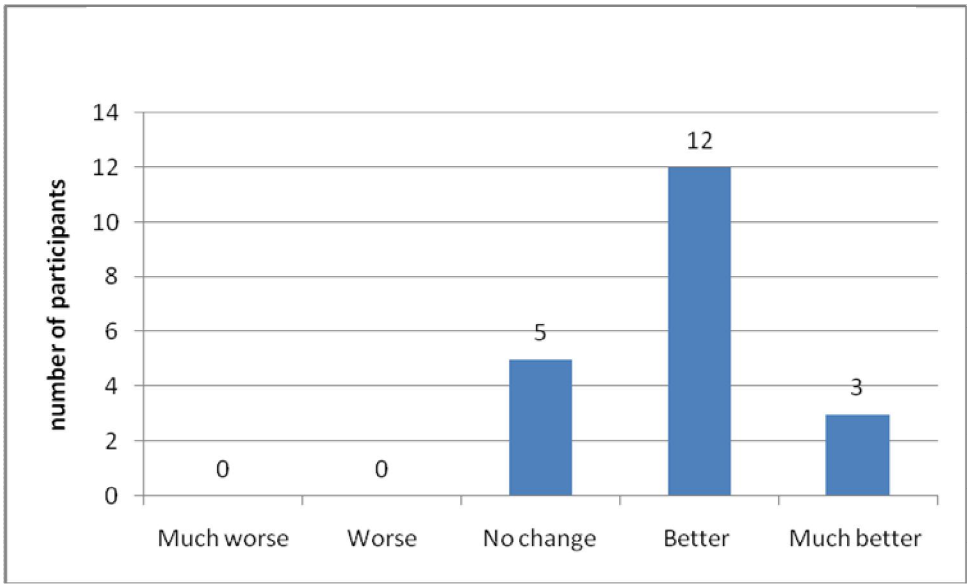


Figure 8-4: The self-reported changes in the DD+DI group's state of well-being after the primary reaction phase

Results from the study are shown in Figure 8-4. 15 participants or 75% of the DD+DI group reported feeling *better* (12 participants or 60%) or feeling *much better* (3 participants or 15%) after the relaxation exercise and the positive affirmation. Moreover, only 5 participants or 25% of the sample reported *no change* in their state of well-being after they completed their domain-independent strategies. Interestingly, no participants felt that the use of the domain-independent strategies had decreased their state of well-being. As the DD participants did not do the relaxation exercise, changes of their state of well-being were not requested.

Overall this primary reaction phase indicated that participants in the DD+DI group registered a positive change in their state of well-being after completing their relaxation exercises regime. This is consistent with the findings of several empirical experiments on the use of relaxation exercises within an educational context (e.g. Johnson, 1982; Barber, 1982; Matthews 1983; Britton & Virean, 1999; Benson et al., 1994; Benson et al., 2000; Deckro et al., 2002).

The analysis of the interview scripts for the DD+DI group provides more insight into the effect of the relaxation exercise session. In general, participants gave positive feedback on the use of relaxation exercises regime. Examples of the interview feedback are as follows:

Interviewer: How did you feel after the relaxation exercise and positive affirmations?

S1: *I felt more relaxed and focused and I felt I had a better learning pace after the relaxation exercise.*

S2: *I felt that the relaxation exercise had reduced my nervousness level and made me more prepared for the upcoming lesson.*

S3: *The pace the relaxation exercises session had made me quite relaxed and reduced my anxiety level.*

S4: *I felt the relaxation exercise had little impact in reducing my negative affective state.*

However, there were 5 students of the DD+DI group who were observed to report no changes in their state of well-being after the relaxation exercise. Perhaps, they were already feeling fine at the start of the experiment or perhaps the training session was not sufficient for these students (Gaines, 2005). As a result, they might have been unable to perform the relaxation skills effectively, given that they were asked to report the changes at their very first attempt at doing the relaxation exercise “for real”.

To summarize, without a comparison group (i.e. the DD group were not asked to report the changes of their state of well-being after the primary reaction phase), it is hard to draw a conclusion about the effectiveness of the domain-independent strategies even though some positive results in the self-reported changes of the state of well-being of the DD+DI students were observed.

8.5.2.2.2 Secondary reaction (Stage 11)

The aim of this section is to investigate the pattern of students’ behaviour after the secondary reaction (Stage 11) at the end of each of the four lessons. The participants of the DD+DI group were presented with the domain-independent strategies (i.e. relaxation exercises and positive affirmations (Stage 10)) and then asked at the end of each lesson to self-report using a single question any change in their state of well-being in comparison to the beginning of that lesson (Stage 11). In contrast, the DD group’s members were asked to self-report any change in their state of well-being (also using the same single question) without undertaking the domain-independent strategies (i.e. relaxation exercises session). Similar to the primary reaction phase, the change in participants’ state of well-being was measured on a single dimension scale of -2 to 2 (-2 = much worse, 2= much better).

Because it was expected that the outcome of the problem-solving would have a marked effect on the participants state of well-being, the comparisons between the DD and DD+DI group for the secondary appraisal and reaction phases are reported separately for the participants’ who *completed their lesson successfully* and for participants who *failed to complete their lesson successfully.*

8.5.2.2.3 Changes in the state of well-being for participants who *completed their lessons successfully*

Over the course of the four lessons, the mean of the self-reported changes in the state of well-being for the DD group was 0.85 (SD =0.65) and was 1.26 (SD = 0.55) for the DD+DI group (Figure 8-5). Note that both groups reported positive changes in their state of well-being as expected. Because the data was not normal a Mann -Whitney test (non parametric test) was used and revealed that the difference in change of state of well-being between the two groups was significant ($U= 526.0$, $p < 0.05$, $r = -12.5$). (See Table I in Appendix F for details).

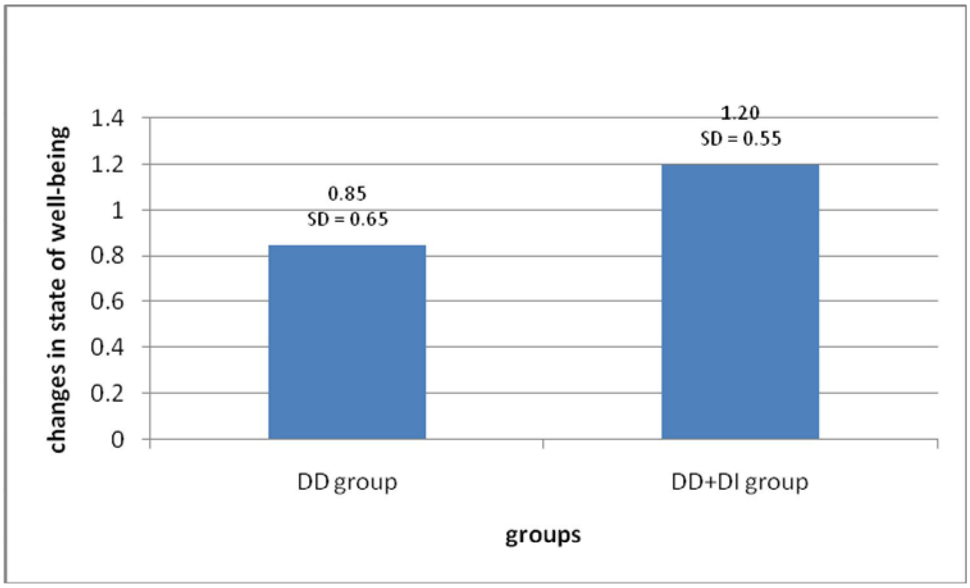


Figure 8-5: The self-reported changes in the state of well-being for the participants who were inferred to be in a state of positive well-being

To get an insight into these changes, data of the self-reported changes of students' state of well-being for each lesson were analysed separately (Figure 8-6).

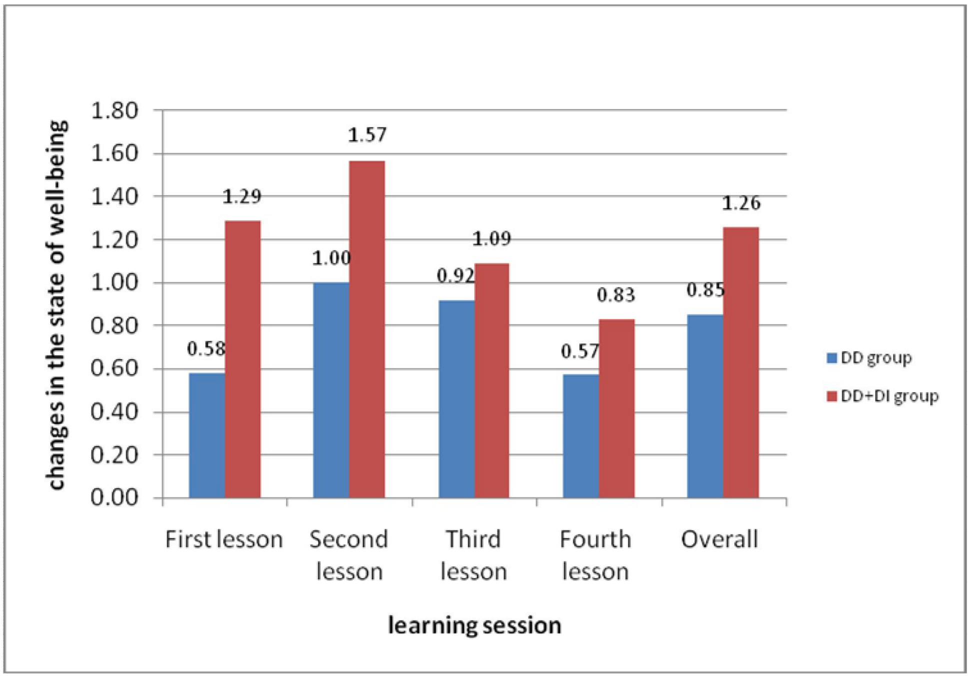


Figure 8-6: The comparison of the self-reported changes in the state of well-being of the participants who completed their lessons successfully

Figure 8-6 above shows the comparison of the self-reported changes in the state of well-being of the participants who completed their lesson successfully after the secondary reaction phase (Stage 10). There were no significant differences found between the DD and the DD+DI participants' change of state of well-being for each of the four lessons separately (see Table I to Table II in Appendix F for the details). These results are contrasted with the overall finding (i.e. when all four lessons were combined) between the DD and DD+DI groups (see Table II in Appendix F). One reason for this contrasting result is the smaller numbers of data points used for the statistical analyses at each lesson. According to statisticians, (e.g. Clark-Carte, 1997; Norusis, 2005; O'Connor, 2006; Field, 2005) it is more difficult to produce a significant inferential analysis result based on small samples (less than 20).

8.5.2.2.4 Changes in the state of well-being for the participants who *failed to complete their lesson successfully*

Our expectation was that students who failed to complete their lessons successfully would suffer a decrease in their state of well-being. The means of the self-reported changes in the states of well-being for the DD and the DD+DI groups were -0.96 (SD = 0.69) and 1.10 (SD = 0.66) respectively (Figure 8-7). Note that the DD group did reported a decrease in their state of well-being, whereas the DD+DI group reported an increase in their state of well-being. The data were not normal and results from the Mann-Whitney test indicate that there was a significant difference between the two groups ($U=59.5$, $p<0.05$, $r= 1.00$) (see Table I in Appendix F for details).

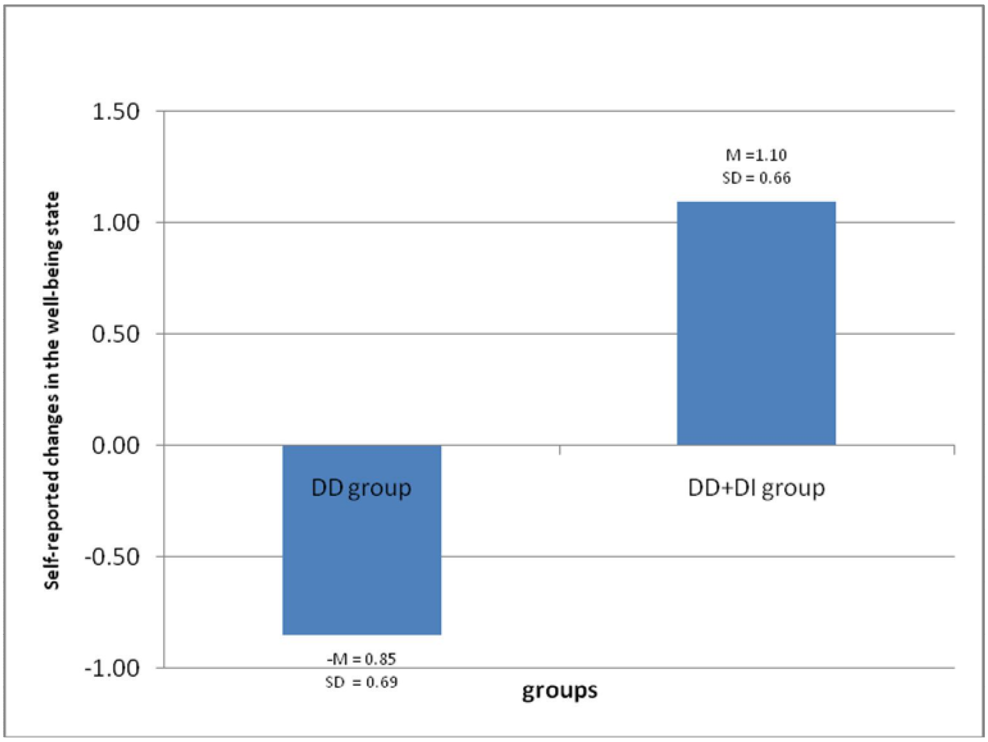


Figure 8-7: The self-reported changes in the state of well-being for the participants who failed to complete their lessons successfully

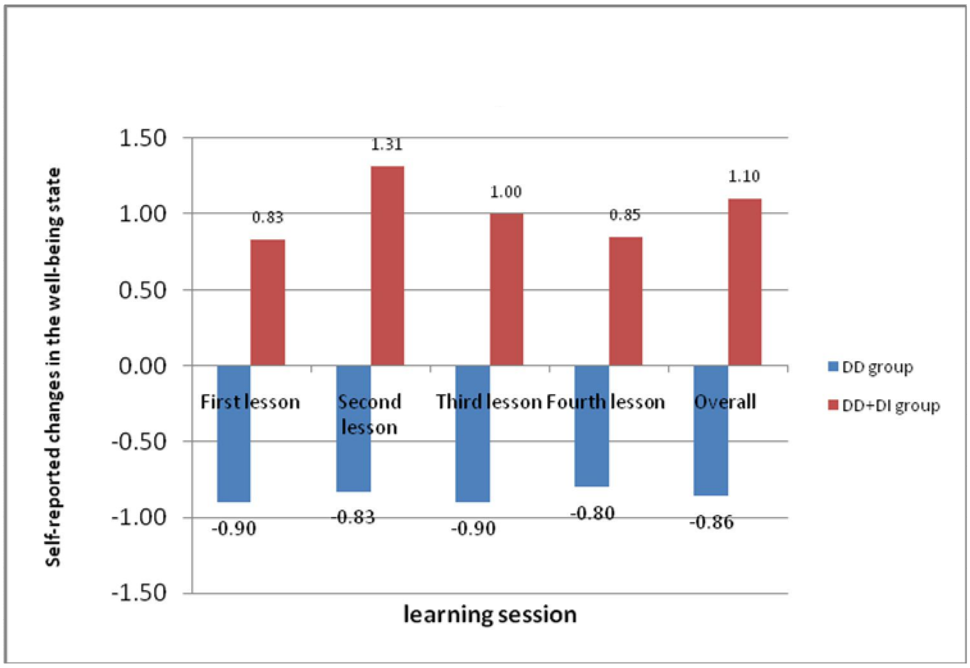


Figure 8-8: The comparison of the self-reported changes in the state of well-being of the participants who failed to complete their lessons successfully after the secondary reaction phase

The above figure (Figure 8-8) depicts, on a lesson by lesson basis, the self-reported changes in the state of well-being of the participants who failed to complete their lesson successfully after the secondary reaction phase. In line with the overall findings (i.e. when all lessons were combined - see Table II of Appendix F), the results of the inferential analyses indicate that there were significant differences between the two groups for each of the four lessons (see Table I Table II in Appendix F for details). This gives some support for the claim that the use of relaxation exercises is useful in improving students' state of well-being during a learning session, for those students who found the lesson hard.

Results from the interview session conducted among the DD+DI group members were used to gain greater insight into the findings. In general, there was evidence that the use of the domain-independent strategies improved participants' states of well-being. Five out of six of the DD+DI participants indicated that the use of the domain-independent strategies was more effective when they were in a state of negative well-being. Only one of the participants felt that the use of the domain-independent strategy did not improve her state of well-being. Excerpts from the interview scripts are as follows:

Interviewer: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?

S1: For me, it was when I was in the negative well-being state. I felt the relaxation exercise had made me become more relaxed and improved my learning focus.

S2: I felt the relaxation exercise was more useful for the negative well-being state. For me, the relaxation exercise reduced my anxiety and uplifted my confidence level

S3: For me, I felt the relaxation exercise was more useful during my negative feeling but did not feel so much different in my positive well-being state after the relaxation exercise activities.

S4: I felt, the relaxation exercise really helped me to reduce my frustration but not really helpful after I got my answer right.

S5: For me, the relaxation exercises helped me to reduce my anxiety level and improve my confidence after I failed to complete my lesson. Although I felt the relaxation exercise was helpful after I got the right answers, it didn't make me feel much better.

S6: I felt the relaxation exercises didn't make any difference to my well-being state during my lesson. I don't use relaxation exercise as a means to regulate my emotions during learning. For me, getting the correct answer was more important.

In summary, there is both quantitative and qualitative evidence to support the hypothesis that the use of domain-independent strategies was useful in improving the state of well-being among participants in this study. More particularly, results of this study indicate that domain-independent strategies were more effective for those who did not succeed on a lesson, and therefore may be inferred to have been in a state of negative well-being, than for those who succeeded on a lesson and may be inferred to have been in a state of positive well-being. The Broaden-and-Build theory of positive emotions by Fredrickson (1998) might provide an explanation for these findings. She postulates that being in a positive affective state itself can help regulate an individual's affective state. So, any further intervention to make them feel better at such moments would be ineffective. Nevertheless, more evidence should be gathered before a definitive explanation can be established.

8.6 Limitations of the study

Although the outcomes of this pilot study have yielded some evidence to support the hypotheses of the study, several shortcomings were noted. The absence of data on the time spent on the lessons and the overall duration of the experiment for each group of participants was the main drawback of the experiment. Without the comparative time data, it is difficult to draw conclusions on the relative effectiveness of the strategies (domain-dependent and domain-independent strategies). Moreover, it is likely that students taking more time over their lessons are more likely to produce better performance in learning. Thus, in the main experiment (see Chapter 9), the durations of the experiment (e,g. time on task) for each group were recorded and compared statistically.

The second issue concerns the relaxation exercise regime at the beginning of the experiments. In the pilot study setup, both the DD and the DD+DI were presented with identical relaxation *training* exercises at the outset of the experiment. As such, any comparative between-groups change in participants' affective state at the beginning of the experiments was difficult to interpret. Consequently, only a weak conclusion could be drawn from the study on the impact of the relaxation exercise (domain-independent strategies) for the DD+DI group at the beginning of the experiment. Therefore, in the main experimental study, the relaxation training exercise was proposed to be conducted for the DD+DI group only so that the influence of the relaxation exercise (domain-independent strategies) at the outset of the experiment could be measured more reliably.

The third shortcoming of the pilot study concerns the absence of a natural event (i.e. an event which did not elicit any emotional state) for the DD group during the secondary reaction phase. No comparison mechanism or activities were presented to the comparison group (i.e. the DD group). Without a comparison event, the impact of the relaxation exercise regime could not be measured effectively. Thus, in the main experiment, sitting quietly for the same amount of time as the relaxation exercise regime was offered to the DD group.

The fourth drawback of the experiment concerns the way that students' performance was recorded and analysed. In the pilot study, the students' performance was measured only at the end of the session and not during the lessons themselves. Without an analysis of students' performance during the lessons, it is hard to assess the interaction between students' state of well-being and their performance. Therefore, two parameters were proposed to be used in the main experiment for gauging students' performance during the lessons. The first was the percentage of students who completed their lessons successfully for each group. The group with the higher percentage of students who complete their lessons successfully can be considered as having better learning performance. For the students who failed to complete their lessons successfully, the quality of students' (failing) answers can be used to determine the learning performance.

The flexibility of students to choose their lesson topics was the fifth shortcoming of this study. As such, students might have chosen different learning paths (i.e. each student might have completed different topics for each lesson) during their session. These different topics might be of different difficulty, hence comparative learning outcomes were difficult to assess. Consequently, the learning gain measurement was not reliable as it measured the effects of different learning topics for the four lessons. Therefore, in the main experiment, student of both groups were offered the same learning topics throughout their experiment including the pre- and post-test.

The use of a reduced version of PANAS questionnaire (only 18 items were used and hostile and jittery emotions were excluded) was the sixth limitation of the pilot study. This raises issues about the validity of the assessment of the students' state of well-being. Therefore, in the main experiment (discussed in Chapter 9), the complete PANAS questionnaire was used.

The seventh drawback of the pilot study was the inclusion of lecturers as participants. They had a different level of knowledge and experience as compared to students, and this could influence the reliability of the findings in the study. Lecturers' performance could be influenced by their experience gained through teaching programming, not due to the manipulation of the different strategies (DD and DI) used in the system. In addition, their states of well-being, and the changes in those states, are likely to have been different from those of students. Therefore, in the main study, lecturers were not included as participants in the experiment.

Finally, the comparisons in the Pilot study did not take student ability into account. Across the literature, it is reported that different levels of student ability play an important role in learning (e.g. Steven et al., 2006; Heng-yu & Sulivan, 2002; Bandura, 1997). Within the ATS community, several researchers have reported different learning performances for students of different ability (e.g. Lester et al., 1999; Andre et al., 1999). Therefore, it is important to study whether the use of domain-independent strategies assist students of different ability to different degrees in their learning. Likewise, 'does the integration of the domain-independent strategies affect the state of well-being of students of different ability to different degrees' is a related question to be studied.

8.7 Conclusion

Overall, the findings of the study have thrown some light on the research questions posed:

a) Did the integration of the domain-independent strategies into an ATS-based environment improve students' learning performance? (RQ 1)

   There is evidence that the integration of the domain-independent strategies into the ATS-based environment improved student performance. Results from section 8.6.1 indicated that the DD+DI group, who were presented with both domain-independent and domain-dependent strategies, recorded a higher learning gain. This provides some evidence for the value of the inclusion of domain-independent strategies as a component in an affective tutoring system framework. However, the study failed to capture and analyse the impact of this integration on students' performance during each lesson. This was fixed for the main experiment.

b) Did the integration of domain-independent strategies in an ATS-based environment improve students' state of well-being?(RQ 2)

   Results from the study (Section 8.5.2.2) indicated that the use of domain-independent strategies was useful in improving participants' state of well-being over the four lessons. In addition, results from Section 8.5.2.2.4 provided some evidence that the use of domain-independent strategies (i.e. relaxation exercises and positive affirmation) improved participants' state of well-being during each lesson, particularly for students who were doing badly.

The next chapter describes the main experiment for which the flaws of the pilot study were fixed.

Chapter 9

Experimental study

In this chapter, we describe an improved experimental design for the evaluation of the ATS framework. We begin by introducing an additional hypothesis for the study. Following this, we discuss the participants' profiles, the materials used and the improved experimental design. Finally, the experimental findings are presented.

9.1 Additional hypothesis

As discussed in Chapter 8, the effect of the domain-independent strategies for different levels of student's ability was identified as the focus of a new hypothesis. Derived from this, the two additional research questions addressed in the new study were:

RQ1. Does the use of domain-independent strategies assist the learning of students of different ability to different degrees?

And,

RQ2. Does the integration of the domain-independent strategies affect the state of well-being of students of different ability to different degrees?

9.2 The participants' profile

The experiments were conducted over a two week period in August 2007 in the Department of Computer Science, University of Tenaga Nasional in Malaysia. They were divided into three sessions. In total, 68 non paid participants (students) were involved in the experiment. They were second and third year students of UNITEN's computer science degree program.

The participants were randomly assigned into two groups; 33 participants were assigned to use the domain-dependent strategies (the DD group) while 35 participants were presented with the full ATS system that uses both domain-independent and domain-dependent strategies (the DD + DI group). Details of the participations and sessions are shown in Table 9-1 below:

Table 9-1: The distribution of participants during the experimental sessions

Session	**Numbers of participants**	**Version**
1 (11/8/2007)	38 (students)	• 21 students for Domain-dependent (DD) • 17 students for Domain-dependent and independent strategies (DD + DI)
2 (12/8/2007)	22 (students)	• 12 students for Domain-dependent (DD) • 10 students for Domain-dependent and independent strategies (DD + DI)
3 (18/8/2007)	8 (students)	• 8 students for Domain-dependent and independent strategies (DD + DI)

Of the 68 participants who took part in the experiment, four participants failed to complete their learning sessions; one DD participant in the first session and three (one DD and two DD+DI participants) in the second session. Thus, there were 64 participants with full data: 31 (17 Male and 14 Females) participants who completed the DD version with an average age of 20.90 (SD = 1.95) and 33 participants (21 Male and 12 Females) who completed the DD + DI version with an average age of 20.81 (SD = 2.50), and were used for further analysis.

9.3 Material used in the experiment

9.3.1 Pre-test session

The pre- and post-test materials used in the study were similar to those used in the pilot study (see Appendix J for details).

9.3.2 Relaxation training session

The procedure used in this experiment was similar to that used in the pilot study (Chapter 8).

9.4 Procedure

As a result of the limitations of the pilot study, several modifications were introduced to improve the experimental procedure. The changes were as follows:

a) The comparison group (DD group) students were asked to sit quietly for the same amount of time as the relaxation exercise sessions for the DD+DI group at the three experimental stages; at the outset (stage 2), primary reaction (stage 4) and secondary reaction phases (stage 9) .
b) Only the DD+DI group were presented with the relaxation exercise at the outset of the experiment.
c) The time spent by both the DD and the DD+DI groups were recorded.
d) All the students were presented with the same fixed learning sequence of topics (i.e. starting with recursive and ending with linked list)
e) Students' performance during the lessons was captured and analysed.
f) Only students and not staff were allowed to be the participants.
g) The complete version of PANAS questionnaire was used to assess students' negative and positive emotions.

The modified version of the experiment consisted of 13 stages. These stages were further grouped into five sub-phases which were used as the framework to investigate the four research questions (i.e. the initial two posed in Section 8.1 and the additional two posed in section 9.1). The complete flowchart of the experimental design is presented in Figure 9-1.

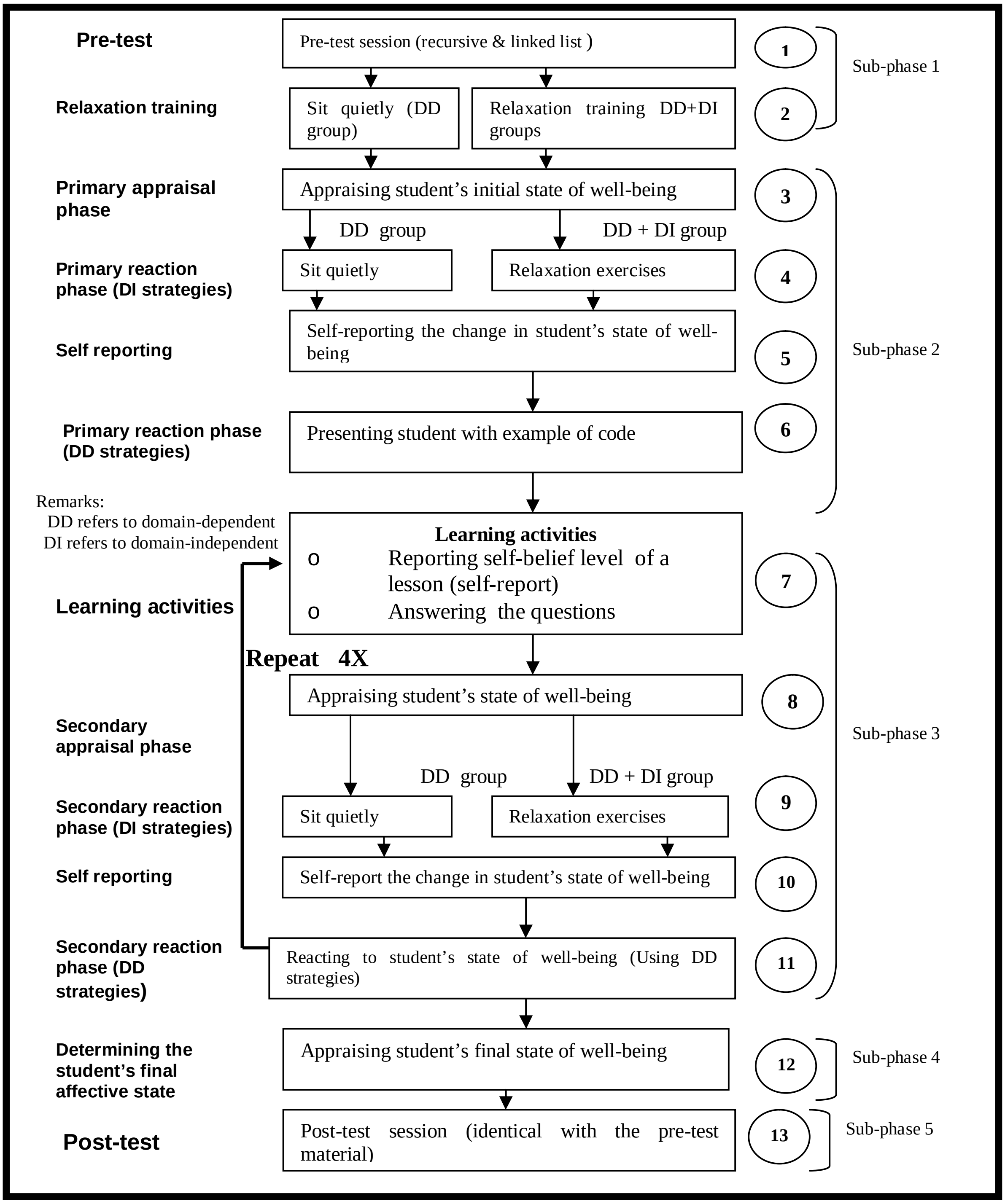


Figure 9- 1: The modified experimental design flowchart

9.5 Results

9.5.1 Students' ability profile

The analyses of this study were based on the two groups (i.e. the DD and the DD+DI groups) and on student ability. Student ability was split into three categories according to their pre-test scores (see Appendix J for the pre-test questions). A student was considered to be in a low ability category if he scored below 33% on the data-structures pre-test. Likewise, a student whose pre-test score was between 34% and 67% was considered to be an intermediate ability student. And, a student was considered to be of high ability if his or her pre-test score was higher than 67%. Due to the large imbalance in the numbers of high ability students between the DD and DD+DI groups, the data from the 8 high ability students were excluded from further analysis. As such, the ability composition of the DD and DD+DI groups on which the analysis was based is as shown in Table 9-2.

Table 9-2: The final classification of participants according to their ability

Group	Students ability level	Number of students
DD group	Low level students	23
	Intermediate level students	6
DD+DI group	Low level students	18
	Intermediate level students	9

9.5.2 The time spent to complete the experiments

Overall, there was no significant difference in the overall time taken for the experiment between the DD group (M = 82.1 mins, SD=19.31) and the DD+DI group (M=74.2 mins, SD=17.9). In addition, no significant difference was found in the total lesson time spent by each group across all four lessons. The average time spent on each lesson (averaged over the four lessons) by the DD group was 9.70 minutes and was 8.62 minutes for the DD+DI group. The analysis of the time spent by both groups is presented in Table 9-3.

Table 9-3: The time spent (in minutes) by the two experimental groups.

	Group	**Mean**	**SD**	Mann-Whitney test (see Table III in Appendix for complete results)
Overall (all students for all four lessons)	DD	82.1 M	19.61	Not significant (U = 421.5, p >.05, r = 0.23)
	DD+DI	74.2 M	17.90	
Lesson 1 (Low ability students)	DD	12.5 M	5.14	Not significant (U = 45.0, p > .05, r = 0.18)
	DD+DI	12.53 M	5.54	
Lesson 1 (Intermediate ability students)	DD	11.53 M	7.53	Not significant (U = 3.0, p > .05, r = 0.12)
	DD+DI	*9.40 M*	*5.40*	
Lesson 2 (Low ability students)	DD	9.42 M	4.56	Not significant (U = 162.5, p > 0.05, r = 0.14)
	DD+DI	8.44 M	3.79	
Lesson 2 (Intermediate ability students)	DD	7.34 M	3.43	Not significant (U = 18.0, p > 0.05, r = 0.23)
	DD+DI	5.59 M	3.99	
Lesson 3 (Low ability students)	DD	10.21 M	5.39	Not significant (U = 183.0, p > 0.05, r = 0.07)
	DD+DI	11.45 M	5.05	
Lesson 3 (Intermediate ability students)	DD	8.01 M	1.87	Not significant (U = 21.0, p > 0.05, r = 0.18)
	DD+DI	9.34 M	5.14	
Lesson 4 (Low ability students)	DD	11.11 M	4.27	Not significant (U = 181.0, p > 0.05, r = 0.08)
	DD+DI	12.38 M	3.82	
Lesson 4 (Intermediate ability students)	DD	9.50 M	4.76	Not significant (U = 23.4, p > 0.05, r = 0.25)
	DD+DI	10.15 M	3.99	
Average of four lessons (Low ability students)	DD	10.42 M	4.84	Not significant (U = 3184.0, p > 0.05, r = 26.5)
	DD+DI	11.20 M	4.55	
Average of four lessons (Intermediate ability students)	DD	9.70 M	4.40	Not significant (U = 79.0, p > 0.05, r = 25.8)
	DD+DI	8.62 M	4.63	

Although not significant, the low ability participants of both groups (the DD and DD+DI groups) were observed to spend slightly more time on difficult topics (i.e. lessons 3 and 4) than on easy ones, with the exception of lesson 1 (see Figure 9-2). One possible reason was that participants required extra time to explore and become familiar with the learning environment (i.e. the notes and the example buttons) during their first lesson.

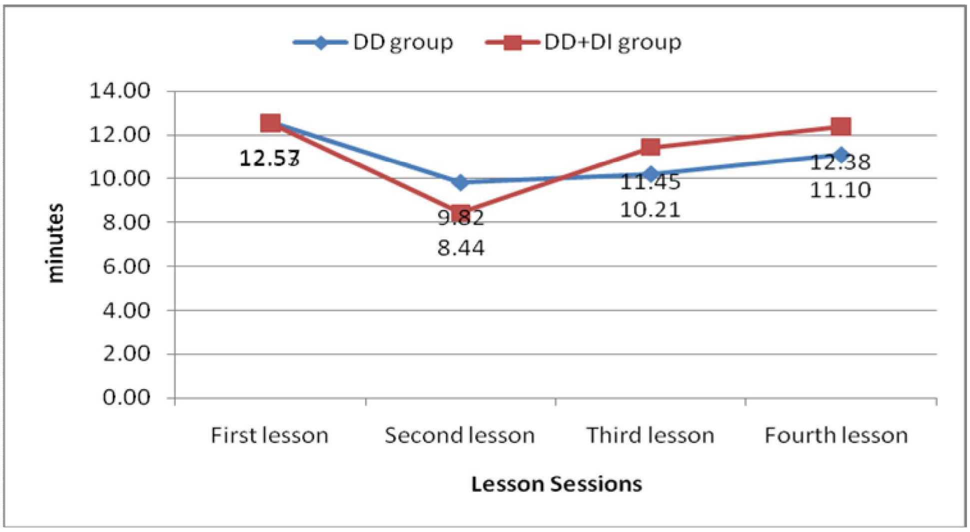


Figure 9-2: The lesson time spent by the low ability students

The intermediate ability students in the DD and DD+DI groups showed a similar lesson time pattern to the low ability students. Although not significant, the intermediate ability students in both the DD and DD+DI groups were observed to spend slightly more time on lesson 1, just as for the low ability students and overall, the time patterns for lessons 1-4 were also similar.

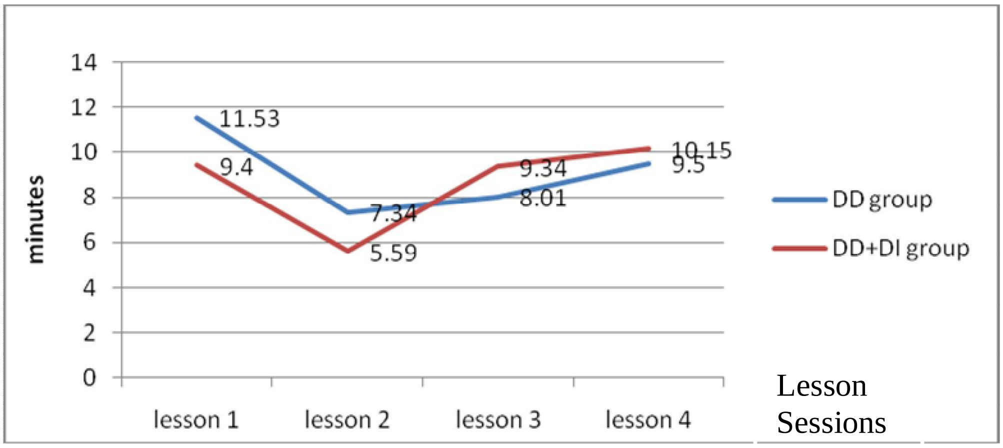


Figure 9-3: The time spent by the intermediate ability students

Although not significant it was also noted that the time spent by the low ability students for both groups was slightly longer than that spent by the intermediate ability students across the four lessons. In conclusion, there was no significant difference between the DD and the DD+DI groups with regard to the overall time spent on the experiment. Likewise, no significant difference was noted between the groups for the times spent specifically on the four lessons themselves.

9.5.3 Did the use of domain-independent strategies improve students' learning performance ?

The performance assessment was conducted at two learning stages:- by the end of the overall session and during each lesson itself. Whilst the difference between the pre-test and the post-test results was used to measure the learning gain by the end of the overall session, the percentage of students who successfully completed each lesson and the quality of the answers produced by the students were used to examine students' performance during each lesson itself.

9.5.3.1 Students' learning performance by the end of the overall session

This section reports the pre-test and post-test scores. Note that the participants' pre- and post- tests papers were marked on a blind basis.

Table 9-4: The *pre-test* score of the two groups

Proficiency Level	N	Mean	SD	Significance Test (see Table V in Appendix for complete results)
Low	DD (23)	16.81	7.21	Not significant (U = 170.5, p >0.05, r = 0.13)
	DD+DI (18)	19.44	9.44	
Intermediate	DD (6)	43.33	20.23	Not significant (U = 55.5, p >0.05, r = 0.18)
	DD+DI (9)	42.20	19.89	
overall	DD (29)	22.30	9.90	Not significant (U = 369..5, p >0.05, r = 0.23)
	DD+DI (27)	27.02	12.92	

The analysis of the pre-test scores revealed that the DD and the DD+DI groups had a comparable level of knowledge about Data structures. Based on the Mann-Whitney test, no significant difference between the two groups for all the categories was noted (Table 9-4).

Table 9-5: The *post-test* score of two groups

Proficiency Level	N	Mean	SD	Significant Test (see Table VI in Appendix for complete results)
Low	DD (23)	37.53	20.40	significant (U = 113.5, p <0.05, r = 0.34)
	DD+DI (18)	52.97	18.60	
Intermediate	DD (6)	58.80	19.08	significant (U = 137.0, p <0.05, r = 0.41)
	DD+DI (9)	82.90	18.83	
overall	DD (29)	41.93	20.12	significant (U = 259.5, p <0.05, r = 0.23)
	DD+DI (27)	62.94	18.67	

By contrast, the analysis of the post-test scores revealed significant differences between the groups, with the DD+DI group scoring more highly. Based on the Mann-Whitney test, significant differences were found between the two groups for each ability level and overall (Table 9-5).

A comparison of learning gains was made using Mann-Whitney test. As discussed in Section 8.5, learning gain was measured using Equation 8.2

Learning gain (g_x(i)) = Post-test score (g_x (i)) - Pre-test score (g_x (i))------ (reproduction of Eq 8.2)
Where (g_x(i)) represents the experimental group.

The low ability students of the DD+ DI group were observed to register a higher learning gain of 33.51% as compared to 20.70% by the low ability students of the DD group. Moreover, the difference was observed to be significant (U = 133.5, $p < 0.05$, r = 0.34) - see Appendix XX of Appendix F). Consistent with the low ability students, the intermediate ability students of the DD+DI group were also noted to register a significantly higher learning gain of 40.70% as compared to 15.60% for the intermediate ability students of the DD. Overall the difference between learning gains of the DD+DI and DD groups was also found to be significant (U = 265.5, $p < 0.05$, r = 0.48). Complete details of the comparisons are compiled in Table 9-6.

Table 9-6: The learning gain comparison for both groups

Proficiency Level	N	Mean	SD	Significance Test (see Table IV in Appendix for complete results)
Low	DD (23)	20.70	17.83	Significant (U = 133.5, p <0.05, r = 0.38)
	DD+DI (18)	33.51	14.83	
Intermediate	DD (6)	15.60	12.23	Significant (U = 140.0, p <0.05, r = 0.32).
	DD+DI (9)	40.70	17.93	
overall	DD (29)	19.64	16.67	Significant (U = 309.0, p <0.05, r = 0.48)
	DD+DI (27)	35.91	15.86	

9.5.3.2 Participants' learning performance during the lessons

The percentage of students who completed their lesson successfully was used as an indicator to evaluate students' learning performance during each lesson. In other words, a group with the higher the percentage of students who completed their lesson successfully was considered as having a better learning performance. Recall that "completing their lesson successfully means getting all the answers right for that lesson within a time criterion". However, this indicator does not include students who failed to complete their lesson successfully. Simply taking the percentage who failed to complete their lesson was not an informative indicator because it was just the inverse of the first indicator. Thus, there was a need to introduce a better indicator to represent the students who failed to complete their lessons. For the students who failed to complete their lesson successfully, we used the quality of the partial answers as the second indicator. A group was considered to have a better learning performance if the quality of their answers (for those who failed) was better.

In the next section, an analysis of the first indicator (i.e. the percentage of students who completed their lesson successfully) is presented and this is followed by a discussion of the second indicator (i.e. the quality of answers for students failed to complete their lessons).

9.5.3.3 The percentage of students who completed their lessons successfully

Table 9-7 shows the comparison between the percentage of members of the DD and the DD+DI groups who completed their lessons successfully. As discussed before, the student had to work through four data-structures lessons in this experiment: recursive level 1, recursive level 2, linked list level 1 and linked list level 2. There were no significant differences between the two groups either by ability level or overall using Mann-Whitney test. In general, the DD+DI group were observed to have a slightly higher (but non significantly different) percentage of students who completed their lessons successfully. It was also noted that the percentage of students who completed their lessons successfully tended to decrease as the lessons became harder.

Table 9-7: Percentage of students who completed their lessons successfully

Ability	Group	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Average	
		%	Sig test	%	Sig test	%	Sig test	%	Sig test	%	Sig. test
Low	DD (23)	39.13	N	30.43	N	34.78	N	8.70	N	28.26	N
	DD+DI (18)	44.44		61.11		61.11		27.78		48.61	
Intermediate	DD (6)	66.67	N	33.33	N	33.33	N	16.78	N	37.52	N
	DD+DI (9)	66.67		55.56		55.56		44.78		55.64	
Overall	DD (31)	41.94	N	29.03	N	32.26	N	9.70	N	28.23	N
	DD+DI (33)	45.16		51.61		51.61		29.13		44.38	

9.5.3.4 The quality of answers for students who failed to complete their lessons successfully

In each lesson, students were asked to answer a variable number of questions depending on the lesson (see Chapter 7 for a sample screen). A score of 3 was given to each correct answer. Likewise, a score of 2 or 1 were given to a partially correct answer and no mark was given to a wrong answer. Thus, the quality of a student's answer for a lesson was an aggregate of all answers divided by the total number of questions. The formula to calculate the quality of students' answers is presented as follow:

$$\sum_{i=1}^{N} Q(i)/N \text{------------} \quad \text{equation 9.1}$$

Where
Q(i) = quality of question i.
N = total number of the question

The mean quality of each *unsuccessfully* concluded lesson is presented in Table 9-8. As the students could change their answers during the lesson, the quality of student's answer was calculated at the point when there was no more time left for that lesson. Although the difference in the quality of the students' answers between the two groups was not significant for any single lesson for both the low and intermediate ability students, the difference in the quality of students answers (of all students) at lessons 2 and 3 and in average quality across four lessons for all students were significant (Table VII of Appendix F for complete results).

Table 9-8: Analysis of the quality students' answer who failed to complete their lessons successfully

Ability	Group	Lesson 1		Lesson 2		Lesson 3		Lesson 4		Average	
		quality	Sig test	quality	Sig test	quality	Sig test	quality	Sig test	quality	Sig. test
Low	DD (23)	1.66	N	1.96	N	1.72	N	1.79	N	1.78	N
	DD+DI (18)	1.76		2.54		2.77		1.51		2.15	
Intermediate	DD (6)	1.00	N	2.45	N	2.31	N	1.82	N	1.89	N
	DD+DI (9)	2.00		2.73		2.31		2.02		2.27	
overall	DD (29)	1.52	N	2.06	Y*	1.84	Y**	1.80	N	1.80	Y***
	DD+DI (27)	1.84		2.60		2.62		1.68		2.19	

Significant value of Y* = (U=106.0, p<0.05, r= 0.30); Y** = (U=79.0, p <0.05, r= 0.40); Y*** = (U=1715.5, p<0.05, r= 0.40)

9.5.3.5 Summary of the performance results by experimental group

Results of the study indicated that the DD+DI group performed significantly better than the DD group by end of the experiment. A similar significant result was noted for the quality of students' answers of all students who failed to complete their lesson successfully. However, the difference between the DD and the DD+DI groups in term of the percentage of students who completed their lesson successfully was not significant. Moreover, no significant difference in performance was noted between the low and the intermediate ability students of the DD and the DD+DI groups at any of the four lessons. A summary of the findings of this section is shown in Table 9-9 below.

Table 9-9 : Summary of the findings of the difference in learning performance between the DD and DD+DI groups during and by the end of the experiment

Learning stage	Parameter	Students classification	Sig Test
By the end of the overall lesson			
	students' learning gain	Overall	Significant
		Low ability students	Significant
		Intermediate ability students	Significant
	Pre-test scores	Overall	Not significant
		Low ability students	Not significant
		Intermediate ability students	Not significant
	Post-test scores	Overall	Significant
		Low ability students	Significant
		Intermediate ability students	Significant
During the lessons	After secondary reaction		
	The percentage of students' who completed their lesson successfully	Overall	Not significant
		Low ability students	Not significant
		Intermediate ability students	Not significant
	The quality of students' answers of students who failed to complete their lesson successfully	Overall	Significant
		Low ability students	Not significant
		Intermediate ability students	Not significant

9.5.4 Did the integration of domain-independent strategies assist students of different ability to different degrees their learning?

In this section, the effect of the integration of the domain-independent strategies on students of different ability was examined. The analysis was conducted at two learning stages; by the end of the overall session and during each lesson itself. In each case we compared the performance difference between the intermediate and low ability students of the DD+DI group with the same performance difference for the DD group. If there was a marked difference between these differences we could conclude that the introduction of the DI strategy had a differential effect by ability.

9.5.4.1 By the end of the overall experiment

The difference in learning gain between the low and intermediate ability students in each of the two experimental groups was calculated and used as a learning performance indicator by the end of the experiment. The DD group recorded a learning gain difference of -5.10% between intermediate and the low ability students. In comparison, the DD+DI group recorded a learning gain difference of 7.19%. Mann-Whitney test indicates that the differences noted between the two groups were significant (Table 9-10).

In the DD group the low ability students gained more than the intermediate ability students, whereas in the DD+DI group the intermediate students gained more than the low ability students. This indicates a differential effect by ability of the addition of the DI strategy in favour of the intermediate students. The complete results of the analysis are presented in Table 9-10 (see Table VIII of Appendix F for complete results).

Table 9-10: The comparison of the difference in learning gain, pre- and post-tests between the two groups

group	Proficiency Level	Learning gain (post-pre test)	The difference in learning gain (intermediate – low) ability students	Sig Test	The difference in pre-test scores (intermediate – low ability students)	Sig. Test	The difference in post-test scores (intermediate – low ability students)	Sig. Test
DD group	Low	20.70%	-5.10%	Y*	26.52%	N	21.27%	N
	Intermediate	15.60 %						
DD+DI group	Low	33.51%	+7.19%		22.76%		29.93%	
	Intermediate	40.70%						

Significant value of Y* = (U=309.0, $p<0.05$, r= 0.50);

9.5.4.2 During the lessons

This section examines differential success by ability on a per-lesson basis within the experimental groups. As such, the difference between the low and intermediate ability students' in terms of the percentage of students who completed each lesson successfully and in terms of the quality of answers for those who failed to complete their lesson successfully were examined.

The Mann-Whitney test indicated that there was no significant difference between the differences by ability for either the percentage success or the quality of unsuccessful answers between the two groups (Table 9-11). Complete results of the analyses are in Table IX of Appendix F. One plausible reason was that the range of the scale used for measuring the quality of students' answers was narrow (between 0-3), hence, this made it difficult to achieve a significant difference.

Table 9-11: The comparison of the difference between the low and intermediate ability students for each group on the percentage who completed their lesson successfully and the quality of answers for those who failed to complete their lesson successfully.

Measures	Group	Ability	Average across four lessons	The difference between intermediate and low ability students	Significance
Percentage of students who completed their lesson successfully	DD	Low	28.26%	9.26%	Not significant (U=323.5, p>0.05, r= 0.30)
		Intermediate	37.52%		
	DD+DI	Low	48.61%	7.03%	
		Intermediate	55.64%		
The quality of answers for students who failed to complete their lesson successfully	DD	Low	1.78	11.00%	Not significant (U=167.0, p>0.05, r= 0.18)
		Intermediate	1.89		
	DD+DI	Low	2.15	12.00%	
		Intermediate	2.27		

9.5.4.3 Summary of differential learning effects by ability

In summary, the integration of domain-independent strategies into the system did assist students of intermediate ability to improve their learning gain significantly as compared to the low ability students by the end of the experiment. However, the difference between the low and intermediate ability students' on the percentage of students who completed their lesson successfully and the quality of answers for those who did not complete their lessons successfully during the lesson for both groups were not significant.

Table 9-12: Summary of the findings of the differences in learning performance between the low and intermediate ability students during the lessons and by the end of the experiment

Learning stage	Parameter	group	Significance
By the end of overall the lesson	The difference in learning gain between the intermediate and low ability students	DD	Significant
		DD+DI	
	The difference in pre-test scores between the intermediate and low ability students	DD	Not significant
		DD+DI	
	The difference in post-test scores between the intermediate and low ability students	DD	Not significant
		DD+DI	
During the lessons	After the secondary reaction		
	The difference in the percentage of students who completed their lesson successfully between the intermediate and low ability students for students	DD	Not significant
		DD+DI	
	The difference in the quality of answers for students who failed to complete their lesson successfully between the intermediate and low ability students.	DD	Not significant
		DD+DI	

9.5.5 Did the integration of domain-independent strategies into the tutorial system improve students' states of well-being?

The change in the state of participants' well-being for each group (i.e. the DD and the DD+DI) was measured at two learning stages;

i) At the end of the overall session (stage 12).

ii) During each lesson (stage 10)

9.5.5.1 By the end of the overall session

Participants' change in the state of well-being was measured using the following formula derived from their answers to the PANAS questionnaire.

Well-being Gain (WBG) = Well-Being at the end of the session – Well-being at the beginning of the session------------- equation 9.3

Overall, a Mann-Whitney test indicated that there was no significant difference in the change in the state of well-being between the DD+DI group and the DD group (Table 9-13) for both the low and the intermediate ability students, as well as overall.

Table 9-13: The participants' change of well-being by the end of overall session

	Group	**Mean**	**SD**	**Significance** (see Table X of Appendix F for complete results)
Low	DD (23)	-0.19	0.47	Not significant (U =221.0, p >0.05, r = 0.11)
	DD+DI (18)	-0.26	0.56	
Intermediate	DD (6)	-0.19	0.50	Not significant (U =29.0, p >0.05, r = 0.26)
	DD+DI (9)	-0.62	0.93	
overall	DD (29)	-0.19	0.48	Not significant (U =468.0, p >0.05, r = 0.36)
	DD+DI (27)	-0.38	0.68	

Also, it is noted that the students of both groups declined in well-being over the course of the experiment. However, this was not surprising. Analysis of students' performance for lesson 4 (the most difficult topic) indicated that only 9.70% of students of the DD group and 29.13% of the students of the DD+DI group (Table 9-7) completed their lesson successfully. This implies that they were likely to be in a state of negative well-being and this was reflected in the negative results for the changes in well-being by the end of the experiment.

To have a better insight, components of the equation (i.e. the students' initial state of well-being at the outset of the experiment and the final state of the well-being at end of the experiment) were examined. As such, the participants' initial state of well-being at the outset of the experiment and final state of well being were measured using Equation 4.1:-

Well-being (WB) = Av (positive affect) – Av(negative affect) ….. Reproduction of Eq 4.1

Table 9-14: The participants' initial state of well-being at the outset of the experiment

	Group	**Mean**	**SD**	**Significance (** see Table XI of Appendix F for complete results)
Low	DD (23)	0.27	0.73	Not significant (U =147.0, p >0.05, r = 0.21)
	DD+DI (18)	0.63	0.82	
Intermediate	DD (6)	0.08	0.51	Significant (U =76.0, p <0.05, r = 0.48)
	DD+DI (9)	1.21	0.67	
overall	DD (29)	0.23	0.68	Significant (U =281.0, p <0.05, r = 0.32)
	DD+DI (27)	0.82	0.77	

Mann-Whitney test results indicated that at the outset the differences in the state of well-being between the DD and DD+DI groups overall and of the intermediate ability students were significant but not for the low ability students. However, no significant differences were found for the groups as a whole or for either ability at the end of the experiment (Table 9-14 and Table 9-15).

Table 9-15: The participants' final state of well-being by the end of the overall session

	Group	**Mean**	**SD**	**Significance Test (** see Table XII of Appendix F for complete results)
Low	DD (23)	0.07	0.90	Not significant (U =175.0, p >0.05, r = 0.11)
	DD+DI (18)	0.35	1.05	
Intermediate	DD (6)	0.16	0.42	Not significant (U =36.0, p >0.05, r = 0.32)
	DD+DI (9)	0.64	1.24	
overall	DD (29)	0.09	0.80	Not significant (U =367.0, p <0.05, r = 0.26)
	DD+DI (27)	0.45	1.11	

9.5.6 The self-reported changes of participants' state of well-being during the lessons

During the experiment, changes in the students' state of well-being were analysed at two learning stages: a) primary reaction (stage 5) and b) secondary reaction (stage 10). As mentioned before, the participants were required to work through four lessons on two Data Structures topics (i.e. Recursive level 1, Recursive level 2, Linked List level 1 and Linked List level 2).

9.5.6.1 At the primary reaction (Stage 5)

After the primary appraisal stage (stage 3), students were presented with the primary reaction strategies. For the DD+DI group, the students were asked to do the relaxation exercise. By contrast, the DD group was just asked to sit quietly for the same amount of time as the relaxation exercise session. Following the primary reaction session, students of both groups were asked to self-report any change of their state of well-being in a scale of 5 (-2 to 2) via a single online question (see Figure 7-4).

Overall, the DD+DI group were observed to have a better change in their state of well-being than the DD group after the primary reaction stage. The differences in the self-reported changes for each ability classification were also significant. The complete results are presented in Table 9-16.

Table 9-16: The participants' self-reported change in their state of well-being at the end of the primary reaction stage

	Group	**Mean**	**SD**	**Significance (** see Table XIII of Appendix F for complete results)
Low	DD (23)	0.13	0.30	Significant (U= 57.5, $p<.05$, r= 0.11)
	DD+DI (18)	0.33	0.25	
Intermediate	DD (6)	0.16	0.42	Significant (U= 190.0, $p<.05$, r= 0.24)
	DD+DI (9)	0.64	0.70	
Overall	DD (29)	0.14	0.32	Significant ($p <0.05$) (U =450.0, $p <0.05$, r = 0.26)
	DD+DI (27)	0.43	0.40	

9.5.6.2 At the secondary reaction stage during the lessons (Stage 10)

Because students had different degrees of success with their lessons, some completing a lesson successfully and some not, the following analysis examines each outcome separately. Note that the assumption has been made (see Chapter 4) that a student who completed a lesson successfully would generally be in a positive state of well-being and one who did not would generally be in a negative state well-being. As such, the analysis of this stage was conducted depending on success in the lessons:- success and a state of positive well-being, and failure and a state of negative well-being. Just as for stage 3, the students of the study were grouped into two sub-categories:

a) Low ability students
b) Intermediate ability students

As discussed before, the students' change in state of well-being was measured using a single question in which they were asked to self-report any change in their state of well-being on a scale of 5 point (-2 to 2) via a single question (see Figure 7-4). This question was asked at the end of each of the four lessons (Stage 10).

9.5.7 The self-reported changes in participants' state of well-being who completed their lesson successfully and who were thus inferred to be in a state of positive of well-being

9.5.7.1 Low ability students

On average the low ability DD+DI students registered a significant positive change (Mann-Whitney test) in their state of well-being: 0.74 compared to -0.13 for the DD group (Table 9-17- see Table XIV of Appendix F for complete results).). Despite the overall difference, the results on a per lesson basis were mixed.

Table 9-17: The self-reported changes in the state of well-being after the reaction phase of the low ability students who succeeded on their lessons and so were inferred to be in a state of positive well-being

Lesson	**DD group**			**DD + DI group**			**Mann-Whitney test**
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	
First lesson	9 (39.1%)	0.11	0.78	8 (44.4%)	0.87	0.64	Not Significant (U=17.5, p >0.05, r = 0.46)
Second Lesson	7 (30.4%)	-0.14	1.21	11 (61.1%)	0.70	0.64	Significant (U= 23.0, p <0.05, r = 0.35)
Third Lesson	8 (34.8%)	0.51	0.99	11(61.1%)	0.81	0.75	Not Significant (U=40.5, p >0.05, r = 0.09)
Fourth lesson	2 (8.7%)	-1.00	0.60	5 (27.8%)	0.60	0.89	Significant (U=15.0, p <0.05, r = 0.20)
Total students	**26(28.3%)**			**35(48.6%)**			
Average		**-0.13**	**0.89**		**0.74**	**0.71**	Significant (U=1345.0, p <0.05, r = 0.23)

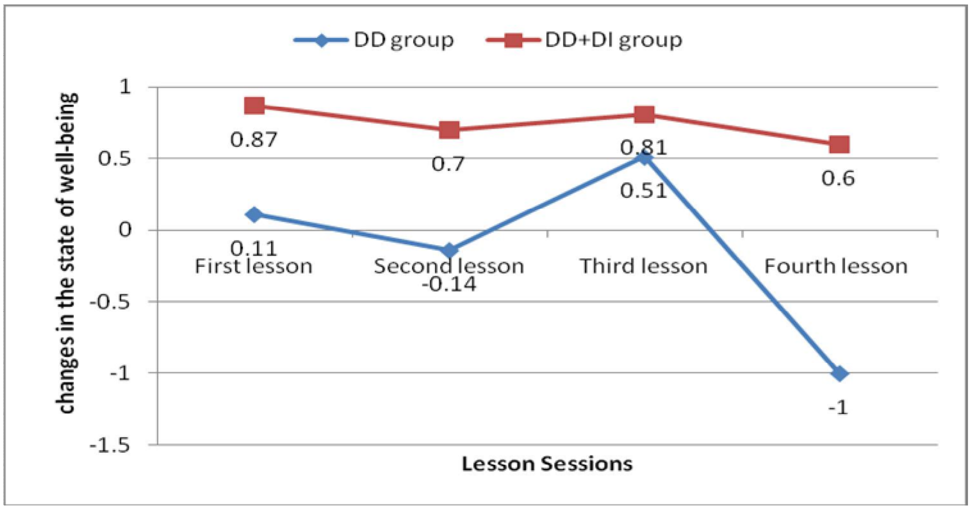


Figure 9-4: The self-reported changes in the state of well-being after the reaction phase of the low ability students who succeeded on their lessons and so were inferred to be in a state of positive well-being

9.5.7.2 Intermediate ability students

The score of self-reported changes in the intermediate students' state of well-being for the DD+DI and DD groups were 0.82 and 0.78 respectively. (Table 9-18 - see Table XV of Appendix F for complete results). Moreover, the Mann-Whitney test showed that the differences observed between the two groups were not significant across all four lessons.

Table 9-18: The self-reported changes in the state of well-being after the reaction phase of the intermediate ability students who succeeded on their lesson and so were inferred to be in a state of positive well-being

Lesson	**DD group**			**DD + DI group**			
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	**Significance**
First lesson	4 (66.7%)	0.75	0.50	6(66.7%)	1.00	0.63	Not Significant (U=9..5, p >0.05, r = 0.56)
Second Lesson	2 (33.4%)	1.50	0.50	5 (55.6%)	1.00	0.53	Not Significant (U=36.5, p >0.05, r = 0.10)
Third Lesson	2 (33.4%)	0.50	0.50	5(55.6%)	0.46	0.51	Not Significant (U=19.5, p >0.05, r = 0.20)
Fourth lesson	1 (16.7%)	0.00	0.00	4 (44.8%)	0.75	1.25	Not Significant (U=34.5, p >0.05, r = 0.15)
Total students	**9(37.5%)**			**20(55.6%)**			
Average		**0.78**	**1.51**		**0.82**	**1.71**	Not Significant (U=1751.5, p >0.05, r = 0.53)

A lesson by lesson analysis indicated that the intermediate ability students of the DD group had a slightly better (but not significantly different) score of state of well-being than the DD+DI group for lesson 1 and lesson 4. In contrast, the intermediate ability students of the DD+DI group reported a slightly better (but not significantly different) score in the change of their state of well-being for lesson 2 and 3 than the DD group.

Therefore, no clear trend in the self-reported changes of state of well-being between the two groups across the four lessons (Figure 9-5) could be established.

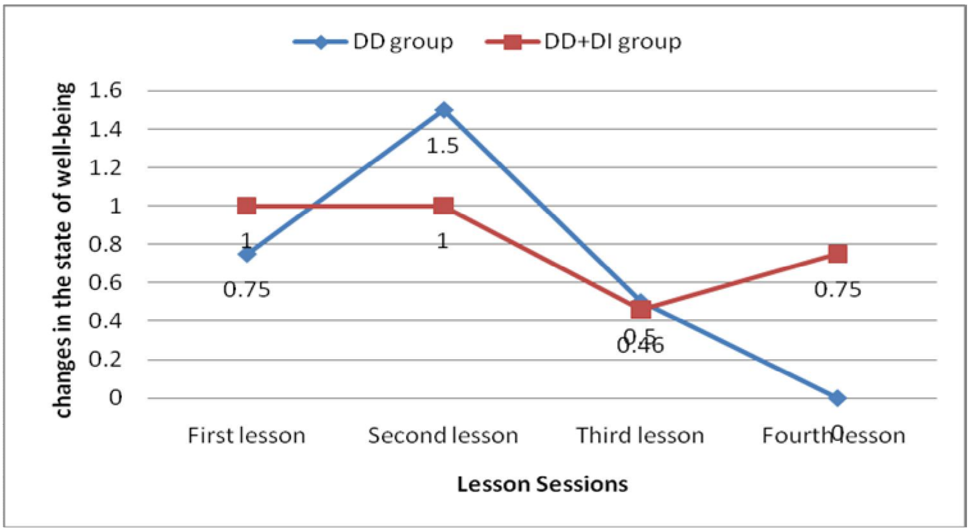


Figure 9-5: The self-reported changes in the state of well-being after the reaction phase of the intermediate ability students who succeeded on their lesson and so were inferred to be in a state of positive well-being

In nutshell, the findings of this section can be summarised as in Table 9-19.

Table 9-19: The self-reported changes in the state of well-being after the reaction phase of students who succeeded on their lessons and so were inferred to be in a state of positive well-being

	Group	**Mean**	**SD**	**Significance** (see Table XVI of Appendix F for complete results)
Low	DD (26)	-0.13	0.89	Significant (U=134.5, p <0.05, r = 0.23)
	DD+DI (35)	0.74	0.71	
Intermediate	DD (9)	0.78	1.51	Not Significant (U=300.0, p >0.05, r = 0.53)
	DD+DI (20)	0.82	1.71	
Overall	DD (35)	0.20	1.12	Significant (U=1421.0, p <0.05, r = 0.23)
	DD+DI (55)	0.76	0.97	

9.5.8 The self-reported changes in the state of well-being state of participants who failed in their lessons and so were inferred to be in a state of negative well-being

As indicated earlier, students who failed to complete their lessons successfully were inferred to be in a state of negative well-being.

9.5.8.1 Low ability students

The low ability students of the DD+DI group registered better scores than the low ability students of the DD group in their self-reported changes of their state of well-being during their lessons. Across the four lessons, the average change of the DD+DI group was 0.76 as compared to -0.28 for the DD group. This represented a significant difference (i.e. Mann-Whitney test) of 0.94 in the self-reported changes in the state of well-being between the two groups.

Table 9-20: The self-reported changes in the state of well-being after the reaction phase of the low ability students who failed in their lesson and so were inferred to be in a state of negative well-being

Lesson	**DD group**			**DD + DI group**			**Mann-Whitney test**
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	
First lesson	9 (68.9%)	-0.28	0.72	8 (56.4%)	0.50	0.70	Significant (U=115.0, p <0.05, r = 0.26)
Second Lesson	7 (69.6%)	-0.19	0.75	11 (29.9%)	0.71	0.48	Significant (U=125.0, p <0.05, r = 0.24)
Third lesson	15(65.2%)	-0.66	0.89	7 (38.8%)	1.14	0.37	Significant (U=253.0, p <0.05, r = 0.16)
Fourth lesson	21 (91.3%)	0.04	0.92	13 (73.2%)	0.69	0.63	Significant (U=225.0, p <0.05, r = 0.36)
Total students	**52(72.7%)**			**39(52.4%)**			
Average		**-0.28**	**0.82**		**0.76**	**0.54**	Significant (U=1222.5, p <0.05, r = 0.56)

Further analysis of the self-reported changes in the state of well-being at each lesson provides more evidence of the effect of the domain-independent strategies. Figure 9-6 shows that the DD+DI group consistently registered significantly better scores in the self-reported changes of well-being for every lesson. The Mann-Whitney test results comparing the differences between the low ability students of the two groups are shown in Table 9-20 (and see Table XVII of Appendix F for complete results)

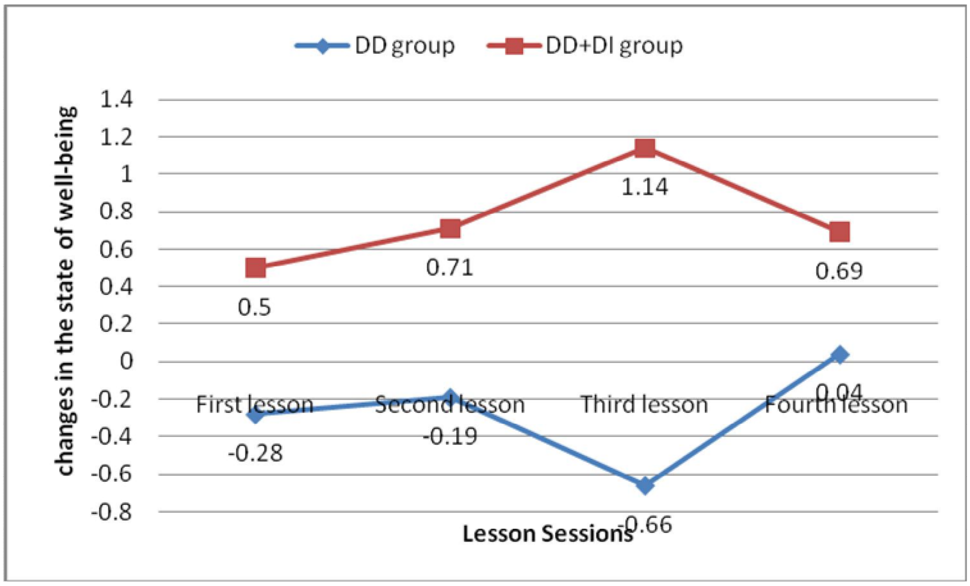


Figure 9-6: The self-reported changes in the state of well-being after the reaction phase of the low ability students who failed in their lesson and so were inferred to be in a state of negative well-being

9.5.8.2 Intermediate ability students

The intermediate ability students of the DD+DI group registered an average score of 0.81 across the four lessons. In comparison the intermediate ability students of the DD group registered an average score of 0.00 over the corresponding lessons. This indicated a significant difference of 0.81 (through Mann-Whitney test) the self-reported changes of state of well-being between the intermediate ability students of the two groups. (Table 9-21- see Table XXVIII of Appendix F for complete results)

Table 9-21: The self-reported changes in the state of well-being after the reaction phase of the intermediate ability students who failed in their lesson and so were inferred to be in a state of negative well-being

Lesson	**DD group**			**DD + DI group**			**Significance**
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	
First lesson	2 (33.3%)	-0.5	0.71	3(33.3%)	0.67	0.58	Significant (U=15.0, p <0.05, r = 0.26)
Second Lesson	4 (67.7%)	0.25	0.95	4 (44.4%)	0.50	1.00	Not Significant (U=13.0, p >0.05, r = 0.21)
Third Lesson	5 (67.7%)	-0.25	1.00	4(44.4%)	1.00	0.00	Significant (U=24.0, p <0.05, r = 0.36)
Fourth lesson	5 (83.73%)	0.20	0.83	5 (55.5%)	1.00	0.63	Significant (U=35.0, p <0.05, r = 0.31)
Total students	**16(63.5%)**			**16(43.8%)**			
Average		**0.00**	**0.89**		**0.81**	**0.55**	Significant (U=123.0, p <0.05, r = 0.46)

There exists a regular trend that the intermediate ability students of the DD+DI group registered better scores in the self-reported changes of state of well-being across the four lessons (Figure 9-7). A Mann-Whitney test indicates that the differences between the intermediate ability students of the two groups were significant for three of the four lessons (lessons 1, 3 and 4).

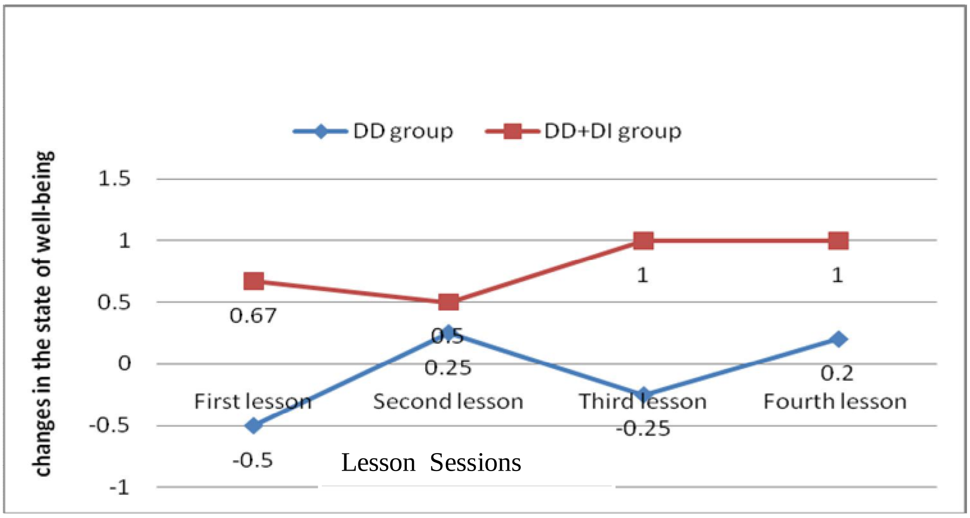


Figure 9-7: The self-reported changes in the state of well-being after the reaction phase of the intermediate ability students who failed in their lesson and so were inferred to be in a state of negative well-being

In nutshell, the findings of this section can be summarised as in Table 9-22.

Table 9-22: The self-reported changes in the state of well-being after the reaction phase of students who failed in their lesson and so were inferred to be in a state of negative well-being

	Group	**Mean**	**SD**	**Significance** (see Table XIX of Appendix F for complete results)
Low	DD (52)	-0.28	0.82	Significant (U=1234.5, p <0.05, r = 0.34)
	DD+DI (39)	0.76	0.54	
Intermediate	DD (16)	0.00	0.89	Significant (U=656.0, p <0.05, r = 0.53)
	DD+DI (16)	0.81	0.55	
Overall	DD (68)	-0.21	0.84	Significant (U=4325.0, p <0.05, r = 0.43)
	DD+DI (55)	0.77	0.54	

9.5.8.3 Summary of the well-being results by experimental group

The results indicated that the differences in the changes in student's state of well-being, as measured by the PANAS questionnaire pre- and post, between the DD and the DD+DI groups (overall and by ability level) was not significant at the end of the experiment. However, the analysis of the self-reported (single question) changes of students' state of well-being after the primary reaction indicates that the difference between the two experimental groups was significant (Table 9-16). At the secondary reaction stages the comparisons of the DD+DI vs DD groups provide mixed results. For students who succeeded in their lessons, there were significant differences for the low ability students but not for the intermediate ability students. For students who failed to complete their lessons successfully, there were significant differences for both low and intermediate ability students. A summary of the findings of this section is shown in Table (9-23 below).

Table 9-23: Summary of the findings of the self-reported changes of students' state of well-being for the DD and DD+DI groups during the lessons and by the end of the experiment

Learning stage	Parameter	Students classification	Significance
By the end of the overall lesson			
	The changes in students' state of well-being	Overall	Not significant
		Low ability students	Not significant
		Intermediate ability students	Not significant
	Initial state of well-being	Overall	Significant
		Low ability students	Not significant
		Intermediate ability students	Significant
	Final state of well-being	Overall	Not significant
		Low ability students	Not significant
		Intermediate ability students	Not significant
During the lessons	After primary reaction		
	The self-reported changes in students' state of well-being	Overall	Significant
		Low ability students	Significant
		Intermediate ability students	Significant
	After secondary reaction		
	The self-reported changes in students' state of well-being for students who completed their lesson successfully and inferred to be in a state of positive well-being	Overall	Significant
		Low ability students	Significant
		Intermediate ability students	Not significant
	The self-reported changes in students' state of well-being for students who failed to complete their lesson successfully and inferred to be in a state of negative well-being	Overall	Significant
		Low ability students	Significant
		Intermediate ability students	Significant

9.5.9 Did the integration of domain-independent strategies affect the state of well-being of students of different ability to different degrees?

This section examines differential changes in students' states of well-being conducted at two learning stages; by the end of the overall session and during the lessons themselves. That is to say it examines whether the differences between the intermediate and low ability students varied across the DD+DI and DD groups.

9.5.9.1 By the end of the overall session

The DD+DI group registered a difference of 0.14 between the intermediate and the low ability students on the change of their scores from the pre- to the post PANAS questionnaire for their state of well-being. In comparison, the DD group recorded a difference of -0.13. The Mann-Whitney test indicated that the difference between the two groups was significant (Table 9-24).

Table 9-24: The comparison of the difference in changes of the state of well-being for the two ability levels within the two experimental groups

	ability	Change of state of well-being by the end of the experiment	The difference of Well-Being score (Intermediate –Low ability students)	**Significance (** see Table XX of Appendix F for complete results)
DD group	Low	-0.19	-0.13	Y (U=2340.0, $p < 0.05$, r = 0.33)
	Intermediate	-0.32		
DD+DI group	Low	-0.26	0.14	
	Intermediate	-0.12		

Likewise, similar results were observed for the initial and final states of well-being. The differences of the initial and final states of well-being between the intermediate and low ability of students for both experimental groups (i.e. Mann-Whitney tests) were significant as in Table 9-25- (see Table XXIII of Appendix F for complete results).

Table 9-25: The comparison of the initial and final states of well-being for the two ability levels within the two experimental groups

	ability	Initial state of well-being	The diff of WB score (Int –low)	Sig Test	Final state of well-being	The diff of WB score (Int – low)	**Significance** (see Table XXIII of Appendix F for complete results)
DD group	Low	0.27	-0.19	Y*	0.07	0.09	Y**
	Intermediate	0.08			0.16		
DD+DI group	Low	0.63	0.58		0.35	0.71	
	Intermediate	1.21			1.06		

Sig level of Y* = U=2459.0, p <0.05, r = 0.56); Y** U=1670.0, p <0.05, r = 0.46)

Taken together these results imply that the intermediate students were more positively affected than the low ability students by the DI strategy, though care must be exercised because of the significant differences between the intermediate and low ability students initially.

9.5.9.2 During the lessons

9.5.9.2.1 Primary reaction

No significant differences were found in the self-reported changes in the state of well-being after the primary reaction stage between the intermediate and the low ability students of the DD and the DD+DI groups (Table 9-26 - see XXI of Appendix F for complete results).

Table 9-26: The difference in the self-reported changes of participants' state of well-being after primary reaction stage

	ability	Change of the state of well-being after primary reaction stage	The diff of WB score (intermediate –low)	Sig Test
DD group	Low	0.13	0.20 (SD 0.18)	N
	Intermediate	0.33		
DD+DI group	Low	0.16	0.48 (SD 0.34)	
	Intermediate	0.64		

9.5.9.2.2 Secondary reaction

In this section, the analyses were conducted separately for two subsets of groups the students; those who succeeded in their lesson and thus were inferred to be in a state of positive well-being and those who did not succeed in their lesson and thus were inferred to be in a state of negative well-being.

9.5.9.2.3 Student who were inferred to be in a state of positive well-being

The Mann-Whitney test indicated that there was a significant difference between the DD and the DD+DI groups in terms of the difference between the intermediate and low ability members of each of those groups for their self-reported changes of well-being after the secondary reaction stage (Table 9-27- see Table XXII of Appendix F for complete results).

Table 9-27: The difference in the self-reported changes of between intermediate and low ability participants' who were in a state of positive well-being after the secondary reaction

	ability	Change of the state of positive well-being after secondary reaction stage	The diff of WB score (Int –low)	Sig Test
DD group	Low	-0.13	0.91 (SD 0.24)	Y
	inter	0.78		
DD+DI group	Low	0.74	0.08 (SD 0.28)	
	Inter	0.82		

Sig level of Y = (U=2378.0, p <0.05, r = 0.42)

9.5.9.2.4 Within the DD group , those students who were inferred to be in a state of positive well-being

The intermediate ability students of the DD group (M= 0.78) registered a better average for their self-reported changes in the state of well-being as compared to the low ability students (M= -0.13) (Table 9-28- see Table XXIV of Appendix F for complete results).

Table 9-28: The self-reported changes in well-being score of the DD group after the reaction phase of participants who were inferred to be in a state of positive well-being

Lesson	**The low ability students of the DD group**			**The intermediate ability students of the DD group**			
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	**Sig-test**
First lesson	9 (39.1%)	0.11	0.78	4 (66.7%)	0.75	0.50	Not Significant
Second Lesson	7 (30.4%)	-0.14	1.21	2 (33.4%)	1.50	0.50	Significant (U=23.0, p <0.05, r = 0.25)
Third Lesson	8 (34.8%)	0.51	0.99	2 (33.4%)	0.50	0.50	Not Significant
Fourth lesson	2 (8.7%)	-1.00	0.60	1 (16.7%)	0.00	0.00	Not Significant
Total students	**26(28.3%)**			**9(37.5%)**			
Average		**-0.13**	**0.89**		**0.78**	**1.51**	Significant (U=1345.0, p <0.05, r = 0.21)

The Mann-Whitney test results indicated that the difference were significant for lesson 2 and for the average across four lessons, but not significant for lessons 1,3 and 4.

9.5.9.2.5 Within the DD + DI group, those who were inferred to be in a state of positive well-being

The differences between the self-reported changes between the two groups at each lesson were not significant (Figure 9-29- see Table XXXX of Appendix F for complete results).

Table 9-29: The self-reported changes in well-being of the DD+DI group after the secondary reaction phase of participants who were inferred to be in a state of positive well-being

Lesson	**The low ability students of the DD+DI group**			**The intermediate ability students of the DD+DI group**			
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	**Sig-test**
First lesson	8 (44.4%)	0.87	0.64	6(66.7%)	1.00	0.63	Not Significant
Second Lesson	11 (61.1%)	0.70	0.64	5 (55.6%)	1.00	0.53	Not Significant
Third Lesson	11(61.1%)	0.81	0.75	5(55.6%)	0.46	0.51	Not Significant
Fourth lesson	5 (27.8%)	0.60	0.89	4 (44.8%)	0.75	1.25	Not Significant
Total students	**35(48.6%)**			**20(55.6%)**			
Average		**0.74**	**0.73**		**0.82**	**1.71**	Not Significant

9.5.9.2.6 Students who were inferred to be in a state of negative well-being

Overall, the Mann-Whitney test revealed that there was a significant differences in the self-reported changes of state of well-being between the intermediate and low ability students for both the DD and the DD+DI groups (Table 9-30 - see Table XXVI of Appendix F for complete results).

Table 9-30: The difference in the self-reported changes in well-being of participants' who were in a state of negative well-being after secondary reaction

	ability	Change of the state of well-being after primary reaction stage	The diff of WB score (Int–low)	Sig Test
DD group	Low	-0.28	0.28 (SD 0.08)	Y
	inter	0.00		
DD+DI group	Low	0.76	0.05 (SD 0.07)	
	inter	0.81		

Sig level of Y = (U=3621.5, $p < 0.05$, r = 0.32)

The details of the study for both groups are presented below.

9.5.9.2.7 Students in the DD group who were inferred to be in a state of negative well-being

On average, both the low and intermediate ability students of the DD group registered negative changes of -0.28 and 0.00 respectively in their self-reported change of state of well-being at the secondary reaction phase. The average difference between the low and intermediate students was significant (Table 9-31 - see Table XXVI of Appendix F for complete results).

Table 9-31: The self-reported changes in well-being of the DD group after the secondary reaction phase of participants who were inferred to be in a state of negative well-being

Lesson	**Low ability DD group**			**Intermediate ability of the DD group**			
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	**Significant Test**
First lesson	9 (68.9%)	-0.28	0.72	2 (33.3%)	-0.5	0.71	Not Significant
Second Lesson	7 (69.6%)	-0.19	0.75	4 (67.7%)	0.25	0.95	Not Significant
Third Lesson	15(65.2%)	-0.66	0.89	5 (67.7%)	-0.25	1.00	Not Significant
Fourth lesson	21 (91.3%)	0.04	0.92	5 (83.73%)	0.20	0.83	Not Significant
Total students	**52(72.7%)**			**16(63.5%)**			
Average		**-0.28**	**0.82**		**0.00**	**0.89**	Significant (U=1124.0, $p < 0.05$, $r = 0.42$)

The intermediate ability students registered slightly better (but not significantly different) scores than the low ability students for the self-reported changes in their state of well-being for lesson 2 3 and 4 (Figure 9-8). The Mann-Whitney test results indicated that the differences between the two ability levels were not significant for any one lesson, but was significant overall.

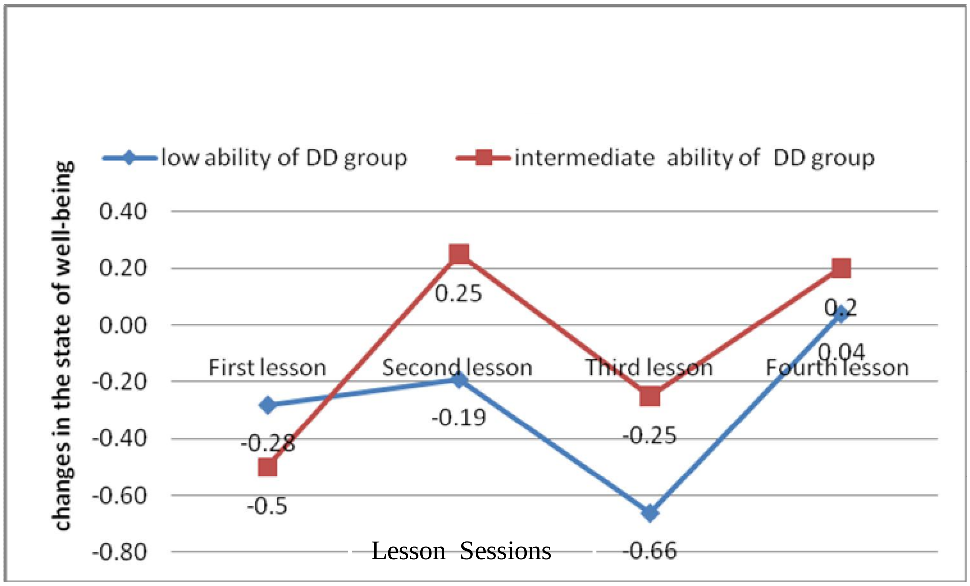


Figure 9-8: The self-reported changes in well-being of the DD group after the secondary reaction phase for participants who were inferred to be in a state of negative well-being

9.5.9.2.8 Students in the DD+DI group who were inferred to be in a state of negative well-being

The intermediate ability students of the DD+DI group had a score of 0.81 for their self-reported change in well-being as compared to a score of 0.76 for the DD+DI group after the secondary reaction phase. This represented a difference of 0.05 in the self-reported changes of the well-being state between the two groups. However, the Mann-Whitney test indicated that the difference was not significant (Table 9-32 - see Table XXVIII of Appendix F for complete results).

Table 9-32: The self-reported changes in well-being of the DD+DI group after the reaction phase of participants who were inferred to be in a state of negative well-being

Lesson	**Low ability students from the DD+DI group**			**Intermediate ability students from the DD+DI group**			
	N	**WB score**	**SD**	**N**	**WB score**	**SD**	**Sig-test**
First lesson	8 (56.4%)	0.50	0.70	3(33.3%)	0.67	0.58	Not Significant
Second Lesson	11 (29.9%)	0.71	0.48	4 (44.4%)	0.50	1.00	Not Significant
Third Lesson	7(29.9%)	1.14	0.37	4(44.4%)	1.00	0.00	Not Significant
Fourth lesson	13 (73.2%)	0.69	0.63	5 (55.5%)	1.00	0.63	Not Significant
Total students	**35(52.4%)**			**16(43.8%)**			
Average		**0.76**	**0.54**		**0.81**	**0.55**	Not Significant

Figure 9-9 depicts the trend in the differences for self-reported changes of state of well-being state between the low and intermediate ability students of the DD+DI group across all four lessons. The differences in the self-reported changes of state of well-being at each lesson and overall were not significant.

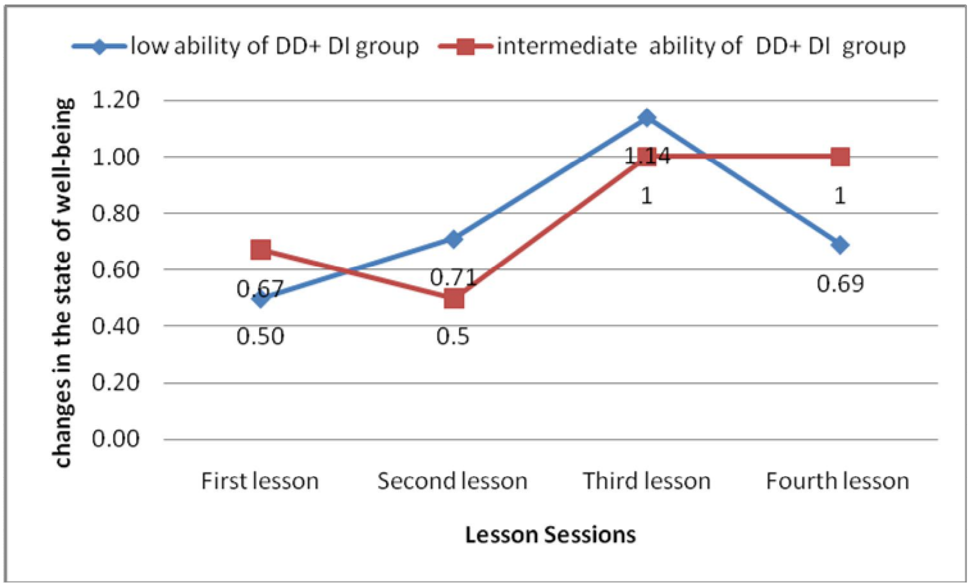


Figure 9-9: The self-reported changes in the well-being scores of the DD+DI group after the secondary reaction phase for participants who were inferred to be in a state of negative well-being

9.6 Summary of the differential well-being results by ability

Results of the study indicated that there was a significant difference in the self-reported changes of student's state of well-being between the low and intermediate ability students for both the DD and the DD+DI groups at end of the experiment. Similarly, significant differences in the self-reported changes of student's state of well-being were noted for the students who completed their lessons successfully and so who were inferred to be in a state of positive well-being and for students who failed to complete their lessons successfully and so who were inferred to be in a state of negative well-being). Only after the primary reaction stage, no significant differences were observed in the self-reported changes of student's state of well-being between the low and intermediate ability students. This shows that the deployment of domain independent strategies did have a differential impact on the self-reported changes in the state of well-being with regard to ability. A summary of the findings of this section is shown in Table 9-33 below.

Table 9-33 : Summary of the findings for the differences in self-reported change of students' state of well-being between the low and intermediate ability students during the lessons, and at the end of the experiment as measured by the PANAS questionnaire

Learning stage	Parameter	Significance
At the end of the overall session	The difference in the changes of state of well-being between the intermediate and low ability students as measured by the PANAS questionnaire	Significant
During the lessons	After primary reaction	
	The difference in the self-reported changes of state of well-being between the intermediate and low ability students	Not significant
	After secondary reaction	
	The difference in the self-reported changes of state of well-being between the intermediate and low ability students for students who completed their lesson successfully and inferred to be in a state of positive well-being	Significant
	The difference in the self-reported changes of state of well-being between the intermediate and low ability students for students who failed to complete their lesson successfully and inferred to be in a state of negative well-being	Significant

9.7 Conclusion

This section presents the overall findings of the study with regard to the questions posed at the outset of this chapter.

a) Did the use of domain-independent strategies improve students' learning performance in the affective tutoring system (ATS)?

Results of the study recorded that the DD+DI students had better learning gain (35.91%) than the students of the DD group (19.64 %). Also, the DD+DI group outperformed the DD group both for the low and intermediate ability students (see Table 9-6). This provides some support for the conclusion that the inclusion of domain independent strategies improved students' performance in the ATS system.

b) Did the integration of domain-independent strategies assist students of different ability to different degrees in their learning?

In general, the integration of domain-independent strategies into the system did assist students of intermediate ability to improve their learning gain significantly more as compared to the low ability students by the end of the experiment. However, the integration of domain-independent strategies did not differentially assist students of different ability of students' performance during the lessons themselves (i.e. the quality of answers for students who failed to complete their lessons successfully).

c) Did the integration of domain-independent strategies in the affective tutorial system improve students' state of well-being?

There was no significant difference in the changes in students' state of well-being as measured by the PANAS questionnaire between the DD+DI and the DD groups by the end of the experiment (see Table 9-13). Also, similar results were observed (i.e. no significant difference between the DD+DI and the DD students) when the students were compared according to their ability:- low and Intermediate .

There were significant differences between the DD+DI and the DD groups overall at the start of the experiment and also for the intermediate ability students (see Table 9-14). However, no significant differences were observed for the state of well-being of students of low ability. And, no significant differences were noted for overall, low and intermediate ability students in their final state of well-being (Table 9-14).

The DD+DI group had a significant difference in the self-reported change in their state of well-being compared to the DD group after the primary reaction phase (see Table 9-16). For students who *completed their lessons successfully*, the difference in the self-reported changes in their state of well-being between the DD and the DD+DI group was significant (see Table 9-23). Similar results were noted for the low (see Table 9-17 but not the intermediate ability (see Table 9-18) students.

As for the students *who failed to complete their lessons successfully*, there was a significant difference in the self-reported changes in their state of well-being after the secondary reaction stage between the DD+DI and the DD groups (see Table 9-22). In line with the overall findings, the findings for low and intermediate ability students across the four lessons also indicated a significant difference between the DD+DI and DD groups see Tables 9-20 and 9-21).

d) Did the integration of domain-independent strategies affect the state of well-being of students of different ability to different degrees?

Significant differences were noted between the DD+DI and the DD groups in the changes in the state of well-being as measured by the PANAS questionnaire between students of different ability by the end of the overall session (Table 9-24). There was no significant difference between the ability levels between the DD+DI and the DD groups in their self -reported changes of well-being after the primary reaction stage. At the secondary reaction stage, there were significant differences between the ability levels between the DD+DI and the DD groups in their self -reported changes of well-being both for those that succeeded in their lessons (Table 9-27) and for those who did not (Table 9-30).

Chapter 10

Discussion

The purpose of this chapter is to use the evidence presented in Chapters 8 and 9 to set the findings of the empirical work in a broader context. This chapter is organised around the research questions presented at the outset:

10.1 Did the use of domain-independent strategies improve students' learning performance in the affective tutoring system (ATS)?

There is evidence to show that the use of domain-independent strategies improved students' performance. For instance, findings of the <u>main</u> study revealed that the DD+DI students obtained a higher learning gain than the students of the DD group by the end of the experiment. Also, the DD+DI group outperformed the DD group for both the low and intermediate ability students (see Table 9-6). Moreover, the <u>pilot</u> study results also indicated that the DD+DI group obtained a higher learning gain than the DD group.

Just looking at the students' learning gain by the end of the overall sessions does not on its own provide sufficient evidence to support the premise. The improvement of the students' learning performance could be attributed to their proficiency level (i.e. pre-test scores) at the outset of the experiments. For instance, Thomson & Zamboaga (2004), Steven et al. (2006) and Bandura (1997) claim that student's prior knowledge contributed significantly to their performance. Thus, it is important to study the students' initial proficiency level so that the cause of their performance can be further examined. Results of <u>both</u> studies indicate that differences in the pre-test scores of both the DD and the DD+DI groups were insignificant (see Table 9-4); the students are of the same level of proficiency.

So, if the prior knowledge of students in the two experimental groups was of the same level, it is plausible to argue that the significant difference in students' performance can be attributed to the use of different strategies presented to the students. Furthermore, results of the post-test scores between the two groups are also noted to be significantly different; the DD+DI performed better than the DD group (see Table 9-5).

This evidence supports the notion that the integration of domain-independent strategies within the ATS contributed to the enhancement of students' achievement. Analysis the quality of answers for those who failed to complete their lesson successfully (see Table 9-8) during their learning session indicates that the DD+DI group performed better than the DD group. Although not significant, the DD+DI group were observed to have a slightly higher percentage of students who completed their lessons successfully than the DD group.

Results from this study complement the results reported by other research on the use of domain-independent strategies (i.e. relaxation exercise and positive affirmation) within an educational environment. For instance, TestEdge® (2003), domain-independent strategies software, recorded a 35% improvement in math scores and a 14% improvement in reading scores. In a similar vein, the work of Carlson et al., (2008) and other recent studies (e.g. Coe et al., 2006; Castelli et al., 2007; Trudeau & Sherhard, 2008; David et al., 2007) also report that domain-independent strategies contribute to a small but significant gain in academic achievement in mathematics, reading and grade point average.

There is also evidence that the use of domain-independent strategies in the classroom improves students' performance (e.g. Barber, 1982; Matthews, 1983; Benson et al., 2000; Deckro et al., 2002). Besides, the effective use of domain-independent strategies has been reported in various other studies:- test anxiety (Virean, 1999), and addiction treatment (Henshaw, 2006). Within the ATS community, there are also studies that indicate that use of domain-independent strategies has improved students achievement (e.g. Andre et al., 1999; Lester et al., 1999a, 1999b).

Cognitive self-perception theories (e.g Bandura 1997; Scherer, 1999) may offer a plausible explanation for the outcome. The domain-independent strategies are expected to improve the state of students' well-being which, in turn, boosts their self-perception (Pajares, 2002, Bandura, 1997, Fredrickson & Levenson, 1998; Pekrun et al., 2002, 2006; Goetz, 2008). Cognitive self-perception theories (e.g. Bandura 1997; Scherer, 1999) assert that the enhancement of the students' self-perception (e.g. self-efficacy and self-esteem) allows them to have a greater sense of self-control or self-awareness over their ability and resources (Canfield, 2006; Henshaw, 2005; Seligman, 1991). Consequently, these students become more motivated (Bandura, 1997), more likely to try harder, persist longer and be more creative (Durr, 2006; Fredrickson & Levenson, 2001), put in a higher degree of effort (Schunk, 2000; Pekrun et al., 2006) and be in a better position to manage their state of well-being. These good qualities, in turn, contribute to the enhancement of the students' performance. In a nutshell, there is evidence from this study to support the hypothesis that the integration of the domain-independent strategies in the ATS system improved students' performance.

10.2 Did the integration of domain-independent strategies assist the learning of students of different ability to different degrees?

In general, the integration of domain-independent strategies did assist students of different ability from the DD and the DD+DI groups to different degrees in their learning by the end of the experiment (see section 9.5.4). However, contrasting results were noted during the lessons; no significant difference was found as a result of the deployment of domain-independent strategies to assist students of different ability to different degrees during their learning. The results are, however, not surprising. Within the ATS community, there are several studies that have produced similar results. For instance, Rebelledo et al. (2006) and Martinez-Miron et al. (2004) reported that the deployment of motivational techniques did not differentially assist students of different ability in learning. Furthermore, there are a substantial number of studies which have produced comparable results. For example, the use of domain-independent strategies (i.e. relaxation and positive affirmation) did not assist students of different ability in a recognition task (Stricherz and Stein, 1980), in students' leaning gain and performance (Job & Depamo, 1991; Doris, 1994; Durr, 2006) and in students' self-concept test scores (Philpot & Bamburg, 1996).

These equivocal partial results can be explained through learning style (e.g. Gardner, 1993; Van der Meij, 2008; Merrill,2000; Zikuda et al., 2005) and adaptive learning system theories (Beokaert, 2003). Based on these theories, students of different ability have different learning styles and should be assisted differently (Hargreaves 2000). By understanding different learning styles, suitable adaptive strategies to assist students of different ability in learning (i.e. to address both affective and cognitive learning elements) can be deployed (Zikuda et al., 2005). However, in our study, a generic domain-independent strategy (i.e. the same relaxation script) was used for all students (for both the low and intermediate ability students). Therefore, we suggest that the lack of performance difference by ability of the use of the domain-independent strategies is partly attributed to the absence of such adaptable strategies.

Moreover, the performance of students of different abilities is influenced by many factors. Across the literature, there is growing evidence that these factors include affect, motivation and effort, self-confidence, teachers and the learning environment itself. (Pekrun, 2006; Hargreaves 2000; Jarvela et al., 2008; Margolis & McCabe, 2006). Moreover, these factors do not work in isolation (Goetz et al., 2008). Rather, they are all interconnected to influence the students' learning performance.

By contrast, our study concentrated only on the improvement of the state of well-being (i.e. an affective factor) as a means to assist students of different ability in learning. As suggested by Brunning et al., (1999), considering only a single aspect of the learning attributes, such as the affective factor, might have an adverse effect on the students' learning. This may lead to the use of incorrect or insufficient remedial strategies for assisting students of different ability. Consequently, this could contribute to the partial result for this aspect of the study.

10.3 Did the integration of domain-independent strategies in a tutorial system improve students' state of well-being

10.3.1 By the end the experiment

Results from the main study indicate no significant difference in the changes of students' state of well-being for all three categories (all students, intermediate and low ability) between the DD+DI and the DD groups by the end of the experiment as measured by the PANAS questionnaire (see section 9.5.5.). There are several possible explanations. The first concerns the limited training session. Gaines (2005) asserts that the lack of a training session hinders students from efficiently performing the relaxation session and this has had a negative repercussion on the students' state of well-being. This is consistent with the findings by Groden et al. (1984) who point out that subjects in their studies enjoyed the benefits of relaxation exercises only after a fair amount of practice.

Within our ATS context, students were presented with only three relaxation exercises sessions at the outset of the experiments. This was perhaps too little compared to other studies that use domain-independent strategies. For instance, Benson et al. (2002) assessed the impact of the relaxation exercise over a whole academic semester (students were asked to do the relaxation exercise every week for about 4 months). In the same vein, Matthews (1983) conducted a 15-minute relaxation training session every day for a period of nine months to assess the effectiveness of the domain-independent strategies. This degree of intense training was not a possibility in our research.

Lacking a clear enough rationale among the participants could be another cause for the non significant results (Gaines, 2005). This phenomenon is particularly common in experiments using volunteers (Gaines, 2005). Participants of such studies sometimes feel that there is no reason to improve their performance. Consequently, participants might feel less emotionally engaged and this may also have reduced the effectiveness of relaxation exercises session. Again, we had no option but to use volunteers.

Another possible reason could be the duration of the relaxation exercise itself. The original Benson's relaxation method needs at least 10 to 20 minutes to practice. In contrast, the duration of relaxation exercise offered to the students in the main study was only about two and half minutes. As pointed out by Felix (1989) and Deckro et al., (2002), the longer duration of the relaxation exercise contributes positively to the efficiency of the relaxation exercise session. It is therefore, plausible that the duration of the relaxation could be one of the causes for the non significant results of the main study. In our study, it was not possible to allocate 10-20 minutes relaxation session as the allocated learning session was only 90 minutes.

We noted that there were some differences in the findings of the <u>main</u> and the <u>pilot</u> studies. However, as the analysis of the pilot study was not conducted according to the students' ability (i.e. the low and intermediate ability students were combined into one group), only the overall results of the <u>main</u> and <u>pilot</u> studies were compared.

The first difference was the comparative initial state of well-being at the beginning of the session. While the <u>pilot</u> study indicated no significant difference between the DD+DI and the DD groups (chapter 8), for the <u>main</u> study this was not the case (chapter 9). The difference in the experimental setups between the main and the pilot studies could have contributed to the inconsistent results. In the pilot study, the DD and the DD+DI groups both undertook the relaxation exercise training before their states of well-being were gauged. Consequently, they were expected to have comparable states of well-being (i.e. no significant difference in their initial states of well-being). By contrast, only the DD+DI students undertook the relaxation exercise training in the main study. As a result, only the initial states of well-being of the DD+DI students were improved, which contributed to the significant results of the main study. In retrospect, it is clear that it would have been better to measure the initial degree of well-being prior to any interaction including the training.

The second contradictory finding was about the changes in students' state of well-being by the end of the experiment. The <u>main</u> study results indicate that the difference in changes in the students' states well-being between the DD+DI and the DD group was not significant. By contrast, the <u>pilot</u> study results suggest otherwise. The disagreement in the findings may be related to a shortcoming of the experimental design of the pilot study. In the pilot study, students were allowed to freely select their upcoming lesson. As a result, each student ended with different learning topics and this may well have affected their state of well-being.

10.3.2 During the lessons

To further examine the effectiveness of the integration of the domain-independent strategies, analyses of the results during the lessons (primary reaction stage (phase 5) and secondary reaction stage (phase 10)) were made. In the primary reaction phase, findings of the main study indicated that the DD+DI group had a significant better self-reported change in their state of well-being than the DD group. Not much can be compared to in the findings of the pilot study as no comparison was made in the students' behaviour between the DD+DI and the DD groups.

As for the secondary reaction phase, students were classified post hoc into two groups for each lesson. The first group consisted of students who completed their lesson successfully and second group consisted of students who failed to complete their lesson successfully. The students who completed their lesson successfully were inferred to be in a state of positive well-being. On the contrary, the students who failed to complete their lesson successfully were inferred to be in a state of negative well-being.

Overall, the main and pilot studies indicated that the self-reported changes in the states of well-being over the course of four lessons for students who completed their lesson successfully were significant. Likewise, significant differences were noted for low ability students but not for the intermediate ability students (see Table 9-19). Cognitive appraisal theories (e.g. Lazarus, 1991; Fridja, 1986; Gross, 1999) offer a plausible explanation for this situation. According to these theories, low ability students are believed to be less capable in completing their lesson successfully. To these students, completing a lesson successfully is considered to be a worthy achievement and subsequently, elicits positive well-being. The integration of domain-independent strategies (i.e. relaxation and positive affirmation strategies) would make the students to have a better control over their ability and resources and in turn, able to better manage their state of positive well-being (Gross, 1999; Love, 2005 ;Seligman,1991).

In contrast, intermediate students are more competent and are expected to achieve better result in learning. Therefore, producing desirable outcomes are within their expectation and would elicit moderate intensity of positive well-being to them after a desirable result is achieved during a learning episode, (i.e. successful completion of the lesson). Consequently, any effort to improve their affective state by the domain-independent strategies may not be effective.

As for the students who failed to complete their lessons successfully, the findings of the main study reveal a significant difference in the self-reported changes of the state of negative well-being after the secondary reaction phase between the DD+DI and the DD groups. In line with the overall findings, the findings of both the low and the intermediate ability students across four learning lessons also indicated a significant difference between the DD+DI and DD groups. Moreover, all the findings of the pilot study were consistent with the main study.

Many benefits have been reported to be associated with the domain-independent strategies (i.e. relaxation exercises and positive affirmation) with regard to a state of negative well-being. Some of the general benefits include a reduction in general anxiety, prevention of cumulative stress and increased self-confidence (Bourne, 2000). Likewise, the domain-independent strategies can increase the students' awareness and thus enable them to relax when they become stressed during their lesson (Neimark, 2001). Besides, relaxation exercise can improve the blood circulation by opening some blood vessel around the stressed body and therefore relieves the stress (Sultanoff & Zalaquett, 2000).

Seligman (1991) asserts that people who practice relaxation exercises have a greater sense of self-control or self-awareness over their ability and resources. He believes that relaxation exercise and positive affirmation are powerful tools for building worthiness and self-perception. As a result, they are expected to be better in managing their state of negative well-being (Gross, 1999; Love, 2005).

The effectiveness of the domain-independent strategies in improving individual state of negative well-being has been recorded in many empirical findings across many research areas (e.g. Benson et al., 2000; Deffenbacher, 2000; Rasid & Parish, 1998; Sapp, 1996; Spalding, 2000). There is evidence that relaxation therapy has helped patients control their hostile and aggressive behaviour (Deffenbacher et al., 1990); reduce tension headaches, (Blanchard et al., 1979); Primavera & Kaiser, 1992; and Mehta, 1992, and manage depression amongst a group of hospital cleaners (Toivanen et al., 1993).

Therefore the findings confirm many results on the use of domain-independent strategies within an educational setting (e.g. Barber, 1982; Matthews, 1983; Benson et al., 2000; Deckro et al., 2002, Johnson, 1982; Britton and Virean,1999). For example, Deckro et al. (2002) claim that relaxation exercises help in reducing psychological distress, state anxiety, and perceived stress between the experimental group and the comparison group. In a similar vein, TestEdge®,(2003) reports that positive-emotion focused and relaxation exercises techniques are useful in improving users' affective state anxiety levels.

However, to our knowledge, except for TestEdge® (2003), not many such comparisons have been made within the ATS community as very few systems have been developed. Nevertheless, the consistent findings of the main and pilot studies provide evidence for the effectiveness in the use of the domain-independent strategies within ATS environment.

More particularly, evidence from the studies indicates that the use of domain-independent strategies improves the states of well-being of students who are initially in a state of negative well-being, but not the students who are already in a state of positive well-being.

10.4 Did the integration of domain-independent strategies affect the state of well-being of students of different ability to different degrees

As anticipated, the effective use of domain-independent strategies should regulate the impact of the state of positive well-being (i.e. when they completed their lesson successfully) or the state of negative well-being (i.e. when they failed to complete their lesson successfully) for both the low and intermediate ability students of the DD+DI group. Consequently, this should lead to a smaller gap between the self-reported changes in the state of well-being for students of different ability (i.e. low and high) in the DD+DI group. In contrast, the absence of domain-independent strategies within the DD group would be reflected in a larger difference in the self-reported changes of the state of well-being for students of different ability. Analysis of the changes in the state of well-being of students of different ability by the end of the overall session revealed significant results. This suggests that the use of domain-independent strategies assist the change the state of well-being of students of different ability to different degrees by the end of the experiment.

Likewise, results of the students' initial state and the final state of well-being indicated indicate that there were significant difference observed in students of different ability (intermediate and low) from the DD+DI and the DD groups (see section 9.5.10) . This makes it harder to interpret the results with certainty.

During the lessons, students' state of well-being was measured at two phases; after the primary reaction and after the secondary reaction. However, results after the primary reaction were contradicted with the initial state of well-being; the difference in the self-reported changes in the state of well-being of students of different ability between the DD+DI and DD groups were not significant. As in the initial phase, the student's main concern remained unchanged; the lesson was not yet started. Hence, less attention may have been given to the regulation process of their affective (i.e. well-being) state (Lazarus, 1991; Ortony et al. 1988). As a result, the gap between the students of different ability was not narrowed which contributed to the non significant difference in the self-reported changes in the state of well-being of students of different ability after the primary reaction.

As for the secondary reaction phase, the difference in the self-reported changes of state of well-being between the intermediate and low ability students who completed their lessons successfully and were inferred to be in a state of positive well-being and the difference in the self-reported changes of state of well-being of students who failed to complete their lesson successfully were also significant.

The significant result of the self-reported changes in the positive state of well-being of students of different ability between the DD+DI and DD groups contributed to the smaller gap in the states of positive well-being between the low and intermediate ability students within DD+DI group. This was probably due to the use of the domain-independent strategies in regulating the students' state of positive well-being offered to the DD+DI students. Across the literature, a number of researchers conclude that domain-independent strategies are effective in helping students to regulate their state of positive well-being (e.g. Asletnier, 2000; Zikuda et al., 2005; Jarvela et al., 2008; Van der Meij, 2008; Pekrun et al., 2002).

The difference in the self-reported changes of state of well-being between the intermediate and low ability students for students who failed to complete their lesson successfully and so who were inferred to be in a state of negative well-being was also significant(see Table 9-30). The provide another evidence to the benefit of the integration of domain-independent strategies into an affective tutoring system. Unfortunately, no comparison could be carried out in the findings between the main study and the pilot study (i.e. not measured in the pilot). Likewise, to our knowledge, very few attempts have been made to study the affect of domain-independent strategies on student of different ability. As such, it is difficult for us to compare the performance of our ATS system with other ATSs.

In conclusion, the evidence gathered from this study indicated that the use of domain-independent strategies did affect the changes of state of positive well-being of students of different ability to different degree by the end of the session. By contract, the use of domain-independent strategies did not affect the changes in the state of negative well-being of student of different ability to different degrees by the end of the session.

10.5 Conclusion

Overall, the findings of the study have thrown some light on the research questions posed:

a) Did the use of domain-independent strategies improve students' learning performance in an affective tutoring system (ATS)?

There is evidence which shows that the integration of the domain-independent strategies into an affective ITS environment improved student performance.

b) Did the integration of domain-independent strategies assist students of different ability to different degrees in their learning?

Results for the study provide evidence which shows that the use of domain-independent strategies did assist students of different ability to different degrees by the end of the lesson but not during the lessons.

c) Did the integration of domain-independent strategies in the affective tutorial system improve students' state of well-being?

By the end of the study, there was no significant difference in the changes of the state of well-being between the DD+DI and the DD groups. However, Results of the analysis during the lessons indicated that the use of domain-independent strategies did improve the state of positive well-being of students who completed their lessons successfully and the state of negative well-being of students who failed to complete their lessons successfully.

d) Did the integration of domain-independent strategies affect the state of well-being of students of different ability to different degrees?

By the end of the study, significant difference was noted in the changes in the state of well-being of students of different ability. In addition, the use of domain-independent strategies during the lessons indicated that the strategies did affect the self-reported changes in the state of well-being of students who were in a state of positive of well-being but not for students who were in a state of negative well-being to different degrees according to their ability.

Although the study was far from complete, our study presents early evidence to support the premise that the integration of domain-independent strategies into an affective ITS system is useful in regulating participants' affective states and improving their learning performance.

Chapter 11

Conclusion

In this chapter, we present the conclusion of this thesis. First, the work carried out in establishing the ATS framework is presented, followed by some pointers to possible future lines of research relating to the framework.

11.1 Review of work

The thesis started by reviewing the importance of emotions in a learning environment and exploring the concept of emotional intelligence and how it contributes to the improvement of students' emotional states in learning. The thesis further explored the regulation process which underpins the emotional intelligence concept. The thesis then reviewed and analysed the current frameworks for an affective tutoring approach which were designed to consider students' affective states in learning (Chapter 2).

The analysis revealed that there are two main gaps between emotion regulation models and current intelligent affective tutoring systems. In order to bridge these gaps, the thesis argued for an affective tutoring system (ATS) framework that integrates the following:

- The introduction of two appraisal and reaction phases: the primary and the secondary appraisal stages. Whilst the primary appraisal is proposed to be carried out before the start of a lesson, the secondary appraisal is proposed to be conducted during the lesson itself.

- The integration of a domain-independent strategy into the reaction phase of the ATS framework to help cope with the student's affective states.

This thesis presented the results of two small exploratory studies that provide support for the proposed approach of the ATS framework (Chapter 3).

The approach of the two appraisal phases of the ATS framework was formulated in Chapter 4. These appraisal phases were aimed at inferring the student's state of well-being. At the beginning of the experiment session, the student's state of well-being was inferred using the *well-being* formula which subtracted the negative overall affective state from the positive overall affective state as derived from the PANAS questionnaire. In the secondary appraisal phase, following the OCC model, (Ortony et al. 1988) the student's state of well-being is appraised using three interaction variables: namely self-belief, independence and number of attempts.

As the integration of a domain-independent strategy is considered to be the main contribution of this thesis to the ITS community, a chapter was dedicated to it (Chapter 5). Based on the exploratory studies (Chapter 3) and the review across a wide research spectrum, two components for the domain-independent strategy were identified and integrated into the reaction phases of the ATS framework; the positive affirmations and the relaxation exercises, i.e. breathing and muscle exercises.

This thesis extends the formulation of the reaction phases of the ATS framework (Chapter 6). Using results from user-centred studies (Chapter 5), suitable approaches for the reaction phases of the framework were identified which use both domain-dependent and domain-independent strategies to cope with the student's affective state. The implementation of the ATS software, designed to teach Data Structures to the students of the College of Computer Science and Information Technology, University Tenaga Nasional was presented in Chapter 7.

A pilot study was conducted as an attempt to explore the suitability of the ATS framework within a Malaysian student environment. Although the study provided some early evidence of the effectiveness in use of the domain-independent strategies to regulate and help students in learning, several limitations were indentified (Chapter 8). These limitations were used to formulate a better experimental procedure for the main study.

An experimental study was conducted to explore the efficacy of the ATS framework (Chapter 9) and to answer the following four research questions:

a) Did the use of domain-independent strategies improve students' learning performance in the affective tutoring system (ATS)?

Results for the studies (both main and pilot) provided evidences that the use of domain-independent strategies (i.e. relaxation exercises and positive affirmation) did assist students of different ability to different degrees at two learning phases either:- during and at the end of the study.

b) Did the integration of the domain-independent strategies assist students of different abilities to different degrees in their learning?

Results for the studies (main and pilot) have provided evidence that the use of domain-independent strategies (i.e. relaxation exercises and positive affirmation) did assist students of different ability to different degree by the end of the lesson but not during the lessons.

c) Did the integration of domain-independent strategies in the affective tutorial system improve students' state of well-being?

Overall, the results of the study suggest that the domain-independent strategies did not improve the state well-being at the end of the study. However, Results of the analysis during the lessons indicated that the use of domain-independent strategies did improve the state of positive well-being of students who completed their lessons successfully and the state of negative well-being of students who failed to complete their lessons successfully.

d) Did the integration of the domain-independent strategies affect the state of well-being of students of different abilities to different degrees?

The results of the studies indicated that the domain-independent strategies did affect the changes in the state of well-being of students of different abilities to different degrees by the end of the study. Also, the analysis of the use of domain-independent strategies during the lessons indicated that the strategies did affect the self-reported changes in the state of well-being of students who were in a state of positive of well-being but not for students who were in a state of negative well-being to different degrees according to their ability.

Finally, a discussion that summarised the findings from the pilot and the experimental studies was presented in chapter 10.

11.2 Contributions

The contributions of this thesis are as follows:

a) To have designed, developed and implemented an affective tutoring system (ATS) framework that bridges the gap between psychological emotion theories (i.e. emotional intelligence and emotion regulation) and affective ITS frameworks.

   Following emotion regulation models (e.g. Gross, 1999; Lazarus, 1991), the system integrates the primary and the secondary appraisal phases at two learning stages into current affective ITS frameworks. The first appraisal (primary) stage takes place at the beginning of a lesson and the second appraisal (secondary) appraisal takes place after the lesson. In contrast, current affective ITS frameworks appraise student's affective state during a learning session. The integration of these appraisal stages has been shown to make the ATS framework effective.

b) To have identified and formulated the domain-independent strategies within the ATS framework.

   Analysis from an empirical study conducted within a Malaysian students' environment identified two components of the domain-independent strategy (i.e. relaxation exercise and positive affirmation). Using the results, the mechanisms of the two components were formulated.

c) To have integrated a domain-independent strategy as a component of the reaction phases of an affective ITS framework.

   Current affective ITS frameworks predominantly use domain-dependent approach in response to a student's affective state (e.g. Conati & Zhou, 2002; del Soldato & du Boulay, 1995; Reilly et al., 2001; Lester et al., 1999a). However, according to emotion regulation models, individuals use both domain-dependent and domain-independent strategies in coping with a problematic environment (e.g. Folkman & Lazarus; 1986; Folkman et al., 1986; Folkman & Lazarus, 1988). Therefore, a domain-independent strategy was included as a component of the reaction phase of an ATS framework.

d) To have evaluated the system in use and provided empirical evidence that the integration of domain-independent strategy in an affective ITS framework improved both the learning performance and students' affective state by the end of a learning session.

   Results from the study provide evidence that the integration of the two appraisal phases and the domain-independent strategy helped the students' to manage their affective states and improve their learning performance.

11.3 Limitations of the study

Although several promising findings were observed during this study, there are several limitations in this study. One of the main drawbacks of this study was the small numbers of participants – in most cases N was less than 15. The main consequence of this small sample was that the data tended to be non-normal. As a result, a more powerful inferential parametric test such as ANCOVA could not be used. Furthermore, with the small sample, it was harder to produce significant results for any statistical test (Field, 2005).

The second limitation of this study relates to the relaxation exercise regime, which did not take into account the intensity of an individual's affective state. There was only one version of the relaxation exercise therapy for all participants at the primary reaction phase. Moreover, there was also a single relaxation exercise therapy used for the student's who were inferred to be in a state of positive or negative well-being at the secondary reaction phase. Perhaps, using different relaxation scripts to cater for different intensity levels would have provided a greater impact of the domain-independent strategies on learning.

The third drawback is that the study did not investigate the effect of individual components of the relaxation session: the relaxation exercise and positive affirmation separately. Instead, they were measured as a single component. One obvious consequence of this approach was that it was hard to predict to what extent each of these components contributed towards the observed outcomes of the relaxation session. Perhaps to comprehensively investigate this issue, it would be better to conduct separate studies so that the contribution of each component could be properly investigated.

Finally it would have been better if the PANAS questionnaire had been administered at the very start of the experiment along with the test of datastructures, prior to the training in relaxation provided to the DD + DI group, and not after this training.

11.4 Future work

The initial ATS framework developed here is far from being a complete framework for an affective ITS system. There are a number of directions which would be promising avenues for future work.

a) To study the effect of the domain-independent components separately
   The ATS framework considers the various domain-independent components as a single component. It would be better to conduct separate studies so that the contribution of each component can be properly investigated.

b) To use video to present the relaxation exercises session.
   In the ATS framework, the relaxation session was presented using audio techniques. It would be interesting to note the difference if the relaxation session were presented using a video clip. Would the use of the video clip session improve the performance of the ATS framework?

c) To conduct a study of the ATS framework in different cultures
   Another potential future direction of the ATS framework is to conduct the study in a different educational culture. It would provide an insight into whether the ATS framework is culturally dependent. Students in the UK might be good candidates for future studies.

11.5 Conclusions

This thesis describes an attempt to develop an affective tutoring system (ATS) framework within an intelligent tutoring system (ITS) environment. This framework is based on the emotional intelligence (Mayor & Salovey, 1990) and emotion regulation theories (Lazarus 1991; Gross, 1999).

The thesis has provided answers for the two research questions posed in Chapter 1. First, the introduction of the two levels of appraisal and reaction phases in the ATS framework has managed to bridge the gap between theory and implementation of emotional intelligence and emotion regulation concept within an intelligent learning environment. Second, the thesis has provided evidence to support the premise that the integration of a domain-independent strategy into the reaction phases of the ATS framework is, indeed, beneficial.

References:

Agras, W. S., Southam, M. A., & Taylor, C. B. (1983). Long-term persistence of relaxation-induced blood pressure lowering during the working day. *Journal of Consulting and Clinical Psychology, 51*, 792-794.

Ahn, H. I., Picard, R.W. (2006). *Affective Cognitive Learning and Decision Making: The Role of Emotions*. Paper presented at the The 18th European Meeting on Cybernetics and Systems Research (EMCSR 2006).

Anderson, J. A. (2001). Understanding Homeless Adults by Testing the Theory of Self-Care. *Nursing Science Quarterly, 14*(1), 59-67.

Andre, E., Rist T, & Muller, J. (1999). Employing AI method to control behaviour of animated interface agents. *Applied Artificial Intelligence, 13*, 415-448.

Ashcraft, M. H., Kirk, Elizabeth P. (2001). The Relationships Among Working Memory, Math Anxiety and Performance. *Journal of Experimental Psychology: General 130*(2, 224-237.

Ashby, G. F., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition, *Psychological Review, 106*, 529-550.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement.* New York: Longman.

Aspinwall, L. G. (1998). Rethinking the role of positive affect in self-regulation. *Cognition and Emotion, 22*, 1-32.

Astleitner, H. (2000). Designing emotionally sound instruction: The FEASP-approach. *Instructional Science, 28*, 169-198.

Baker, J. A., Terry, T., Bridger, R., & Winsor, A. (1997). Schools as caring communities: A relational approach to school reform. *School Psychology Review, 26*(4), 586-602.

Baker, J. P., Berenbaum,H. (2008). The Efficacy of Problem-Focused and Emotional Approach Interventions Varies as a Function of Emotional Processing Style *Cognitve Res 32*, 66-82.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review, 84*, 191-215.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman.

Barber, P. K. (1982). Relaxation in a College Management Class. *Journal of Accelerative Learning and Teaching, 7*(3), 233-238.

Bar-on, R. (2001). Emotional Intelligence and Self-Actualization. In J. Ciarrochi, Forgas, J. P., & Mayer, J. (Ed.), *Emotional Intelligence in Everyday Life, Psychology Press* (pp. 82-97). New York and Hove/UK.

Barret, L. F., Salovey, P., Mayer, J.D. (2002). *The Wisdom in Feeling: Psychological Processes in Emotional Intelligence*: Guilford Press.

Bates, J., Loyall, A. B., & Reilly, W. S. (1992). *An architecture for action, emotion, and social behaviour (School of Computer Science No. CMU-CS-92-144)*. Pittsburgh: Carnegie Mellon University.

Bates, J. (1994). The role of emotion in believable agents. *Communication of ACM, 37*(7), 122-125.

Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological Inquiry, 7*(1), 1-15.

Baylor, L. A., Shen, E., & Warren, D. (2004). *Supporting learners with Math anxiety: The impact of pedagogical agent emotional and motivational support*. Paper presented at the In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System.

Beal, R. C., Shaw, E., Chiu, YW., Vilhjalmsson, H., & Qu, L. (2005). Enhancing ITS instruction with integrated assessments of learner mood , motivation and gender. In C. K. Looi et al (Ed.), *Proceeding of Artificial Intelligence in Education (AIED)* (pp. 750-753): IOS press.

Beard, C. (2005). Student achievement: the role of emotions in motivation to learn–Emotional maps (Pedagogic research project report: Sheffield Hallam University). Retrieved July 8, 2006, from http://www.hlst.heacademy.ac.uk/project.r4-beard-complete.pdf

Beck, A. T. (1988). Cognitive approaches to panic disorder: Theory and therapy. In S. Rachman, & Maser, J. D. (Ed.), *Panic: Psychological perspectives. Hillsdale*. NJ: Erlbaum.

Benson, H. (1975). *The relaxation response*. New York: William Morrow.

Benson H., K. A., Kornhaber C., LeChanu M., Zuttermeister, P., Myers P. & Friedman R. (1994). Increases in Positive Psychological Characteristics with a New Relaxation-Response Curriculum in High School Students. *Journal of Research and Development in Education, 27*(4), 226-231.

Benson, H. M., Wilcher, B., G., Huggins, E., Zuttermeister, M. E., Myers, P. C., & Friedman, R,. (2000). Academic performance among middle school students after exposure to a relaxation response curriculum. *Journal of Research and Development in Education, 33*(3).

Bernstein, D. A., & Borkovec, T. D. (1973). *Progressive relaxation training*. Champaign, IL: Research Press.

Blanchard, E. B., Ahles, T. A., & Shaw, E. R. (1979). Behavioral treatment of headaches. In M. Hersen, Eisler, R. M., & MIller, P. M. (Ed.), *Progress in behaviour modification* (Vol. 8). New York: Academic Press.

Blatter, B. M., and Bongers, P.M. (2002). Duration of computer use and mouse use in relation to musculoskeletal disorders of neck and upper limb. *International Journal of Industrial Ergonomics 30* 295-306.

Bloom, S. J., Mesia, B. B. & Krathwohl, R. D. (1964). *Taxonomy of Educational Objectives (two vols: The Affective Domain & The Cognitive Domain)*. New York: David McKay.

Boekaerts, M. (1993). Being concerned with well-being and with learning. *Educational Psychologist, 28*(2), 149-167.

Bolin, B. L., & Dodder, R. A. (1990). The affect balance scale in American college population. *The Journal of Social Psychology, 130*(6), 839-840.

Bolton, M. B., Tilley, B. C., Kuder, J., Reeves, T.,& Schultz, L. R. (1991). The cost and effectiveness of an education-program for adults who have asthma. *Journal of General Internal Medicine, 6*, 401-407.

Borkovec, T. D., & Sides, K. (1979). Critical procedural variables related to the physiological effects of progressive relaxation: A review. *Behaviour Research and Therapy, 17*, 119-126.

Boucsein, W. (1992). *Electro dermal Activity*. New York: Plenum Press.

Boud, D., Keogh R. and Walker, D. (1985). Promoting Reflection in Learning: A Model. In D. Boud, Keogh R. and Walker D. (Ed.), *Reflection: Turning Experience into Learning* (pp. 18-40). London: Kogan Page.

Boud, D. (1994). *Conceptualising learning from experience: developing a model for facilitation.* Paper presented at the Proceedings of the 35th Annual Conference of the Adult Education Research Conference, Knoxville, Tennessee.

Boud, D., & Miller, N. (1996). Synthesising traditions in learning from experience. In D. Boud, & Miller, N. (Ed.), *Working with Experience: Animating Learning* (pp. 14-24). London: Routledge.

Bourne, E. (2000). *The Anxiety and Phobia Workbook. 3rd. Edition*. Oakland, CA: New Harbinger Publications, Inc.

Bowles, T. (1999). Focusing on Time Orientation to Explain Adolescent Self-Concept and Academic Achievement: Part II. Testing a Model. *Journal of Applied Health Behaviour, 1*, 1-8.

Boyd, B. L. D., E. K. , Felton, S. (2006). Measuring learning in affective domain using reflective writing about a virtual international agriculture experience. *Journal of agriculture education, 47*(3), 24-32.

Bradburn, N. (1969). *The Structure of Psychological Well-being*. Chicago: Aldine.
Bradburn, N., Sudman, S (1988). *Polls and Surveys: Understanding What They Tell Us*: Jossey-Bass.
Breazeal, C., Wang, A. and Picard, R.W. (2007). *Experiments with a Robotic Computer, Body, Affect and Cognition Interactions.* Paper presented at the Proceedings of the Second International Conference on Human-Robot Interaction, Washington DC.
Brewer, B. W., Kozimor, J., Lewis B. P., Linder, D. E., Van Raalte, J. L., Wildman, G. (1995). Cork! the Effects of Positive and Negative Self-Talk on Dart Throwing Performance. *Journal of Sport Behaviour, 18*, 50-57.
Brickman, P., Rabinowitz, V. C., Karuza, J., Coates, D., Cohn, E., & Kidder, L. (1982). Models of helping and coping. *American Psychologist, 41*, 1078-1089.
Britton, B., & Virean, D. . (1999). Effects of relaxation and positive self-talk interventions on test anxiety of mathematics TASP test repeaters. (Texas academic skills program.). *Dissertation Abstracts International Section A: Humanities & Social Sciences, 59*, 10-A.
Broekens J., D. D., and Kosters A. W. (2008). Formal models of Appraisal: Theory, Specification, and Computational Model. *Cognitive Systems Research 9* 173-197.
Brown, J., & Burton, R. R. (1975). Multiple representation of knowledge for tutorial reasoning. In D. C. Bobrow, A. (Ed.), *Representation and Understanding* (pp. 311-349). New York: Academic Press.
Brunning R, S. G., Ronning R (1999). *Cognitive psychology andinstruction (3rdEd.)*. Upper Saddle River NJ: Prentice Hall.
Bryan, T., & Bryan, J. (1991). Positive mood and math performance. *Journal of Learning Disabilities, 24*, 490-494.
Burleson, W., & Picard, R. (2004). *Affective Agents: Sustaining motivation to learn through failure and a state of "stuck"*. Paper presented at the In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System.
Burleson, W., Picard, R.W. (2007). Evidence for Gender Specific Approaches to the Development of Emotionally Intelligent Learning Companions. *IEEE Intelligent Systems, Special issue on Intelligent Educational Systems, 22*(4), 62-69.
Burnett., P. C. (1994). Self-talk in upper elementary school children: Its relationship with irrational beliefs, self-esteem, and depression. *Journal of Rational-Emotive & Cognitive-Behaviour Therapy, 12*(3), 181-188.
Burnett, P. C. (2003). Positive Statements, Positive Students, Positive Classrooms. *Australian Journal of Guidance and Counselling (Special Issue Mental Health Issues and Schools), 13*(1), 20-31.
Busse, W. W., Kiecolt-Glaser, J.K., Coe, C., Martin, R.J., Weiss, ST., & Parker, S.R. (1995). NHLBI Workshop summary. Stress and asthma. *American Journal of Respiratory and Critical Care Medicine, 151*, 249-252.
Cabanac, M. (1971). Psychological role of pleasure. *Science, 173*, 1103-1107.
Cambach, W., Chadwick-Straver,R.V.M.,Wagenaar,R. C., van Keimpema, A.R.J.,& Kemper, H.C.G. (1997). The effects of a community-based pulmonary rehabilitation programme on exercise tolerance and quality of life: A randomized controlled trial. *European Respiratory Journal, 10*, 104-113.
Canfield, J. (2003). What You SAY is What You Get How to Speak Your Way to Success. Retrieved September 10, 2006, from http://www.jackcanfield.com/SuccessStrategies/052506.htm
Carlson, S. A., Fulton, J.E.,Lee,. S.M, Maynard, L.M., Brown, D.R., Kohl, H.W., Dietz, W.H. (2008). Physical Education and Academic Achievement in Elementary School: Data From the Early Childhood Longitudinal Study *American Journal of Public Health, 10*, 120- 126.

Castelli, D. M., Hillman, C.H., Buck, S.M., and Erwin, H. (2007). Physical fitness and academic achievement in 3rdand 5thgrade students. *Journal of Sport and Exercise Psychology, 29*, 239-252.
Chaffar, S., & Frasson, C. (2004). *Using an emotional intelligent agent to improve the learner's performance*. Paper presented at the In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System.
Chan, T. W., & Baskin, A. (1998). *Studying with the prince - The computer as a learning companion*. Paper presented at the First International Conference of ITS
Charney, R. S. (2000). *Teaching children to care: Management in the responsive classroom*. Greenfield, MA: Northeast Foundation for Children.
Chekering, A. W. (1969). *Education and Identity*. San Francisco: Jossey-Bass.
Chen, Y. P., Dai, T., Spector, E. P., and Jex, M. S. . (1997). Relation Between Negative Affectivity and Positive Affectivity: Effects of Judged Desirability of Scale Items and Respondents' Social Desirability. *Journal of Personality Assessment, 69*(1), 183-198.
Clark, M. S., & Fiske, S. T. (1982). *Affect and cognition*. Hillsdale: NJ:Erlbaum.
Clark-Carter, D. (1997). *Doing Quantitative Psychological Research: from design to report*. Sussex, UK: Psychology Press.
Claxton, G. (1989). *Being a teacher: A positive approach to change and stress*. London: Cassell Educational Limited.
Clore, G. L., & Ortony, A. (2000). Cognition in Emotion: Always, sometimes, or never? In L. Nadel, Lane, R., & Ahern, G.L. (Ed.), *The cognitive neuroscience of emotion*: Oxford University Press.
Clum, G., A., Clum, G. A., & Surls, R. . (1993). A meta-analysis of treatments for panic disorder. *Journal of Consulting and Clinical Psychology, 61*(2), 317-326.
Coe, D. P., Ivarnik, J.M., Womack, C., J., Reeves, M.J., & Malina, R.M. . (2006). Effects of physical education and physical activity levels on academic achievement in children. *Medicine & Science in Sports and Exercise, 38*, 1515-1519.
Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. . (2004). Learning styles and pedagogy in post-16 learning: A systematic and critical review. www.LSRC.ac.uk: Learning and Skills Research Centre. January 15, 2008, from http://www.lsda.org.uk/files/PDF/1543.pdf
Coles, G. (1998). *Reading Lessons: The Debate over Literacy*. New York: Hill & Wang.
Collingwood, J. (2007). Realism and Optimism: Do You Need Both? Retrieved 1 July 2008 from http://psychcentral.com/lib/2007/realism-and-optimism-do-you-need-both/
Conati, C., & Zhou, X. (2002). Modelling students' emotions from cognitive appraisal in educational games. In International Conference on Intelligence Tutoring System. Biarritz, France. Retrieved October, 2004, from http://www.cs.ubc.ca/~conati/my-papers/its2002.pdf
Conati, C. (2002). Probabilistic assessment of user's emotions in education games. *Journal of Applied Artificial Intelligence, 16* (Special Issue on managing cognition an Affect in HCI), 555-575.
Conati, C. a. M., H. . (2004). *Evaluating A Probabilistic Model of Student Affect.* Paper presented at the 7th International Conference on Intelligent Tutoring Systems.
Connelly, T. (2004). Magazine for Hypnosis and Hypnotherapy. Retrieved September 10, 2006, from http://www.hypnos.co.uk/hypnomag/jacobson.htm
Connors, G. L., & Hodgkin, J. E. (1997). Pulmonary rehabilitation. In G. G. Burton, Hodgkin, J. E., & Ward, J. J. (Ed.), *Respiratory care. A guide to clinical practice* (pp. 877-888). Philadelphia.
Cook, C., Burgess-Limerick, R., Chang, S. (2006). The prevalence of neck and upper extremity musculoskeletal symptoms in computer mouse users *International Journal of Industrial Ergonomics, 26*, 347-356.

Coover, G. E., & Murphy, S. T. (2000). The communicated self. *Human Communication Research, 26*(1), 125-148.

Cornelius, R. R. (1996). *The science of emotions: Research and tradition in the psychology of emotion*: Prentice Hall.

Coyne, J. C. (1970). Depressions and the response of others. *Journal of Applied Physiology, 14*, 61-69.

Credit, A. G., M. (1999). A study of relaxation techniques and coping skills with moderately to highly stressed middle and high school students. *Master's Action Research Project, Saint Xavier University and IRI/Skyligh, Illinois*(ERIC Document Reproduction Service No. ED434298).

Creer, T. L., Reynolds, R. V., & Kotses, H. (1991). Psychological theory, assessment, and interventions for adult and childhood asthma. In J. J. Sweet, Rozensky, R. H., & Tovian, S. M. (Ed.), *Handbook of clinical psychology in medical settings* (pp. 497-515). New York: Plenum.

Crocker, P. R. E., Kowalski, K. C., & Graham, T. R. (1998). Measurement of coping strategies in sport. In J. L. Duda (Ed.), *Advances in measurement of sport and exercise psychology* (pp. 149-161). Morgantown, WV: Fitness Information Technology.

Dagrou, E., Gauvin, L., & Halliwell, W. (1992). Effects of positive, negative, and neutral self-talk on motor performance. *Canadian Journal of Sports Sciences, 17*, 145-147.

Daniels, L., M., Haynes, Tara, L., Stupnisky, Robert ,H.,Raymond, P., Pekrun, R. (2007). A longitudinal study of cognitive, emotional and achievement outcomes. *Contemporary Educational Psychology* 156-166.

Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work*. San Francisco: Jossey-Bass Publishers.

David, D., Schnur, J., Birk, J. (2004). Functional and dysfunctional feelings in Ellis' cognitive theory of emotion: An empirical analysis. *Cognition & Emotion, 18*(6), 2004.

Davies, J., and Brember, I. (1999). Reading and Mathematics Attainments and Self-Esteem in Years 2 and 6 – An Eight Year Cross-Sectional Study. *Educational Studies, 25*, 145–157.

Davis, C. (1992). The effects of music and basic relaxation instruction on painand anxiety of women undergoing in-office gynecological procedures. *Journal of Music Therapy, 24*(4), 202-216.

Davis, C. L., Tomporowski, P.D., Boyle, C.A., Waller, J.L., Miller, P.H., Naglieri, J.A., & Gregoski, M. (2007). Effects of aerobic exercise on overweight children's cognitive functioning: a randomized controlled trial. *Research Quarterly of Exercise and Sport, 78*(5), 510-519.

Day, C., & Leitch, R. (2001). Teachers' and teacher educators' lives: The role of emotion. *Teaching and Teacher Education, 17*, 403-415.

De Vicente, A., & Pain, H. (1999). Motivation self-report in ITS. In S. P. Lajoie, & Vivet, M. (Ed.), *In Proceeding of the Ninth World Conference on Artificial Intelligence in Education* (pp. 651-653). Amsterdam: IOS Press.

De Vicente, A. (2002). *Towards tutoring systems that detect students' motivation: an investigation. Unpublished PhD thesis.*, University Of Edinburgh.

Deckro G., B., K., Hoyt M., Wilcher M., Dusek J., Myers P., Greenberg B., Rosenthal D. & Benson H. (2002). The Evaluation of a Mind/Body Intervention to Reduce Psychological Distress and Perceived Stress in College Students. *Journal of American College Health, 50*(6), 281-287.

Deffenbacher, J. L., Demm, P.M., & Brandon, A.D. (1986). High general anger: Correlatesand treatment. *Behaviour Research and Therapy, 24*, 480-489.

Deffenbacher, J. L., & Suinn, R. (1987). Generalized anxiety syndrome. In L. Michelson, & Ascher, L. M. (Ed.), *Anxiety and stress disorders: Cognitive-behavioral assessment and treatment*. New York: Guilford Press.

Deffenbacher, J. L., McNamara, K., Stark, R. S., & Sabadell, P. M. (1990). A combination of cognitive, relaxation, and behavioral coping skills in the reduction of general anger. *Journal of College Student Development, 31*, 351-358.

Deffenbacher, J. L., & Stark, R.S. (1990). *Relaxation and cognitive-relaxation treatments of general anger*: Department of Psychology, Colorado State University, Fort Collins, CO.

Deffenbacher, J. L. (1992). Trait anger: Theory, findings, and implications. In C. D. Spielberger, & Butcher, J.N. (Ed.), *Advances in Personality Assessment* (Vol. 9, pp. 177-201). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Deffenbacher, J. L. (2000). Social skills training. In A. E. Kazdin (Ed.), *Encyclopaedia of psychology* (Vol. 7, pp. 370-373). Washington , D.C. : American Psychological Association/Oxford University Press.

Del Soldato, T., & du Boulay, B. (1995). Implementation of motivational tactics in tutoring system. *Journal of Artificial Intelligence in Education, 4*(6), 337-378.

Denis, A., Hasan C., Ali, K.,Thomas, D., B, Bichelmeyer, J. B. (2006). *Student Achievement in the Cisco Networking Academy:Performance in the CCNA1 Course*, Paper presented at the 39th Hawaii International Conference on System Sciences Hawaii

Denollet, J., & De Vries, J. (2006). Positive and negative affect within the realm of depression, stress and fatigue: the two-factor distress model of the Global Mood Scale (GMS). *Journal of Affect Disorder, 91*(2-3), 171-180.

Desilva, L. C., Miyasato, T., & Nakatsu, R. (1997). *Facial emotion recognition using multi-modal information*. Paper presented at the Paper presented at the IEEE International Conference on Information, Communication and Signal Processing.

Diener, E., Lucas, Richard E. (2000). Subjective Emotional Well-Being. In M. Lewis, & Haviland, J. M. (Ed.), *Handbook of Emotions (2nd Ed.)* (pp. 325-337). New York: Guilford.

Dierk, J. C., M., Rauh, E., Schlumberger, P., Hebebrand, J.& Rief, W. (2006). What determines well-being in obesity? Associations with BMI, social skills, and social support. *Journal of Psychosomatic Resources, 60*(3), 219-227.

Dipamo, B., and Job, R. F. S. (1990). An evaluation of SALT (Suggestive-accelerative learning and teaching) techniques. *Australian Journal of Educational Technology, 6*(1), 36-55.

D'Mello, S., Picard R.W, and Graesser, A. (2007). Towards An Affect-Sensitive AutoTutor. *IEEE Intelligent Systems, Special issue on Intelligent Educational Systems, 22*(4), 53-61.

Donato, G., Barlett, M. S., Hager, J. C., Ekman, P., & Sejnowski, T. J. (1999). Classifying facial actions. *IEEE Pattern Analysis and Matching Intelligence, 21*, 974-989.

Doris, L. C.-m. (1994). *Students Achievement in Educational Technology Course as Enhanced by Cooperative Learning,*The Chinese University of Hong Kong Graduate School.

Du Boulay, B., and Luckin, R. (2001). Modelling human teaching tactics and strategies for tutoring systems. *International Journal of Artificial Intelligence in Education, 12*(3), 235-256.

Dugan , M. K., & Hock,R.R (2000). *It's My Life Now: starting over after an abusive relationship or domestic violence*. New York: Routledge.

Dunn, J. (1994). Understanding others and the social world: Current issues in developmental research and their relation to preschool experiences and practice. *Journal of Applied Developmental Psychology, 15*, 571-583.

Durr, C. J. (2006). Factors Affecting Student Performance in Principles of Macroeconomics Course *Issue on political economy 8*, 80-89.

Efklides, A., & Volet, S. . (2005). Feelings and emotions in the learning process [Special issue]. *Learning and Instruction, 15*(5), 1-10.
Ekman, P. (1982). *Emotion in human face*. New York: Cambridge U. Press.
Ekman, P. (1997). *Facial Action Coding System*. Palo Alto: Consulting Psychologists Press.
Elliot, C. (1992). *The affective reasoning: A model of emotions in a multi-agen. Unpublished PhD thesis.* Northwestern University.
Eysenck, M. (1998). *Psychology, an Integrated Approach* Harlow: Longman.
Felix, U. (1989). *An Investigation of the Effects of Music, Relaxation and Suggestion in Second Language Acquisition in Schools. Unpublished PhD thesis.* Flinders University, Adelaide, Australia.
Field, A. (2005). *Discovering Statistics Using SPSS (2nd Edition)*: SAGE publication.
Finn, J. (1985). Cornpetitive excellence: Ils a matter of mind and body. *The Physician and Sportsrnedicine, 13*(2), 61-75.
Flett, G. L., Blankstein, K.R., Hewitt, P.L.& Koledin, S. . (1992). Components of perfectionism and procrastination in college students. *Social Behavior and Personality, 20*(2), 85-94.
Folkman, S., & Lazarus, R. S. (1980). An analysis of coping in a middle aged community sample. *Journal of Health and Social Behavior, 21*, 219-239.
Folkman, S., & Lazarus, R. S. (1981). Reply to Shinn and Krantz. *Journal of Health and Social Behavior, 22*, 457-459.
Folkman, S. (1984). Personal control and stress and coping processes: A theoretical analysis. *Journal of Personality and Social Psychology, 46*, 839-852.
Folkman, S., & Lazarus, R. S. (1985). If it changes it must be a process: Study of emotion and coping during three stages of a college examination. *Journal of Personality and Social Psychology, 48*, 150-170.
Folkman, S., Lazarus, R. S., Gruen, R. J., & DeLongis, A. (1986). Appraisal, coping, health status, and psychological symptoms. *Journal of Personality and Social Psychology, 50*, 571-579.
Folkman, S., Lazarus, R. S., Dunkel-Schetter, C., DeLongis, A., & Gruen, R. (1986). The dynamics of a stressful encounter: Cognitive appraisal, coping and encounter outcomes. *Journal of Personality and Social Psychology, 50*, 992-1003.
Folkman, S., Lazarus, R. S., Dunkel-Schetter, C., DeLongis, A., & Gruen, R. (1986). The dynamics of a stressful encounter: Cognitive appraisal, coping and encounter outcomes. *Journal of Personality and Social Psychology, 50*, 992-1003.
Folkman, S., & Lazarus, R. S. (1988). *Manual for the Ways of Coping Questionnaire*. Palo Alto, CA: Consulting Psychologists Press.
Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion, 12*, 191-220.
Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*, 300-319.
Fredrickson, B. L. (2000). Cultivating positive emotions to optimize health and well-being. *Target article in Prevention and Treatment, 3*.
Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*, 218-226.
Fredrickson, B. L. (2003). The value of positive emotions. *American Scientist,, 91*, 330-335.
Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Larkin, G. (2003). What good are positive emotions in crises?: A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology, 84* 365-376.
Fredrickson, B. L., & Losada, M. F. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist, 60*, 678-686.
Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19*, 313-332.

Fredrickson, B. L., & Joiner, T. (2002). Positive emotions trigger upward spirals toward emotional well-being. *Psychological Science*, *13*, 172-175.

Fredrickson, L. (1998). What good are positive emotions? *Review of General Psychology, 2*, 300-319.

Frey, D., & Carlock, C.J. (1989). *Enhancing self-esteem*. Muncie, IN: Accelerated Development, Inc.

Fridja, H. C. (1986). *The emotions*: Cambridge U. Press.

Fridja, N. H., & Swagerman, J. (1987). Can computers feel? Theory and design of an emotional system. *Cognition and Emotion, 1*(3), 235-257.

Gaines, A. M. (2005). Houston Independent School District executive summary. Retrieved September 10, 2006, from http://www.houstonisd.org/vgn/images/portal/cit_23015118/130204459/Executive Summary_Gross Elementary Relaxation1.pdf

Gama, A. C. (2005). *Integrating metacognition instruction in interactive learning environments. Unpublished Dphil Thesis.* University of Sussex, UK.

Gamble, J., Gamble, D., Parr G. & Caskey O. (1982). The Effects of Relaxation Training and Music upon Creativity. *Journal of Accelerative Learning and Teaching, 7*(2), 111-123.

Garder, J., Braafladt, N., & Zeman, J. (1990). The regulation of sad affect: An information-processing perspective. In B. S. Moore, & Isen, A. M. (Ed.), *Affect and Social Behaviour* (pp. 209-240).

Gardner, H. (1993). *Frames of mind: The theory of multiple intellegences (10th anneversary edition)*. New York: Basic Books.

Gardner, H. (1993). *Multiple intelligences: The theory in practice*. New York: Basic Books, Inc.

Gaudreau, P., Blondin, J.P. (2002). Development of a questionnaire for the assessment of coping strategies employed by athletes in competitive sport setting. *Psychology of Sport and Exercise, 3*(1), 1-34.

Gillihan, J. (2004). Recovery from sad mood in formerly depressed and never depressed individuals. Retrieved February 19, 2004, from http://www.psych.upenn.edu/~gillihan/research/699.html

Goetz, T., Zirngibl, A., Pekrun, R., & Hall, N. C. (2003). Emotions, learning and achievement from an educational-psychological perspective. In P. R. Mayring, C.v. (Ed.), *Learning emotions. The influence of affective factors on classroom learning* ((pp. 9−28). Frankfurt: Peter Lang.

Goetz, T., Hall, N.C., Anne, C. F., Pekrun, R. (2006). A hierarchical conceptualization of enjoyment in students. *Learning and Instruction* (16), 323-338.

Goetz, T., Preckel, F.,Pekrun, R., Hall, N.C. (2007). emotional experience during test taking: Does cognitive ability make a difference? . *Learning and individual differences*(17), 3-16.

Goetz, T., Frenzel, Anne. C., Hall, Nathan. C. Pekrun, R. (2008). Antecedents of academic emotions: Testing the internal/external frame of reference model for academic enjoyment. *Contemporary Educational Psychology, 33* 9-33.

Goetz, T., Pekrun, R., Hall, N. C., & Haag, L. (2006). Academic emotions from a social-cognitive perspective: Antecedents and domain specificity of students' affect in the context of Latin instruction. *British Journal of Educational Psychology 76,*(2), 289−308.

Goleman, D. (1995). *Emotional Intelligence: Why it can matter more than IQ*: Bloomsbury Publishing Plc.

Gore, P. A. (2006). Academic Self-Efficacy as a Predictor of College Outcomes. *Two Incremental Validity Studies journal of Career Assessment*, *14*(1), 92-115.

Gratch, J. (2000). *Emile: Marshalling passions in training and education*. Paper presented at the 4th International Conference on Autonomous Agents.

Gratch, J., & Marsella , S. (2001). *Tears and Fears: Modelling emotions and emotional behaviour in synthetic agents*. Paper presented at the 5th International Conference on Autonomous Agents.
Gratch, J., & Marsella, S. (2002). *Evaluating a general model of emotional appraisal and coping*: Foundations, Palo Alto, California.
Green, B. S., Salkind, J. N., & Akey, M. T. (1997). *Using SPSS for Windows: Analysing and Understanding Data*. New Jersey: Prentice Hall.
Greene, B. A., and Miller, R.B. (1996). Influences on Achievement: Goals, Perceived Ability, and Cognitive Engagement *Contemporary Educational Psychology, 21*(2), 181-192.
Greene, J., & D'Oliveira, M (1999). *Learning to use statistic tests in psychology (2nd Ed)*. Buckingham: Open University Press.
Greenwood, M. M., & Benson, H. (1977). The efficacy of progressive relaxation in systematic desensitization and a proposal for an alternative competitive response. *Behaviour Research and Therapy, 15*, 337-343.
Gross, J. J. (1998). Antecedent and response-focused emotion regulation: Divergent consequences for experience, expression and psychology. *Journal of Personality and Social Psychology, 74*(1), 224-237.
Gross, J. J. (1999). Emotion and emotions' regulation. In L. A. Pervin, & John, O. P. (Ed.), *Handbook of Personality: Theory and Research (2nd Edition)* (pp. 525-552). New York: Guildford.
Hair, J. F., Anderson, R.E., Tatham, R.L., Black, W.C. (1998). *Multivariate Data Analysis 5th ed.* New Jersey: Prentice-Hall.
Hakala, P. T., Rimpelä,A.H., Saarni,L.A., Salminen,J.J,. (2006). Frequent computer-related activities increase the risk of neck–shoulder and low back pain in adolescents. *The European Journal of Public Health, 16*(5), 536-541.
Hall, M., Ponton, P (2002). *A Comparative Analysis of Mathematics Self-Efficacy of Developmental and Non-Developmental Freshman Mathematics Students*. Paper presented at the Meeting of Louisiana/Mississippi Section of the Mathematics Association of America.
Hall, M. (2005). Bridging the heart and mind: community as a device to link cognitive and affective learning. *Journal of cognitive affective learning 1*(3), 8-12.
Hanin, Y. L. (2000). *Emotions in sport*: Human Kinetics.
Hanin, Y. L. (2000). Individual zones of optimal functioning (IZOF) model: Emotion-performance relationships in sport. . In Y. L. Hanin (Ed.), *Emotions in sport* (pp. 65-89): Champaign, IL: Human Kinetics.
Hansford, B. C., and Hattie, J. A. (1982). The Relationship Between Self and achievement/Performance Measures. *Review of Educational Research, 52*(123–42).
Harackiewicz, J. M., Barron, K.E., Tauer, J.M., & Elliot,A.J. (2002). Predicting success in college: Alongitudinal study of achievement goals and abilitymeasures as predictors of interest and performancefrom freshman year through graduation. *Journal ofEducational Psychology, 94*, 562-575.
Harding, S. D. (1982). Psychological well-being in Great Britain: an evaluation of the Bradburn Affect Balance Scale. *Personality and Individual Differences, 3*, 167–175.
Hargreaves, A. (1998). The emotional practice of teaching. *Teaching and Teacher Education, 14* (8), 835-854.
Hargreaves, A. (2000). Mixed Emotions: Teachers' Perceptions of their Interactions with Students. *Teaching and Teacher Education, 16*, 811-826.
Hayman-Abello, S. E., & Warriner, E.M. (2002). Child clinical/pediatric neuropsychology: some recent advances. *Annual Review of Psychology, 53*, 309-339.
Heng-Yu, K., Sullivan, Howard J. (2002). Student performance and attitudes using personalized mathematics instruction *Educational technology research and development, 50*(1), 21-34.

Henshaw, H. (2005). Individualized positive affirmations for improving self-esteem. Retrieved September 19, 2006, from http://www.articlecity.com/articeles/self-improvement_and_motivation/article_3557.shtml

Holt, N. L., & Dunn, G.H.J. (2004). Longitudinal idiographic analyses of appraisal and coping responses in sport. *Psychology of Sport and Exercise, 5,* 213–222.

Howard, G.S. (1994). Why do people say nasty things about self-reports? *Journal of organizational Behavior, 15,* 399-404.

Howard Margolis, P. M. (2006). Improving Self-Efficacy and Motivation: What to Do, What to Say. *Intervention in School and Clinic 41*(4), 218-227.

Howell, D. C. (1997). *Statistical Methods for Psychology (4th Ed)*: International Thomas Publishing Inc.

Ireson, J., Hallam, S. (2008). Academic self-concepts in adolescence: Relations with achievement and ability grouping in schools. *Learning and Instruction in press*

Isen, A. M. (1990). The Influence of positive and negative affect on cognitive organizations for development. In N. Stein, Leventhal, B. & Trabrasso, T. (Ed.), *Psychological and biological approaches to emotion* (pp. 75-94). Hillsdale, NJ: Erlbaum.

Isen, A. M. (2000). Positive affect and decision making. In J. M. M. Lewis & Haviland-Jones (Ed.), *Handbook of Emotions 2nd Edition* (pp. 417-435). New York: Guilford Press.

Isen, A. M., & Reeve, J. (2005). The influence of positive affect on intrinsic and extrinisic motivation: Facilitating enjoyment of play, responsible work behavior, and self-control. *Motivation and Emotion, 29*(4), 297-325.

Isen, M. A., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilities creative problem solving. *Journal of Personality and Social Psychology, 52*(6), 1122-1131.

Izard, C. E. (1984). Emotion-cognition relationships and human development. In C. E. Izard, Kagan, J., & Zajonc, R.B. (Ed.), *Emotions, cognition, and behavior*. New York: Cambridge University Press.

Jackson, S. L., Joseph, K., & Soloway, E. (1999). The design of guided learner-Adaptable Scaffolding in Interactive Learning environment. Retrieved March, 22, 2004, from http://hi-cd.eeecs.umich.edu/papers/design_of_guided/index.html

Jacob, R. G., Shapiro, A. P., Reeves, R. A., Johnson, A. M., McDonald, R. H., & Coburn, C. (1986). Relaxation therapy for hypertension: Comparison of effects for concomitant placebo, diuretic and beta-blocker. *Archives of Internal Medicine, 146*, 2335-2340.

Jacobson, E. (1938). *Progressive Relaxation*. Chicago: University of Chicago Press.

James, W. (1884). What is emotion? . *Mind, 8*, 188-209.

Jaques, P., Andrade, A., Jung, J., Bordini, R., & Vicari, R. (2002). *Towards user's emotion recognition: A case in an educational system*. Paper presented at the 2nd International conference on Computational Intelligence, Robotics and Autonomous Systems (CIRAS).

Jarvela, S., & Niemivita M (1999). The changes in learning theory and the topicality of the recent research in motivation. *Research dialogue in learning instruction* (1), 57-65.

Jarvela, S., Jarvenoja, Hanna., Veermans, Marjaana. (2008). Understanding the dynamics of motivation in socially shared learning. *International Journal of Educational Research 47* 122–135.

Jarvenoja H, J. S. (2005). How students describe the source of their emotional and motivational experiences during the learning process: A qualitative approach *learning and instruction*, 465-480.

Jenning, D., McGinnis, D., Lovejoy, S., & Stirling, J. (2000). Valence and arousal ratings for Velten mood induction statements. *Motivation and Emotions, 24*(2), 285-297.

Jiang, H., and Vidal, M., J.(2006). *From Rational and to Emotional Agents.* Paper presented at the In Proceedings of the AAAI Workshop on Cognitive Modeling and Agent-based Social Simulation.

Job, R. F. S., and Dipamo, B. (1991). Examination of the effects of subject anxiety and task difficulty on the outcome of SALT (Suggestive Accelerative Learning and Teaching) techniques. *Australian Journal of Educational Technology, 7*(2), 144-152.

Johnson, P. L. (1982). The Effect of a Group Relaxation Exercises on Second- and Sixth-Grade Children's Spelling Scores. *Journal of Accelerative Learning and Teaching, 7*(3), 239-253.

Johnson, W. L., Rickel, J., Stiles, R., & Munro, A. . (1998). Integrating pedagogical agents into virtual environments. *Presence: Teleoperators and Virtual Environment, 7*(6), 523-546.

Johnson, W. L., & Rickel, J. (1998). Steve: An animated pedagogical agent for procedural training in virtual environments. *SIGARD Bulletin, 8*, 16-21.

Johnson, W. L., Rickel, J., & Lester, C. J. (2000). Animated Pedagogical Agent: Face To Face Interaction in Interactive Learning Environments. *International Journal of AI in Education, 11*, 47-78.

Jones, A., & Issroff, K. (2005). Learning Technologies: Affective and Social Issues in Computer Supported Collaborative Learning. *Computers and Education, 44*(4), 395-408.

Jordan, P. J., Ashkanasy, N. M., Härtel, C. E. J., & Hooper, G. S. (2002). Workgroup emotional intelligence scale development and relationship to team process effectiveness and goal focus. *Human Resource Management Review, 12*, 195–214.

Kahneman, D. (1999). Objective happiness. In E. D. D. Kahneman, & N. Schwarz (Ed.), *Well-being: The foundations of hedonic psychology* (pp. 3–25). New York: Russell Sage Foundation.

Kapoor, A., Qi, Y. and Picard, R.W. (2003). Fully Automatic Upper Facial Action Recognition. IEEE International Workshop on Analysis and Modelling of Faces and Gestures (AMFG 2003) held in conjunction with ICCV 2003, October 2003, Nice, France. Retrieved November, 12, 2004, from http://vismod.media.mit.edu/pub/tech-reports/TR-571.pdf

Kapoor, A., Picard, R.W. and Ivanov, Y. (2004). Probabilistic Combination of Multiple Modalities to Detect Interest. International Conference on Pattern Recognition, August 2004, Cambridge, U.K. Retrieved February, 1, 2005, from http://affect.media.mit.edu/pdfs/04.kapoor-picard-ivanov.pdf

Kapoor, A., Burleson, W., and Picard, R.W. (2007). Automatic Prediction of Frustration. *International Journal of Human-Computer Studies, 65*(8), 724-736.

Kay, R. H., Loverock, H. (2008). Assessing emotions related to learning new software: The computer emotion scale,*Computers in Human Behavior, 24*, 1605-1623.

Kazarian, S. S., Evans, D. R. (1997). *Cultural Clinical Psychology: Theory, Research, and Practice*: Oxford University Press.

Keefe, J. W. (1979). Learning style: An overview. In NASSP's (Ed.), *Student learning styles: Diagnosing and proscribing programs* (pp. 1-17). Reston, VA: National Association of Secondary School Principles.

Keig, P. F. a. R., Peter A. (1993). Translations of representations of the structure of matter and its relationship to reasoning, gender, spatial reasoning, and specific prior knowledge. *Journal of Research in Science Teaching,, 30*, 883-898.

Kelleher, M. (2003). The ghost in the learning management system? Retrieved January 20,2007 from http://www.know-2.org/index.cfm?PID=162

Keller, J. M. (1987). Strategies for stimulating the motivation to learn. *Performance and Instruction Journal, 26*(8), 1-7.

Kempen, G. I. J. M. (1992). Psychometric properties of Bradburn's affect balance scale among elderly persons. *Psychological Reports, 70*, 638.

Kendall, P. C., & Hollon, S. D. (1984). Behavioral assessment and methodology. In G. T. Wilson, Franks, C. M., Brownell, K. D., & Kendall, P. C. (Ed.), *Annual review of behavior therapy* (Vol. 9, pp. 39-94). New York: Guilford.

Kendall, P. C. H., S. D. (1981). *Assessment strategies for cognitive-behavioural interventions*. NY: Academic Press.
Kendall, P. C. H., S. D. (1983). Calibrating therapy: Collaborative archiving of tape samples from therapy outcome trials. *Cognitive Therapy and Research, 7*, 199-204.
Kort, B., Reilly, R., & Picard, R. W. (2001). An affective model of interplay between emotions and learning: Reengineering educational pedagogy - building a learning companion. In Proceedings of ICALT. Retrieved January 12, 2003, from http://vismod.media.mit.edu/pub/tech-reports/TR-547.pdf
Krathwol, D. R., B.S. Bloom, and B.B. Masia. (1964). *Taxonomy of Educational objectives. The Classification of Educational Goals. Handbook II: Affective Domain*. New York: David McKay.
Kushner, M., Sher, K., & Beitnian, B. (1990). The relation between alcohol problems and the anxiety disorders. *American Journal of Psychiatry, 147*, 685-695.
Lam, A. G., and Zane, Nolan. W. S. (2004). Ethnic Differences in Coping with Interpersonal Stressors : A Test of Self-Construals as Cultural Mediators,*Journal of Cross-Cultural Psychology, 35*(4), 446-459
Lam, J., & Winter, S. (2000). Developing positive attitudes for life in the twenty-first century: The 'Thought Power' programme used with teenage students in Hong Kong. *School Psychology International, 21*(2), 136-151.
Lazarus, R. S., & Folkman, S.(1984). *Stress, appraisal, and coping*. New York: Springer.
Lazarus, R. S. (1999). *Stress and emotion: A new synthesis* New York: Springer.
Lazarus, S. R. (1991). *Emotion and Adaptation*: Oxford U. Press.
Lehman, R. (2005). The role of emotion in creating instructor and learner presence in the distance education experience *Journal of cognitive affective learning, 1*(2), 12-26.
Lehrer, P. M. (1978). Psycho physiological effects of progressive relaxation in anxiety neurotic patients and of progressive relaxation and alpha feedback in nonpatients. *Journal of Consulting and Clinical Psychology, 46*, 389-404.
Lehrer, P. M., Hochron, S., McCann, B., Swartzman, L, & Reba, P. (1986). Relaxation decreases large airway but not small airway asthma. *Journal of Psychosomatic Research, 30*, 13-25.
Lehrer, P. M., Hochron, S.M., Rausch, L., Isenberg, S., Lasoski, A.M., & Carlson, V . (1992). *Relationship Between Changes in Vagal Tone, Facial EMG, and Spirometry Measures in a Study of Relaxation Therapy for Asthma*. Paper presented at the Annual meeting of the Society for Behavioral Medicine.
Lekander, M., Fuerst, C.J., Rostein, S., Hursti, T.J., & Fredrickson, M. . (1997). Immune effects of relaxation during chemotherapy for ovarian cancer. *Psychotherapy and Psychosomatics, 66*, 195-191.
Lent, R. W., & Hackett, G. (1987). Career self-efficacy: Empirical status and future directions. *Journal of Vocational Behavior, 30*, 347-382.
Lent, R. W., & Hackett, G. (1987). Career self-efficacy: Empirical status and future directions. *Journal of Vocational Behavior, 30*, 347-382.
Lester, J. C., Converse, S. A., Stone, B. A., Kahler, S. E., & Barlow, S. (1997). *Animated pedagogical agents and problem-solving effectiveness: A large-scale empirical evaluation.* Paper presented at the In Proceedings of the Eighth World Conference on AI in Education.
Lester, J. C., Voerman, J. L., Towns, S. G., & Callaway, C. B. (1999 a). Deictic believability: Coordinating gesture locomotion and speech on lifelike pedagogical agents. *Applied Artificial Intelligence, 13*, 383-414.
Lester, J. C., Zettlemayor, L. S., Gregoire, J., & Bares, W. H. (1999 b). *Exploratory lifelike avatars: Performing user-designed task in 3rd learning environments* Paper presented at the Third International Conference on Autonomous Agents.
Lester, J. C., Stone, B. A., & Stelling, G. D. (1999 c). Lifelike pedagogical agents for mixed initiative problem solving constructivist learning environments. *User Modelling and User-Adapted Interaction, 9*, 1-44.

Lewinsohn, P., Mischel, W., Chaplin, W., & Barto, R. (1980). Social competence and depression: The role of illusionary self-perceptions? . *Journal of Applied Physiology, 89*, 203-212.

Lewis, M., & Haviland, M. J. (1999). *Handbook of Emotions, 2nd edition*: The Guilford Press.

Liang, J. (1985). A structural integration of the Affect Balance Scale and the Life Satisfaction. *Journal of Gerontology, 40*, 552-561.

Linnenbrink, E. A. (2006). Emotion research in education: Theoretical and methodological perspectives on the integration of affect, motivation, and cognition *Educational Psychology Review, 18*, 307-314.

Linnenbrink, E. A. P., P, A. (2002). achievement goal theory and affect: an asymmetrical bidirectional model. *Educational psychologist 37* (2), 69- 78.

Love, J. (2005). Positive Self-Talk. EzineArticles. Retrieved October 12, 2006, from http://ezinearticles.com/?Positive-Self-Talk&id=30657

Low, B. G., & Nelson, B.D. (2004). Emotional Intelligence: Effectively bridging the gap between high schools and collage. Retrieved July 8, 2006, from http://education.tamuk.edu/eiconf/papers/TASSPEI04.pdf

Luckin, R. (1998). *"Ecolab": Explorations in the zone of proximal development. Unpublished DPhil thesis.* University of Sussex,UK.

Luckin, R., & du Boulay, B. (1999). Ecolab: The development and evaluation of a Vygotskian design framework. *International Journal of Artificial Intelligence in Education, 10,* 198-220.

Luckin, R., & Hammerton, L. (2002). Getting to know me: Helping learners understand their own learning needs through meta-cognitive scaffolding. In S. A. Cerri, Gouardères, G. & Paraguaçu, F. (Ed.), *Proceedings of Sixth International Conference on Intelligent Tutoring Systems, ITS 2002* (pp. 759-771). Berlin: Springer.

Lundqvista, L., Ahlstrfmb, G. (2006). Psychometric evaluation of the Ways of Coping Questionnaire as applied to clinical and nonclinical groups. *Journal of Psychosomatic Research, 60*, 485- 493.

Mahoney, M. J., & Avener, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive Therapy Research, 1*, 135-141.

Malone, T., & Lepper, M. (1987). Making learning fun. In R. Snow, & Farr, M. (Ed.), *Aptitude, Learning and Instruction: Cognitive and Affective Process Analyses*: Lawrence Erlbaum.

Mannion, M. (2002). Managing the emotional factor in medicine; a new approach to diagnosing and treatment patients. Retrieved July 28, 2006, from http://www.mindshiftinstitute.org/Article_Emotional_Factor_In_Medicine.htm

Margolis, H., McCabe., Patrick. (2006). Improving Self-Efficacy and Motivation: What to Do, What to Say. *Intervention in School and Clinic 41*(4), 218-227.

Marjorie, W. S., and Martin, L. Maehr. (1983). Affect, Ability, and Science Achievement: A Quantitative Synthesis of Correlational Research. *Review of Educational Research, 53*(3), 369-396

Marsella, S., & Gratch, J. (2002). *A step toward irrationality : Using emotion to change belief*. Paper presented at the First International Conference on Autonomous Agents and Multiagent System.

Marsella, S., & Gratch, J. (2003). *Modelling coping behaviour in Virtual Humans: Don't Worry, Be happy*. Paper presented at the 2nd International Joint Conference on Autonomous Agents and Multi-agents System.

Marsh, H. W., Parada, R. H. & Ayotte, V. (2004). A multidimensional perspective of relations between self-concept (Self Description Questionnaire II) and adolescent mental health (Youth Self Report). *Psychological Assessment, 16*, 27-41.

Marsh, H. W., & Perry, C. (2005). Does a positive self-concept contribute to winning gold medals in elite swimming? The causal ordering of elite athlete self-concept and championship performances. *Journal of Sport and Exercise Psychology, 27,* 71-91.

Marshall, T. (2002). Yoga instructor's lessons getting high grades; Hollywood school incorporates exercises in classes: [Broward Metro Edition]. South Florida. Retrieved September 21, 2006, from http://proquest.umi.com/pqdweb?index=5&did

Martinez- Miron, E. A., du Boulay, B. & Luckin, R. (2004). *Analyzing the role of student's goal orientation during their interaction with ILE* Paper presented at the Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System.

Martinez- Miron, E. A., Harris, A., du Boulay, B. & Luckin, R. (2005). The role of learning goals in the design of ILEs, some issues to consider. In C. K. Looi et al (Ed.), *Proceeding of Artificial Intelligence in Education (AIED)* (pp. 427-434): IOS press.

Mary, P. D. (2006). Relaxation Techniques for Labour. Retrieved August, 4, 2006, from http://www.babybag.com/articles/doula.htm

Marzano, R. J. (1998). *A theory-based meta-analysis of research on instruction*. Aurora, CO: Mid-continent Regional Educational Laboratory.

Master, J. C., Barden, R. C., & Ford, M. (1979). Affective states, expressive behaviour, and learning in children. *Journal of Personality and Social Psychology, 37*, 380-390.

Master, J. C. (1991). Strategies and mechanisms for the personal and social control of emotion. In J. Garber, & Dodge, K.A. (Ed.), *The development of emotion regulation and dysregulation* (pp. 182-207). Cambridge, U K: Cambridge University Press.

Matsubara, Y., & Nagamachi, M. (1996). *Motivation systems and motivation models for intelligent tutoring*. Paper presented at the Third International Conference in Intelligent Tutoring System.

Matthews, D. B. (1983). *Relaxation Training: Its Usefulness in the Middle School Curriculum*. Paper presented at the Annual Meeting of the National Middle Schools.

Maurer M. M. &. Simonso, M. R. (1994). The Reduction of Computer Anxiety: Its Relation to Relaxation Training, Previous Computer Coursework, Achievement, and Need for Cognition. *Journal of Research on Technology in Education 26* (2), 212-221.

Mayer, J. D., & Salovey, P. (1993). The intelligence of emotional intelligence. *Intelligence, 17* (4), 433-442.

McCarthy, K. (2000). Learning by heart: The role of emotional education in raising school achievement and promoting the caring community. In R. Best (Ed.), *Education for Spiritual, Moral, Social and Cultural Development* (pp. 80-90). London: Continuum.

McCoy, L. C., & Master, C. J. (1990). Children's strategies for the control of emotion in themselves and other. In B. S. Moore, & Isen, A. M. (Ed.), *In Affect and Social Behaviour*: Cambridge U. Press.

McLeod, D. B. (1992). Research on Affect in Mathematics Education: A Reconceptualization. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning*. New York: Macmillan.

Mehta, M. (1992). Biobehavioral intervention in recurrent headaches in children. *Headache Quarterly, 3*(4), 426-430.

Merrill, D. (2000). Instructional Strategies and Learning Styles: Which takes Precedence? In R. Reiser, & Dempsey, J. (Ed) (Ed.), *Trends and Issues in Instructional Technology*: Prentice Hall.

Mesquita, B., Frijda, N. H., & Scherer, K. R. (1997). Culture and emotion. In P. Dasen, & Saraswathi, T. S. (Ed.), *Handbook of cross-cultural psychology* (Vol. 2, pp. 255-297). Boston: Allyn & Bacon.

Ming, Z., Zaproudina, N. (2003). Computer use related upper limb musculoskeletal (ComRULM) disorders. *Pathophysiology, 9*, 155-160.

Ming, Z., Närhi, M, Siivola J. (2004). Neck and shoulder pain related to computer use. *Pathophysiology, 11*, 51–56.

Miranda, H., Viikari-Juntura, E., Martikainen, R., Takala, E-P., and Riihimäki, H. (2001). A prospective study of work related factors and physical exercise as predictors of shoulder pain. *Occup. Environ. Med., 58,* 528-534.

Mitsutake G, O. K., Cornelissen G, Herold M, Gunther R, Dawes C, Burch JB, Watson D, Halberg F. . (2001). Measuring the Circadian and infradian rhythms in mood. *Biomed Pharmacother, 55,* 94-100.

Moore, S. B., & Isen, M. A. . (1990). Affect and Behaviour. In S. B. Moore, & Isen, M. A. (Ed.), *Affect and Social Behaviour*: Cambridge U. Press.

Morgan, R. L., & Heise, D. . (1988). Structures of emotions. *Social Psychology Quarterly, 51*, 19-31.

Morrow, G. R. (1986). Effect of the cognitive hierarchy in the systematic desensitization treatment of anticipatory nausea in cancer patients: A component comparison with relaxation only, counselling, and no treatment. *Cognitive Therapy and Research, 10*, 421-446.

Mota, S., and Picard, R.W. (2003). *Automated Posture Analysis for Detecting Learner's Interest Level*. Paper presented at the Workshop on Computer Vision and Pattern Recognition for Human-Computer Interaction, CVPR HCI.

Namazi, K. H., Eckert, J. K., Kahana, E., & Lyon, S. M. . (1989). Psychological well-being of elderly board and care home residents. *The Gerontologist, 29*, 511-516.

Neimark., N. F. (2001). A Comparison Between the Fight or Flight Response and the Relaxation Response. Retrieved September 10, 2006, from http://www.mindbodymed.com/EducationCenter/fight.html

Nelson, D., and Low, G. (1999). *Exploring and developing emotional intelligence skills*. Corpus Christi EI Learning System.

Nietfeld, J., Cao, L., & Osborne, J. (2005). Metacognitive monitoring accuracy and student performance in the postsecondary classroom. *The Journal of Experimental Education, 74*(1), 7-28.

Nkambou, R., & Heritier,. V. (2004). *Facial expression analysis for emotion recognition in ITS*. Paper presented at the In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System.

Nkambou, R. (2006). *Affective Intelligent Tutoring System*. Paper presented at the Workshop on Motivational and Affective Issues in ITS, 8th International Conference on ITS.

Noddings, N. (1992). *The challenge to care in schools: An alternative approach to education*. New York: Teachers College Press.

Norman, D. A., Ortony, A., Russell, D. M. (2003). Affect and machine design: Lessons for the development of autonomous machines *IBM SYSTEMS JOURNAL, 42*(1), 38-44.

Norusis, M. J. (2005). *SPSS@ 13.0 Guide to Data analysis*. New Jersey: Prentice Hall.

Oatley, K. (1992). *Best laid scheme: The psychology of emotion*: Cambridge U. Press.

Oatley, K., & Nundy, S. . (1996). Rethinking the role of emotions in education. In D. R. Olson, & Torrance, N. (Ed.), *The handbook of education and human development: New models of learning, teaching and schooling* (pp. 257-274). Cambridge, MA: Blackwell.

O'Connor, T. (2006). Research Methods, jus 308, Syllabus. Retrieved July ,2, 2006, from http://faculty.ncwc.edu/toconnor/308/308lect06.htm

O'Regan, K. (2003). Emotion and E-Learning [Electronic version]. International Journal of Instructional Technology & Distance Learning, 7(3). . Retrieved April 15, 2004 from http://www.aln.org/publications/jaln/v7n3/v7n3_oregan.asp

Ortiz, J., La Grange, L. (2006). Efficacy of Relaxation Techniques in Increasing Sport Performance in Women Golfers. The sport journal, 9 (1). Retrieved August 15, 2006, from http://www.thesportjournal.org/2006Journal/Vol9-No1/OrtizLaGrange1.asp

Ortony, A., Clore, G., & Collins, A. (1988). *The cognitive structure of emotion*: Cambridge U. Press.

Ortony, A. (2003). On making believable emotional agants believable. In R. Trappl, Petta, P., & Payr, S. (Ed.), *Emotions in humans and artifacts.*: MIT Press.
Ortony, A., Norman, D. A. & Revelle, W. (2005). The role of affect and proto-affect in effective functioning. In J.-M. Fellous, & Arbib, M.A. (Ed.), *Who needs emotions: The brain meets the machine*: Oxford University Press.
Paiva, A., Prada, R., and Picard, R.W. (2007, September 12-14). *Affective Computing and Intelligent Interaction, Second International Conference, ACII 2007.* Paper presented at the Proceedings Springer Lisbon, Portugal.
Pajares. (2002). Self-efficacy beliefs in academic contexts: An outline. Retrieved September, 07, 2006, from http://des.emory.edu/mfp/efftalk.html
Pajares, F., Schunk, D. H. (2002). Self And Self-Belief In Psychology And Education: An Historical Perspective. In J. Aronson (Ed.), *Improving Academic Achievement*. New York: Academic Press.
Parker, D. (2002). Changing drivers' attitudes to speeding: using the Theory of Planned Behaviour. In D. Rutter, and Quine, L. (Ed.), *Changing Health Behaviour* (pp. 138–152): Open University Press, Buckingham.
Parker, J. C., & Gilbert, G. (1978). Anxiety management in alcoholics: A study of generalized effects of relaxation techniques. *Addictive Behaviours, 3*, 123-127.
Parker, J. D. A., Endler N.S., Bagbyb R.Michael (2008). If It Changes, It Might Be Unstable: Examining the Factor Structure of the Ways of Coping Questionnaire *Educational and Psychological Measurement, Vol. 68*(No. 2), 262-280
Pearce, M. J. (2004). *An investigation of interaction and flow: student behaviour during online instruction. Unpublished PhD thesis.* University of Melbourne.
Pekrun, R. (2000). A social-cognitive, control-value theory of achievement emotions. In I. J. Heckhausen (Ed.), *Motivational psychology of human development. Developing motivation and motivating development* (pp. 143-163). New York: Elsevier.
Pekrun, R., Elliot, A. J., & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: a theoretical model and prospective test. *Journal of Educational Psychology, 98*, 583–597.
Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review, 18.*, 315-341.
Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Educational Psychologist, 2*(37), 91-105.
Pekrun, R., Goetz, T., Perry, R. P., Kramer, K., Hochstadt, M., & Molfenter, S. (2004). Beyond test anxiety: Development and validation of the Test Emotions Questionnaire (TEQ). *Anxiety, Stress, and Coping, 3*(17), 287−316.
Penchina, S., & Hoffman, S (2000). Accentuate the Positive Self-Talk Children Succeed with Positive Affirmations. Retrieved October, 1,2006 from http://www.2imaginethis.com/files/accentuate_positive_self_talk.pdf
Peper, E., Gibney, K.H. (1998). Computer Related Symptoms: A Major Problem For College Students. Computer Related Symptoms - Articles. from http://www.tifaq.com/articles/computerrelated-symptoms-peper-gibney.html
Pereira, D., Oliveira, E., and Moreira, N. (2006). *Towards an Architecture for Emotional BDI Agents,* : Universidade do Porto.
Philpot, V. D., Holliman, W.B., & Madonna, S. (1995). Self-statements, locus of control, and depression in predicting self-esteem. *Psychological Reports, 76*, 1007-1010.
Philpot, V. D., & Bamburg, J.W. (1996). Rehearsal of positive a0nd negative self-statements and restructured negative self-statements to increase self-esteem and decrease depression. *Psychological Reports, 79*, 83-91.
Picard, R. W. (1997). *Affective computing*. MA: MIT.
Picard, R. W. (2000). Toward computers that recognise and respond to user emotions. *IBM system Journal, 39*, 705.

Picard, R. W. (2007). Toward Machines with Emotional Intelligence. In G. Matthews, Zeidner, M., & Roberts, R. D. (Ed.), *The Science of Emotional Intelligence: Knowns and Unknowns*. Oxford, UK: Oxford University Press.

Price, P. (2003). Online relaxation exercises. Retrieved September 13, 2006, from http://www.allaboutdepression.com/relax/index.html

Prichard, A. (1986). A SALT pilot study: College developmental mathematics. *The Journal for the Society of Accelerative Learning and Teaching, 11* (3), 167-175.

Primavera, J. P., & Kaiser, R. S. (1992). Non-pharmacological treatment of headache: Is less more? . *Headache, 32*(8), 393-395.

Puurula, A., Neill, S., Vasileiou, L., Husbands, C., Lang, P., Katz, Y.J., Romi, S., Menezes, I., & Vriens, L. (2001). Teacher and student attitudes to affective education: A European collaborative research project. *British Association for International and Comparative Education, 31*(2), 165-186.

Qu, L., & Johnson, L. (2005). Detecting the learner's motivational states in an interactive learning environment. In C. K. Looi et al (Ed.), *Proceeding Artificial Intelligence in Education* (pp. 547-554). Amsterdam: IOS Press.

Rasid, Z. M., & Parish, T. S. (1998). The effects of two types of relaxation training on students' levels of anxiety. *Adolescence, 33*, 99-101.

Razek, M., A, Chaffar, Soumaya., Frasson. Claude., Ochs, Magalie. (2006). *Using Machine-Learning Techniques to Recognize Emotions for On-Line Learning Systems, in Affective and Emotional Aspects of Human-Computer Interaction* Paper presented at the Game-Based Learning and Innovative Approaches.

Rebolledo M., G., du Boulay B., & Luckin, R. (2005). Be hold and take a challenge: Could Motivation strategies improve help-seeking? . In C. K. Looi et al (Ed.), *Proceeding Artificial Intelligence in Education* (pp. 459-466). Amsterdam: IOS press.

Rebolledo M., G., du Boulay, B., & Luckin, R. (2006). Motivating the learners: An Empirical Evaluation. In M. Ikeda, Ashley, K. D., Chan, T.K. (Ed.), *Intelligent Tutoring Systems: 8th International Conference, ITS 2006* (pp. 545-554). Berlin: Springer.

Reed, M., & Aspinwall, L. G. (1998). Self affirmation reduces biased processing of health risk information. *Cognition and Emotion, 22*, 99-132.

Reilly, R., Kort, B., and Picard, R.W. (2001). External Representation of Learning Process and Domain Knowledge: Affective State as a Determinate of its Structure and Function. Proceedings the IEEE Artificial Intelligence in Education Conference, San Antonio, Texas. Retrieved January, 12, 2004, from http://vismod.media.mit.edu/pub/tech-reports/TR-546.pdf

Reilly, W. S. N. (1996). *Believable social and emotional agents. Unpublished PhD Thesis.* Carnegie Mellon University (CMU-CS-96-138).

Renninger, K. A. (1992). Individual interest and development: Implications for theory and practise. In K. A. Renninger, & Krapp, A. (Ed.), *The Role of Interest in Learning and Development* (pp. 361-395). Hillsdale: Erlbaum.

Rickel, J., Gratch, J., Hill, R., Marsella , S., & Swartout, W. (2001). *Stave goes to Bosnia: Towards a new generation of Virtual Humans for interactive experiences*. Paper presented at the AAAI Spring Symposium on Artificial Intelligence and Interactive Entertainment.

Rompelman, L. (2002). *Affective Teaching*. Lanham, MD: University Press of America.

Rose, C. (1985). *Accelerated learning*. New York: Dell Publishing.

Rose, C. (1995). Accelerated learning: action guide In B. Tracy (Ed.), *Accelerated learning techniques: the express track to super intelligence*. Niles, Illinois: Nightingale-Conant.

Roseman, I. J. (1991). Appraisal determinants of discrete emotions. *Cognition and Emotion, 5*, 161-200.

Roseman, I. J., Antoniou, A. A., & Jose, E. . (1996). Appraisal determinants of emotions: Constructing a more accurate and comprehensive theory. *Cognition and Emotion, 10*, 241-277.

Roseman, I. J. (2001). A model of appraisal in the emotion system: Integrating theory, research and application. In K. R. Scherer, Schorr, A., & Johnson, T. (Ed.), *Appraisal Processes in Emotion: Theory, Methods, Researches* (pp. 68-91). Oxford: Oxford U. Press.

Roseman, I. J., & Evdokas, A.(2004). Appraisal cause experienced emotions: Experimental evidence. *Cognition and Emotion, 18*(1), 1-28.

Rosenberg, M. (1986). Self-concept from middle childhood through adolescence. In J. Suls (Ed.), *Psychological perspectives on the self* (Vol. 3, pp. 107-136). Hillsdale, NJ: Erlbaum.

Rosenberg, M., Schooler, C., & Schoenbach, C. (1989). Self-esteem and adolescent problems: Modelling reciprocal effects. *American Sociological Review, 54*, 1004-1018.

Salovey, P., & Mayer, D. J. (1990). Emotional intelligence. Imagination. *Cognition and Personality, 9*(3), 185-211.

Sapp, M. (1996). Three treatments for reducing the worry and emotionality components of test anxiety with undergraduate and graduate college students: cognitive-behavioral hypnosis, relaxation therapy, and supportive counselling. *Journal of College Student Development, 37*, 79-87.

Sasson, R. (2001). The Power of Affirmations. Retrieved January 20,2006, from http://www.successconsciousness.com/index_00000a.htm

Schaubroeck, J., and Jones, R. J. (2005). Antecedents of workplace emotional labor dimensions and moderators of their effects on physical symptoms *Journal of Organizational Behavior, 21*(2), 163– 183.

Scherer, K. R. (1999). Appraisal theory. In T. Dalgleish, & Power, M. (Ed.), *Handbook of cognition and emotion* (pp. 637-663). Chichester: John Wiley.

Scherer, K. R. (2000). Psychological models of emotion. In J. Borod (Ed.), *The neuropsychology of emotion* (pp. 137-162). Oxford/New York: Oxford University Press.

Scherer, K. R., & Davidson, R. J. (2003). *Handbook of affective sciences.* London: Oxford University Press.

Schraw, G., & Brooks, W. B. (2004). Helping students self regulate in Chemistry courses: Improving the will and the skills. Retrieved February 19, 2004, from http://dwb.unl.edu/Chan/Selfeg.html

Schultz, J. H., & Luthes, W. (1969). Autogenic therapy. In *Autogenic methods* (Vol. 1, pp. 12-21). New York: Grune & Stratton.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26* (3 & 4), 201-231.

Schunk, D. H. (2000). *Motivation. In Learning theories: An educational perspective*. NJ: Merrill.: UpperSaddle River.

Schutz, P. A., & Lanehart, S. L. (2002). Emotions in education [Special issue]. *Educational Psychologist, 3,*(2), 110-121.

Schutz, P. A., Pekrun, Reinhard. (2007). *Emotion in Education*: Academic Press.

Schwarze, R., Schwarzer (1996). critical survey of coping intruments In Z. N. S. Endler (Ed.), *Handbook of Coping* New York: Wiley.

Seligman, M. E. P. (1991). *Learned optimism*. New York: A.A. Knopf.

Seligman, M. E. P. (2002). *Authentic Happiness: Using the New Positive Psychology to Realize Your Potential for Lasting Fulfillment*. New York: Free Press.

Sharma, A. K., Khera,S., Khandekar, J. (2006). Computer Related Health Problems Among Information Technology Professionals in Delhi. *Indian Journal of Community Medicine, 31*(1).

Shaw, E., Ganeshan, R., Johnson, W. L., & Miller, D. (1999). *Building a case for agent-assisted learning as a catalyst fro curriculum reform in medical education.* Paper presented at the Proceedings of the Ninth International Conference on Artificial Intelligence in Education.

Shaw, E., Johnson, W., & Ganeshan, R. (1999). *Pedagogical agent on the web* Paper presented at the Third International Conference on Autonomous Agent.

Shrier, A. L., Shih, M. and Beardslee, W R (2005). Affect and Sexual Behavior in Adolescents: A Review of the Literature and Comparison of Momentary Sampling With Diary and Retrospective Self-Report Methods of Measurement. *PEDIATRICS, 115*(5), 573-581.

Sloman, A., & Croucher, M. (1981). *Why robot will have emotions.* Paper presented at the In Proceeding Seventh International Conference on AI.

Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology, 48*, 813-838.

Spalding, B. (2000). The contribution of a Quiet Place to early intervention strategies for children with emotional and behavioural difficulties in mainstream schools. *British Journal of Special Education, 27* (3), 129–134.

Stevens, T., Olivárez., Arturo, Jr., and Hamman, Doug. (2006). Students Mathematics Achievement Gap Between Hispanic and White. *The Hispanic Journal of Behavioral Sciences,28*(2), 161-186.

Stewart, K. L., & Felicetti, L. A. (1992). Learning styles of marketing majors. *Educational Research Quarterly, 15*(2), 15-23.

Strauss, M., Reynolds, C., Hughes, S., Park, K., McDarby, G. and Picard R.W. (2005). *The HandWave Bluetooth Skin Conductance Sensor*. Paper presented at the The 1st International Conference on Affective Computing and Intelligent Interaction.

Streiner, D. L., Norman, G.R. (2003). *Health Measurement Scales: A Practical Guide to Their Development and Use (Oxford Medical Publications)*: Oxford University Press.

Stricherz, M. E., & Stein, V.T. (1980). Cognitive Expansion, Relaxation and Music Background in a Recognition Task. *Journal of Accelerative Learning and Teaching, 5*(2), 99-105.

Sultanoff, B., and Zalaquett, C. (2000). Relaxation Therapies. In D. Novey (Ed.), *Clinician's Complete Reference to Complementary & Alternative Medicine* (pp. 114-129). New York: Mosby.

Sutto, E. R., & Wheatley, F. K. (2003). Teacher' Emotions and Teaching: A review of Literature and Directions for Future Research. *Education Psychology Review, 15*(4), 327-357.

Swing, S. R. a. P., Penelope L. (1982). The Relationship of Student Ability and Small-Group Interaction to Student Achievement. *American Educational Research Journal,19*(2), 259-274.

Tacken, M. (1989). Comfortable wind climate for outdoor relaxation in urban areas *Building and Environment, 24*(4), 321-324.

Taylor, G. J. (2001). Low emotional intelligence and mental illness. In J. Ciarrochi, Forgas, J. P., and Mayer, J. D. (Ed.), *Emotional Intelligence in Everyday Life: A Scientific Inquiry* (pp. 67-81). Philadelphia: Taylor & Francis.

Teeters, A., el Kaliouby, R., Goodwin, M., Shandell, M., and Picard, R.W. (2008). *Novel Wearable Apparatus for Quantifying and Reliably Measuring Social-Emotional Expression Recognition in Natural Face-to-Face Interaction*. Paper presented at the Poster at International Meeting for Autism Research (IMFAR).

TestEdge®. (2003). Retrieved September, 20,2003 from http://www.heartmath.org/education/testedge/why.php

Thompson, R., A., and Zamboanga, Byron L. (2002). Academic Aptitude and Prior Knowledge as Predictors of Student Achievement in Introduction to Psychology. *Journal of Educational Psychology, 94*(3), 562-575.

Thompson, R. A. a. Z., Byron L. (2002). Academic Aptitude and Prior Knowledge as Predictors of Student Achievement in Introduction to Psychology *Journal of Educational Psychology,94*(3), 562-575.

Tiba, A., Szentagotai, A. (2005). Positive emotions and irrational beliefs: Dysfunctional positive emotions in healthy individuals *Journal of Cognitive and behaviour Psychotherapies 1* 53-72.

Timmermans, D., Henneman, L., Hirasing, RA., and van der Wal, G. (2008). *Parents' perceived vulnerability and perceived control in preventing Meningococcal C infection: a large-scale interview study about vaccination*: BMC Public Health. 2008; 8: 45. .

Toivanen H, H., P., Hanninen (1993). Impact of regular relaxation training and psychosocial working factors on neck-shoulder tension and absenteeism in hospital cleaners. *Environment Medicine, 35*, 1123-1130.

Trochim, M. K. W. (2005). Designing designs for research. Retrieved Jun 27, 2006 from http://www.socialresearchmethods.net/kb/desdes.htm

Trudeau F, S. R. (2008). Physical education, school physical activity, school sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity, 25*(5), 10-25.

Tsai, S., and Swanson-Crockett, M. (1993). Effects of relaxation training, combining imagery, and meditation on the stress level of Chinese nurses working in modem hospitals in Taiwan. *Issues in Mental Heath Nursing, 14*, 51-66.

Tugade, M. M. F., B. L. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. . *Journal of Personality and Social Psychology, 86*(320-333.).

Tusek, D. L., & Cwynar, R. E. (2000). Strategies for Implementing a Guided Imagery Program to Enhance Patient Experience. *Complementary and Alternative Therapies : AACN Clinical Issues: Advanced Practice in Acute & Critical Care. Complementary and Alternative Therapies, 11*(1), 68-76.

Van der Meij, H. (2008). Designing for user cognition and affect in software instructions *Learning and instruction 18*(18-29).

VanLehn, K. (1988). Student Modelling. In M. C. Polson, & Richardson, J.J (Ed.), *The foundation of Intelligent Tutoring System* (pp. 55-78). Hillsdale, NJ: Lawrence Erlbaum Associates.

Vazquez, M. I., & Buceta, J. M. (1993). Effectiveness of self-management programmes and relaxation training in the treatment of bronchial asthma: Relationships with trait anxiety and emotional attack triggers. *Journal of Psychosomatic Research, 37*(1), 71-81.

Vollmann, M., Renner, B., Weber, H. (2007). Optimism and social support: The providers' perspective. *The Journal of Positive Psychology, 2*(3), 205 - 215.

Voogt, E., van der Heide A, van Leeuwen AF, Visser AP, Cleiren MP, Passchier J, van der Maas PJ. (2005). Positive and negative affect after diagnosis of advanced cancer. *Psychooncology, 14*(4), 262-273.

Warburton, N. (2000). *Thinking from A to Z, second edition*: Routledge.

Watson, D., Tellegen, A. (1985). Toward a consensual structure of mood. *Psychology Bulletin, 98*, 219 –235.

Watson D, C. L., Tellegen A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063 –1070.

Waugh, C. E. F., B. L. (2006). Nice to know you: Positive emotions, self-other overlap, and complex understanding in the formation of new relationships. *Journal of Positive Psychology, 1*, 93-106. .

Weinberg, R. S., Chan, R., & Jackson, A. . (1983). Mental preparation strategies and performance: Is a combination of techniques better than a single technique. *Journal of Sport Sciences, 1*(3), 211-216.

Wentzel, K. R., Wigfield., Allan. (1998). Academic and Social Motivational Influences on Students' Academic Performance *Educational Psychology Review, 10*(2).

Whitelock, D., & Scanlon, E. (1996). *Motivation, media and motion: Reviewing a computer supported collaborative learning experience* Paper presented at the Proceeding of the European Conference on Artificial Intelligence in Education.

Wigfield, A. L., and Jacquelynne S. Eccles.(2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109-132.

Winkielman, P., Berridge, C. K., and Wilbarger, J.L. (2006). Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. Retrieved August 1,2006 from http://psy.ucsd.edu/~pwinkiel/Winkielman Berridge Wilbarger-PSPB.pdf

Wong, P. T. P., Wong, Lilian, Chui Jan, Lonner,Walter, J. (2006). *Handbook of Multicultural Perspectives on Stress and Coping*: Springer.

Yasutake, D., & Byran, T. (1995). The influence of induced positive affect on middle school children with and without learning disabilities. *Learning Disabilities Research and Practice, 10*, 38-45.

Yeh, T. L. (2005). Issues of collage persistence between asian and asian pacific american students. *Journal of College Student Retention: Research, Theory and Practice 6*(1), 81-96.

Yip, B., & Rowlinson, S. (2006). Coping Strategies among Construction Professionals:Cognitive and Behavioural Effort to Manage Job Stressors:. *Journal for Education in the Built Environment, Vol. 1*(Issue 2), 70-79.

Yusoff, M. Z., & du Boulay,B. (2005). *Integrating Domain-Independent Strategies into an Emotionally Sound Affective Framework.* Paper presented at the In proceeding, Agents that want and like: motivational and emotional roots of cognition and action: Symposium of AISB, University of Hertfordshire.

Zalaquett, C. P., & McCraw, A. (2001). About relaxation. Retrieved September, 06,2006, from http://www.coedu.usf.edu/zalaquett/relax/About_Relaxation.htm

Zikuda, M., Fuß,Stefan., Laukenmann, Matthias., Metz, Kerstin., Ran, Christoph.(2005). Promoting students’ emotions and achievement e Instructional design and evaluation of the ECOLE-approach, *Learning and Instruction, 15*, 481-495.

Appendix A- Student's affective state before the start of a programming laboratory session

To whom it may concern

Thank you for taking part in my survey. The objective of this survey is to study how you feel during programming tasks. Please refer to the definition of important concepts before answering this questionnaire.

If for any reason you wish to withdraw you have the right to do so. Your formal consent is required to confirm that your participation is voluntary and that you are aware that you have the right to refuse or withdraw from this survey at any time.

Should you have any inquiries, please do not hesitate to contact me at: M.Z.Yusoff@sussex.ac.uk

I understand the conditions of the survey and that it is part of a scientific study, the results of which may be published but my name will not be disclosed. I hereby consent to participate in this survey.

Name : ________________________

Gender : __________

Age (optional) : ____________________

Signature :_______________________

Please tick the best answer that describes your feeling at the present moment

1. Interested

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

2. Distressed

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

3. Excited

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

4. Upset

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

5. Strong

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

6. Guilty

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

7. Scared

Very slightly

☐ or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

8. Afraid

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

9. Enthusiastic

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

10. Proud

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

11. Irritable

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

12. Alert

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

13. Ashamed

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

14. Inspired

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

15. Happy

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

16. Determined

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

17. Attentive

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

18. Nervous

☐ Very slightly or not at all ☐ a little ☐ moderately ☐ quite a bit ☐ extremely

Appendix B – Students' coping strategies exploratory study questionnaire

To whom it may concern

Thank you for taking part in my survey. The objective of this survey is to study the your strategies coping dealing with stressful leaning events such as learning difficult programming assignments or exams. If for any reason you wish to withdraw you have the right to do so. Your formal consent is required to confirm that your participation is voluntary and that you are aware that you have the right to refuse or withdraw from this survey at any time.

Should you have any inquiries, please do not hesitate to contact me at: M.Z.Yusoff@sussex.ac.uk

I understand the conditions of the survey and that it is part of a scientific study, the results of which may be published but my name will not be disclosed. I hereby consent to participate in this survey.

Name : ______________________
Gender : _________
Age (optional) : ___________________
Signature : ______________________

Select the programming subject(s) that you have taken at UNITEN
__ C Programming
__ JAVA Programming
__ Multimedia Programming (e.g. VRML)
__ Data Structures and Algorithm
__ Internet Programming (HTML, XML)
Others :_________________________

Scenario

Recall your actions and activities when you were asked to hand in a very difficult programming assignment or to take a very difficult exam in two days time. However, you were unsure of your programming skills or you had problems to understand certain topics of the subject. Think of what did in the last 12 hours of the situation as a means to cope with your stressful environment.

Please read each item below and indicate, by using the following rating scale, to what extent you used it in the situation you have just described.

Not Used	Used Somewhat	Used Quite A Bit	Used A great deal
0	**1**	**2**	**3**

_____ 1. Just concentrated on what I had to do next – the next step.
_____ 2. I tried to analyze the problem in order to understand it better.
_____ 3. Turned to work or substitute activity to take my mind off things.
_____ 4. I felt that time would make a difference – the only thing to do was to wait.
_____ 5. Bargained or compromised to get something positive from the situation.
_____ 6. I did something which I didn't think would work, but at least I was doing something.
_____ 7. Tried to get the person responsible to change his or her mind.
_____ 8. Talked to someone to find out more about the situation.
_____ 9. Criticized or lectured myself.
_____ 10. Tried not to burn my bridges, but leave things open somewhat.
_____ 11. Hoped a miracle would happen.
_____ 12. Went along with fate; sometimes I just have bad luck.
_____ 13. Went on as if nothing had happened.
_____ 14. I tried to keep my feelings to myself.
_____ 15. Looked for the silver lining, so to speak; tried to look on the bright side of things.
_____ 16. Slept more than usual.
_____ 17. I expressed anger to the person(s) who caused the problem.
_____ 18. Accepted sympathy and understanding from someone.
_____ 19. I told myself things that helped me to feel better.
_____ 20. I was inspired to do something creative.
_____ 21. Tried to forget the whole thing.
_____ 22. I got professional help.
_____ 23. Changed or grew as a person in a good way.
_____ 24. I waited to see what would happen before doing anything.
_____ 25. I apologized or did something to make up.
_____ 26. I made a plan of action and followed it.
_____ 27. I accepted the next best thing to what I wanted.
_____ 28. I let my feelings out somehow.
_____ 29. Realized I brought the problem on myself.
_____ 30. I came out of the experience better than when I went in.
_____ 31. Talked to someone who could do something concrete about the problem.
_____ 32. Got away from it for a while; tried to rest or take a vacation.
_____ 33. Tried to make myself feel better by eating, drinking, smoking, using drugs or

medication, etc.

_____ 34. Took a big chance or did something very risky.
_____ 35. I tried not to act too hastily or follow my first hunch.
_____ 36. Found new faith.
_____ 37. Maintained my pride and kept a stiff upper lip.
_____ 38. Rediscovered what is important in life.
_____ 39. Changed something so things would turn out all right.
_____ 40. Avoided being with people in general.
_____ 41. Didn’t let it get to me; refused to think too much about it.
_____ 42. I asked a relative or friend I respected for advice.
_____ 43. Kept others from knowing how bad things were.
_____ 44. Made light of the situation; refused to get too serious about it.
_____ 45. Talked to someone about how I was feeling.
_____ 46. Stood my ground and fought for what I wanted.
_____ 47. Took it out on other people.
_____ 48. Drew on my past experiences; I was in a similar situation before.
_____ 49. I knew what had to be done, so I doubled my efforts to make things work.
_____ 50. Refused to believe that it had happened.
_____ 51. I made a promise to myself that things would be different next time.
_____ 52. Came up with a couple of different solutions to the problem.
_____ 53. Accepted it, since nothing could be done.
_____ 54. I tried to keep my feelings from interfering with other things too much.
_____ 55. Wished that I could change what had happened or how I felt.
_____ 56. I changed something about myself.
_____ 57. I daydreamed or imagined a better time or place than the one I was in.
_____ 58. Wished that the situation would go away or somehow be over with.
_____ 59. Had fantasies or wishes about how things might turn out.
_____ 60. I prayed.
_____ 61. I prepared myself for the worst.
_____ 62. I went over in my mind what I would say or do.
_____ 63. I thought about how a person I admire would handle this situation and used that as a model.
_____ 64. I tried to see things from the other person’s point of view.
_____ 65. I reminded myself how much worse things could be.
_____ 66. I jogged or exercised.

Appendix C- A regression model for self-confidence

1.0 A regression model for self-confidence

The aim of this study was to study and establish a regression relationship between the duration of the student's lesson and the quality of the student's answers, and the student's self-reported *self-confidence*.

The study was conducted over a period of two weeks in three different forty minutes sessions in a traditional classroom environment. It was carried out and completed at the end of the second week of November 2005. Twenty-eight students of the Collage of Computer Science and Information Technology, University Tenaga Nasional, Malaysia were involved in the study.

2.0 Material

In this study a paper-based *self-confidence* question was used to gauge the student's *self-confidence*. The learning materials were taken from author's data structure teaching bank. (see Appendix D for details)

3.0 Procedure

Students were asked first to select one data structure topic of the four available learning topics, namely: the recursive, the linked list, the stack and the tree. Seven students chose the recursive question, ten students chose the linked list question, and the other eleven students chose the tree question. Subsequently, after selecting the topic, the students were presented with a *self-confidence* question. The question required students to make a personal judgment about how confident they were in solving the selected data structure problem on a scale of 1 to 3. A value of 1 represents a student who is not-confident or slightly confident student. A value of 2 in the *self-confidence* scale represents a moderately confident student and a value of 3 represents a very confident student

After completing the *self-confidence* question, students were required to immediately begin to work on the questions. Students were allowed to work on these questions according to their own pace. However, each student was asked to note the start and finish time of their lesson. Upon completion of the lesson, students were required to submit their paper to a tutor.

The tutor then evaluated each of the student's answers. A score of 0 was given to a totally wrong answer, while a perfectly right answer was given a score of 3 and a partially right answer was given a score of either 1 or 2. The final score of the student's answers was calculated by normalising the aggregate scores of all questions into a scale of 0 to 10.

4.0 Result and discussion

Using a linear regression test, the relationship between the *self-confidence* levels, the duration of the students' lesson and the quality of the students' answers was analysed. The results of the analysis are as in Figure 1 and Figure 2:

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.939	2	2.970	6.462	.005[a]
	Residual	11.489	25	.460		
	Total	17.429	27			

a. Predictors: (Constant), Quality, Time

b. Dependent Variable: Self_efficacy

Figure 1: The ANOVA results of the regression test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.805	.612		1.315	.200
	Time	-.054	.023	-.392	-2.390	.025
	Quality	.721	.242	.490	2.986	.006

a. Dependent Variable: Self_efficacy

Figure 2: The Coefficients results of the regression test

The regression model revealed that two independent variables: the duration of student's lesson, and the quality of student's answers, were significant predictors of the student's *self-confidence* level (($F_{(2,25)} = 6.4$, $p < 0.05$)). Moreover, further analysis of these variables simplified the relationship among these three variables to the following equation:

$$\textbf{\textit{Self-confidence}}\ (\boldsymbol{i}) = \mathbf{b0 + b1\ Time}(\boldsymbol{i}) + \mathbf{b2\ Quality}\ (\boldsymbol{i})$$
$$= \mathbf{0.8 + (-.05 * Time}\ (\boldsymbol{i})\ \mathbf{) + (0.7 * Quality}\ (\boldsymbol{i})\mathbf{)}; \textbf{ -- equation 2}$$

5.0 Conclusion

Results from this study established a linear regression relationship between student's *self-confidence,* with the two independent variables: the duration of student's lesson and the quality of student's answer. This means that, by considering the duration of a student's lesson and the quality of his answer, this regression model can be used to predict the student's expected corresponding *self-confidence* level. As a result, it enables us to examine and validate the students' actual *self-confidence* assessment ability of their own *self-confidence* level: for example, if a student appears to have assessed his self confidence much higher or much lower than his performance would suggest, as compared to other students via the regression model. Thus, the concern of wrong assessment of the students' *self-confidence* can be minimized.

Appendix D – Self-belief regression study

PANAS Questionnaire

Instruction:
Read each item of the following phases phase to describe your present emotional state before answering the following questions. Please tick to indicate to what extend you experiencing it. Use the following scale to record your answers:

1 (very slightly or not at all)		2 (a little)	3 (moderately)	4(quite a bit)	5(extremely)
Afraid	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Excited	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Nervous	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Alert	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Confident	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Happy	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Frightened	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Determined	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Bold	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Distressed	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Shaky	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Strong	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Interested	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Enthusiastic	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Upset	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Ashamed	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Inspired	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5
Scared	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5

Self-confidence question- Recursive

Please indicate how confident you are to solve the problem below:

[ ] no confident   [ ] moderately   [ ] extremely confident

Recursive question

Starting time :____________

Write a recursive program to add the first 20 elements of the series

1 + 1/2 + 1/3 +1/4 + 1/5 + …. + 1/20

by completing the codes of the following ***segment i*** and ***segment ii***

```
#include <stdio.h>

float SumOfNumbers(int);

void main() {
        int n = 20

        printf("sum of the series = %lf",_________);


}

float SumOfNumbers (int x) {

    if (x == _____)
        return ______;
    else
        _______ ( ______ + 1/_______(____));

}
```

Finishing time: ______________

Self-confidence question – linked list

Please indicate how confident you are to solve the problem below:

[ ] no confident [ ] moderately [ ] extremely confident

Linked list Question

Starting time :____________

The following linked list structure is used to store staff information of Tenaga Baru company.

```
struct  Staffnode {
        char[10]   Name;
        char[12]   Address;
        int        ID;
        int        Salary
        struct Listnode  *next;
        }StaffNode;

StaffNode  *Staff;
```

a) Using the above structure, write a function to calculate and display the **average** salary of Tenaga Baru staff.

```
void  CalADisplaySalary ( StaffNode * staff)
{
    int count;
    float  salary,AvSalary;
    while ( Staff ! = NULL) )
    {
        salary = salary  + Staff-> _____;
        _____;
        __________;
    }
    AvSalary =_______;
    printf(" average Salary of Tenaga Baru staff  = % f", _______);
}
```

Finishing time :_______________

Self-confidence question- Stack

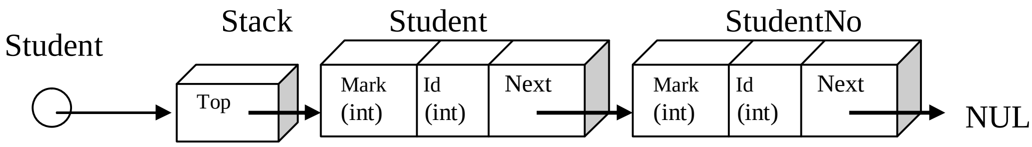
Please indicate how confident you are to solve the problem below:

[ ] no confident [ ] moderately [ ] extremely confident

Stack question

Starting time :____________

The stack diagram below is used to store the result of CMPB274 final exam. Based on the stack, do the following:



a) Write the data structure of the stack

```
typedef struct Studentnode {
int Mark;
int Id;
struct Studentnode  * Next;
} StudentNode;

typedef struct stack {
StudentNode * Top;
} Stack;

Stack _______;
```

b) Using the basic functions of Stack (pop, push etc), write a function to determine and display the best student's mark and ***Id*** of the CMPB274 final exam.

```
void  DispBesPer ( Stack * Student)
{
        Stack * TopS;
        int HM = 0;
        int M; Char Id;

        while (!EmptyStack(________t))
        {
                pop ( &_,&___,____)
                if ( M > ___)
                push ( _,_, &____);}
        ___ (&M,&Id,Tops);
        printf (______________________);
}
```

Finishing time:________________

Self-confidence question-Tree

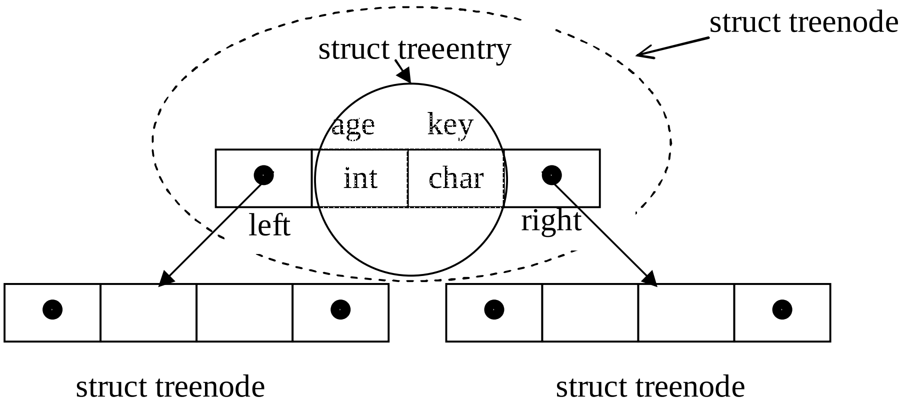
Please indicate how confident you are to solve the problem below:

[ ] no confident [ ] moderately [ ] extremely confident

Tree question

Starting time : ___________

a) Write the definition of the binary search tree structure below:




```
typedef struct treeentry{
      int ___;
      ____ key;
} TreeEntry;

typedef struct treenode{
      TreeEntry _______;
      struct treenode ______;
      ______________ * right;
} TreeNode;
```

b) Write the function that counts the number of nodes containing *age* value greater than 50.

```
int  FindBiggerT50t ( StudentTree  * T)
{
      int count;

      if  (> 50)
            ___________;
      FindBiggerT50t (_________);
      _____________ ( T->Rchild);
}
```

Finishing time:____________________

Appendix E – Relaxation technique

i) Example of Jacobson's progressive relaxation technique

Please lean back in your chair. Make yourself comfortable. Place both feet flat on the floor. Rest your hands comfortably in your lap. Follow the instructions on your screen. Begin by stretching your legs as far as they can go...Relax. Stretch your legs, again. Move your feet up, towards you, hold...turn your feet down, away from you...Hold...Relax. Now, tighten the muscles in your calves and those in your thighs. Tight. Hold it, hold it...and relax.

Let your legs go back, slowly, down to their original position and relax all the muscles in your feet, all the muscles in your calves, all the muscles in your thighs. Let your leg be completely relaxed. And now, feel that wonderful relaxation coming up from your toes, up your calves and your thighs. Feeling nicely relaxed, very calm...and...very relaxed. Calm and relaxed. Take some time to take your attention away from the screen. Focus on your legs and feel your relaxation.

Now, stretch out your arms. Make two fists, tighten the muscles in your fingers. Feel the tightness...Hold it, hold it...and relax. Let your arms go down to their resting position. Feel that relaxation. Now stretch your arms again. Tighten the muscles in your wrists, in your lower arms, in your upper arms...Hold it, hold it...And, let go, just let go, let your arms go down to their original position. Stop for a second, and take your time to notice that quieting feeling of relaxation through your fingers, your hands; through your lower arms, and upper arms. Let your arms go completely limp. Take your time to increase that feeling of relaxation. Very relaxed, very calm, very relaxed and calm.

Now, arch your back backwards, raise your chest. Tighten the muscles in your chest, your abdomen, your back, and your neck. Hold it...hold it...Let go of the tension. Just let go of the tension. Notice your muscle relaxation. Take time to feel the muscles relax in your chest, in your abdomen, in your neck, all over your back. All your muscles feel nicely relaxed.

Now, tighten the muscles in your face, first the muscles around your forehead, then the muscles around your eyes. Make them tighter. Hold it...hold it...and relax. Now, tighten the muscles of your cheeks, the muscles around your mouth, the muscles of your chin. Make them tighter...Hold it, hold it...and relax. Let all the muscles in your face relax, first the muscles of your chin, then the muscles around your mouth, the muscles of your cheeks, the muscles around your eyes, the muscles of your forehead. Let all the tension drain from your face. Let your chin sag if that feels good. Take your time to enjoy the feeling of relaxation. Very relaxed and very calm. Relaxed and calm.

Now, breathe in through your nose, slowly, and deeply. Breathe the air down into your abdomen first, then your chest, and your throat. Hold it, hold it...and slowly breathe it out through your nose. Feel the relaxation. Breathe in, tense up...Breathe out, relax. Once again, take a very deep breath, hold it...hold it and slowly let it out. Let go of all your tension, your frustrations, your anxieties, feeling more and more relaxed. Relaxed and calm.

Now, take some time to scan your body. If you notice any tensional spot, take your time to release that tension. Very good, very relaxed. Now, take time to breathe in and out; stretch your body; focus on your surroundings. Be ready to continue your day. Relaxed and calm.

ii) Example of Benson's steps

The following is the relaxation response technique developed by Benson (1975). He teaches the following nine step to his patients:

Step 1. Pick a focus word or short phrase that is firmly rooted in your belief system.

Step 2. Sit quietly in a comfortable position.

Step 3. Close your eyes.

Step 4. Relax your muscles.

Step 5. Breathe slowly and naturally, and as you do, repeat your focus word, phrase, or prayer, silently to yourself as you exhale.

Step 6. Assume a passive attitude. Don't worry about how well you are doing. When other thoughts come to mind, simply say to yourself, Oh well, And gently return to the repetition.

Step 7. Continue for 10 20 minutes.

Step 8. Do not stand up immediately. Continue sitting quietly for a minute or so, allowing other thoughts to return. Then open your eyes and sit for another minute before rising.

Step 9. Practise this technique once or twice daily.

Adapted from Benson (1975, p 136)

iii) The relaxation exercise and positive affirmation script of the exploratory study

Make your self as comfortable as possible [pause for a few second] **Close your eyes** [pause for a few second] **and become aware of which part of your body** [pause for a few second] **are feeling tense and which part are relaxed** [pause for a few second]

Now [pause for a few second] **take a deep breath** [pause for a few second] **taking the air through your nose** [pause for a few second] **holding it momentarily** [pause for a few second]. **Now** [pause for a few second] **slowly exhaling through your nose** [pause for a few second] **feel yourself relaxing more and more deeply** [pause for a few second] **relax** [pause for a few second] **relax** [pause for a few second] **relax** [pause for a few second] **enjoy the good feeling of yourself** [pause for a few second]

Now [pause for a few second] **I'm going to ask you to tense and relax various part of your body**[pause for a few second] **when I say tense** [pause for a few second] **I'd like you to tense your body part** [pause for a few second] **when I say relax** [pause for a few second] **I'd like you to let go all of the tensions** [pause for a few second] **try to focus on one body part at one time** [pause for a few second]

Now [pause for a few second] **get in touch with your breathing** [pause for a few second] **breath in** [pause for a few second] **breath out** [pause for a few second] i**magine** [pause for a few second] **as each part of your body is relaxed** [pause for a few second] **all tension is gone** [pause for a few second]

Push your shoulder back [pause for a few second] **relax** [pause for a few second] **pull your shoulder forward** [pause for a few second] **relax** [pause for a few second]. **Now** [pause for a few second**] work on your arms** [pause for a few second] **make a fist on one hand** [pause for a few second] **relax** [pause for a few second] **tense the upper hand** [pause for a few second] **relax** [pause for a few second] **tense the hold arm** [pause for a few second] **relax** [pause for a few second] **make fist with the other hand** [pause for a few second] **relax** [pause for a few second] **tense the upper hand** [pause for a few second] **relax** [pause for a few second] **tense the hold arms** [pause for a few second] **relax** [pause for a few second]

Now [pause for a few second] **let's work with your face and head** [pause for a few second] **clinch your jaw** [pause for a few second] **relax** [pause for a few second] **open your mouse wide** [pause for a few second] **relax** [pause for a few second] **grim your face** [pause for a few second] **scrunch up your whole face** [pause for a few second] **keep breathing** [pause for a few second] **breath in** [pause for a few second] **breath out** [pause for a few second] **enjoy the lovely feeling of relaxation** [pause for a few second]

Now, [pause for a few second] **it is the time to see the positive quality of yourself** [pause for a few second] **say I'm confident** [pause for a few second] **I know I cant do it** [pause for a few second] this **going to be my best performance** [pause for a few second**] I know I can do it** [pause for a few second] **this is the best change to show how good am I.**

Appendix F - Statistical analysis results

Variables	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Pre-test scores	149.50	359.5	-1.70	0.87
Learning gain	142.50	395.5	-1.99	0.23
Self-reported changes in participants' state of well-being between the DD and the DD+DI groups by the end of the experiment	139.50	392.500	-2.028	0.21
The state of well-being for the participant who were inferred to be in a state of positive well-being	677.00	1538.00	-1.869	0.89
The change in the state of well-being for the participants who were inferred to be in a state of positive well-being	526.00	1387.00	-2.825	0.01
The state of well-being for the participants who were inferred to be in a state of positive well-being after the first lesson between the experimental groups	76.50	181.50	-0.037	0.504
The change in the state of well-being for the participants who were inferred to be in a state of negative well-being	59.50	1187.50	-7.90	0.00
The state of well-being for the participants' who were inferred to be in a state of negative well-being	798.50	1926.50	-1.132	0.52

Table I: The Mann-Whitney Test of the between the DD and DD+DI groups

	F	t	df	Asymp. Sig. (one Tailed)
Post-test scores	0.831	0.811	40	0.81
Initial state of well-being	0.25	-0.852	40	0.72
The participants' final state of well-being	1.063	-2.058	40	0.82
The state of well-being for the participants who were inferred to be in a state of positive well-being after the second lesson between the experimental groups	0.061	0.664	15	0.51
The state of well-being for the participants who were inferred to be in a state of positive well-being after the third lesson between the experimental groups	8.18	1.696	23	0.20
The state of well-being for the participants who were inferred to be in a state of positive well-being after the fourth lesson between the experimental groups	0.144	1.422	13	0.34
The state of well-being for the participants who were inferred to be in a state of negative well-being after the first lesson between the experimental groups	0.453	0.728	15	0.82
The state of well-being for the participants who were inferred to be in a state of negative well-being after the second lesson between the experimental groups	0.012	-0.197	23	0.84
The state of well-being for the participants who were inferred to be in a state of negative well-being after the third lesson between the experimental groups	1.199	-1.023	15	0.66
The state of well-being for the participants who were inferred to be in a state of negative well-being after the fourth lesson between the experimental groups	1.503	-2.135	25	0.04

Table II: The T-Test analysis of the between the experimental groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Time Spend all	421.50	982.50	-1.20	0.43
Low ability lesson 1	45.00	150.00	-1.46	0.28
Intermediate ability lesson 1	3.00	6.00	-1.00	0.84
Low bility lesson2	162.50	333.50	-1.18	0.48
Intermediate ability lesson 2	18.0	24.00	-1.00	0.64
Low bility lesson 3	183.00	459.00	-0.63	0.93
Intermediate ability lesson 3	21.0	27.00	-0.67	0.81
Low bility lesson 4	181.00	457.00	0.68	0.90
Intermediate ability lesson 4	23.4	33.00	-2.00	0.14
Average Low ability across four lesson	3184.00	7464.00	-424.00	0.87
Average Intermediate ability across four lesson	79.00	115.00	-0.74	0.84

Table III: The inferential statistical analysis of time spent (in minutes) by the two experimental groups.

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Learning Gains Low ability students	113.500	389.500	-2.464	0.02
Learning Gains Intermediate ability students	140.00	74.500	-1.394	0.32
Learning Gains all students	309.000	805.000	-2.726	0.01

Table IV: The inferential statistical analysis of the learning gain comparison for both groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Low ability students	170.500	446.500	-0.966	0.66
Intermediate ability students	55.500	91.500	-0.292	0.90
all students	369.500	865.500	-1.912	0.10

Table V: The inferential statistical analysis of the *pre-test* score of the two groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Low ability students	113.500	389.500	-2.461	0.02
Intermediate ability students	137.000	73.000	-2.301	0.04
all students	259.000	755.000	-3.397	0.002

Table VI: The inferential statistical analysis of the post-*test* score of the two groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Low ability lesson 1	5.000	26.000	-0.577	0.85
Intermediate ability lesson 1	2.000	5.000	-0.645	0.90
All students lesson 1	73.500	193.500	-1.438	0.30
Low ability lesson2	19.000	155.000	-2.484	0.26
Intermediate ability lesson 2	5.000	26.000	-0.577	0.96
All students lesson 2	106.500	382.500	-2.762	0.01
Low ability lesson 3	10.500	130.500	-3.114	0.920
Intermediate ability lesson 3	6.000	27.000	0.000	1.000
All students lesson 3	79.000	289.000	-1.927	0.05
Low ability lesson 4	184.500	460.500	-0.594	0.94
Intermediate ability lesson 4	16.000	37.000	-1.328	0.38
All students lesson 4	119.500	210.500	-0.605	0.94
All students	1751.500	5072.500	-2.559	0.010

Table VII: The inferential statistical analysis of the quality students' answer who were failed to complete their lessons successfully

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
The difference in learning gain (Intermediate – low) ability students	309.50	982.50	-2.20	0.03
The difference in pre-test scores (Intermediate – low ability students)	183.00	459.00	-0.63	0.93
The difference in post-test scores (Intermediate – low ability students)	3184.00	7464.00	-424.00	0.77

Table VIII: The inferential statistical analysis of the difference in learning gain, pre- and post-tests between the two groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Percentage of students who completed their lesson successfully	323.50	862.50	-2.20	0.86
The quality of answers for students who failed to complete their lesson successfully	167.00	349.00	-0.65	0.93

Table IX: The inferential statistical analysis of the comparison of the difference between the low and Intermediate ability students' on the percentage of students who completed their lesson and the quality of answers for both group

		Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Well-being gain	Low ability student	221.000	95.000	-0.856	0.392
	Intermediate ability student	29.000	165.000	-0.970	0.332
	All students	468.00	1046.500	-0.350	0.731

Table X: The inferential statistical analysis of the change of well-being by the end of overall session

		Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Initial state of well-being	Low ability student	147.000	423.000	-1.570	0.22
	Intermediate ability student	76.000	152.000	-2.84	0.05
	All students	281.000	777.000	-3.101	0.004

Table XI: The inferential statistical analysis the initial state of well-being for the participants of the DD and the DD+DI groups

		Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Final state of well-being	Low ability student	17.500	95.500	-0.796	0.88
	Intermediate ability student	36.00	426.00	-.834	0.80
	All students	367.000	863.000	-1.946	0.10

Table XII: The inferential statistical analysis the final state of well-being for the participants of the DD and the DD+DI groups

		Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Improvement after primary reaction	Low ability student	57.500	95.500	-0.796	0.64 s
	Intermediate ability student	190.00	320.00	-2.77	0.04
	All students	450.000	863.000	-1.946	0.05

Table XIII: The inferential statistical analysis of the participants' state of well-being at the end of the primary reaction stage

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (One Tailed)
lesson 1	17.500	62.500	-1.928	0.10
lesson2	23.000	51.000	-2.519	0.02
lesson 3	40.000	106.000	-0.354	0.83
lesson 4	15.00	45.00	-2.496	0.04
All students	1345.500	5456.500	-2.559	0.02

Table XIV: The inferential statistical analysis of the changes in well-being score of the low ability students after the reaction phase of participants who were inferred to be in a state of positive well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	9.500	19.500	-0.619	0.25
lesson2	36.5	73.000	-0.559	0.76
lesson 3	19.500	67.500	-0.216	0.82
lesson 4	34.500	84.500	-1.496	0.24
All students	1751.500	5072.500	-2.559	0.68

Table XV: The inferential statistical analysis of the changes in well-being score of the Intermediate ability students after the reaction phase of participants who were inferred to be in a state of positive well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Low ability	134.50	934.0	-2.313	0.04
Intermediate	300.0	800.0	-0.21	0.72
Overall	1421.0	1982.50	-2.20	0.02

Table XVI: The inferential statistical analysis of the changes in well-being score of participants who were inferred to be in a state of positive of well-being after the reaction phase

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	115.0	137.000	-2.560	0.02
lesson2	125.0	451.000	-2.519	0.023
lesson 3	253.000	523.000	-2.608	0.00
lesson 4	225.00	311.500	-2.936	0.01
All students	1222.500	1650.500	-2.559	0.02

Table XVII: The inferential statistical analysis of the changes in well-being score of the low ability students after the reaction phase of participants who were inferred to be in a state of negative well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	15.0	19.500	-2.619	0.04
lesson2	13.00	39.000	-2.559	0.06
lesson 3	24.00	12.000	-2.000	0.05
lesson 4	35.00	20.00	-2.436	0.01
All students	123.500	720.500	-2.559	0.05

Table XXVIII: The inferential statistical analysis of the changes in well-being score of the Intermediate ability students after the reaction phase of participants who were inferred to be in a state of negative well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Low ability	1234.50	1934.0	-2.93	0.00
Intermediate	656.0	800.0	-2.71	0.001
Overall	4321.0	7982.50	-2.60	0.002

Table XIX: The inferential statistical analysis of the changes in well-being score of participants who were inferred to be in a state of negative of well-being after the reaction phase

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
The diff of well-being gain (Intermediate - low ability) student	2340.000	1795.000	-2.856	0.00

Table XX: The inferential statistical analysis of the comparison of the difference change in the state of well-being for the two groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
The Change of the state of well-being after primary reaction stage (Intermediate – Low ability students)	17.500	95.500	-0.796	0.426

Table XXI: The inferential statistical analysis of the participants' state of well-being at the end of the primary reaction stage

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
The change of the state of positive well-being after secondary reaction stage (Intermediate – Low ability students)	2378.0	3795.500	-2.796	0.04

Table XXII: The comparison of the difference in changes of the state of well-being for the two ability levels within the two experimental groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
Initial state (Intermediate – Low ability students)	2459.0	3795.500	-2.596	0.00
Final state (Intermediate – Low ability students)	1670.0	2341.500	-2.213	0.01

Table XXIII: The comparison of the initial and final states of well-being for the two ability levels within the two experimental groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	17.00	62.500	-2.928	0.01
lesson2	23.000	51.000	-2.519	0.02
lesson 3	40.000	106.000	-0.354	0.78
lesson 4	1.500	4.500	-1.496	1.00
All students	1345.500	3456.500	-2.559	0.02

Table XXIV: The inferential statistical analysis of the changes in well-being score of the DD group after the reaction phase of participants who were inferred to be in a state of positive well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	9.500	19.500	-0.619	0.24
lesson2	3.00	13.000	-0.559	0.83
lesson 3	4.500	19.500	-0.216	0.829
lesson 4	1.500	4.500	-1.496	0.24
All students	1751.500	5072.500	-2.559	0.64

Table XXV: The inferential statistical analysis of the changes in well-being score of the DD+DI group after the reaction phase of participants who were inferred to be in a state of positive well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
The difference in the changes of participants' who were in a state of negative well-being after secondary reaction	3621.50	5982.50	-2.20	0.03

Table XXVI: The inferential statistical analysis of the difference in the changes of participants' who were in a state of negative well-being after secondary reaction

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	62.500	137.000	-1.560	0.12
lesson2	72.000	151.000	-1.919	0.23
lesson 3	63.000	123.000	-1.608	0.21
lesson 4	130.500	311.500	-0.936	0.65
All students	1122.500	4650.500	-2.559	0.001

Table XXVII: The inferential statistical analysis of the changes in well-being score of the DD group after the reaction phase of participants who were inferred to be in a state of negative well-being

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (one Tailed)
lesson 1	17.500	19.500	-0.619	0.729
lesson2	23.00	39.000	-1.559	0.631
lesson 3	12.00	15.000	-1.000	0.746
lesson 4	15.00	20.00	-0.936	0.655
All students	246.500	720.500	-1.559	0.089

Table XXVIII: The inferential statistical analysis of the changes in well-being score of the DD+DI group after the reaction phase of participants who were inferred to be in a state of negative well-being

Appendix G- The Kolmogov-Smirnov Tests

		Kolmogov-Smirnov test
Variables	groups	***Significant***
PreTest Score	DD	***.117***
	DD+DI	***.015***
Participants initial well-being level	DD	***0.98***
	DD+DI	***0.41***
The participants who were inferred to be in a positive well-being state	DD	***0.00***
	DD+DI	***0.00***
The participants who were inferred to be in a negative well-being state	DD	***0.00***
	DD+DI	***0.09***
The change in student's satisfaction level after secondary reaction phase	DD	***0.01***
	DD+DI	***0.00***
The change in student's dissatisfaction level after secondary reaction phase	DD	***0.00***
	DD+DI	***0.00***
Participants' satisfaction level after first lesson	DD	***0.05***
	DD+DI	***0.25***
Participants' satisfaction level after second lesson	DD	***0.82***
	DD+DI	***0.57***
Participants' satisfaction level after third lesson	DD	***0.05***
	DD+DI	***0.36***
Participants' satisfaction level after fourth lesson	DD	***0.91***
	DD+DI	***0.27***
	DD+DI	***0.98***
Participants' dissatisfaction level after second lesson	DD	***0.31***
	DD+DI	***0.23***
Participants' dissatisfaction level after third lesson	DD	***0.11***
	DD+DI	***0.75***
Participants' dissatisfaction level after fourth lesson	DD	***0.11***
	DD+DI	***0.21***
The change in participants' satisfaction level after first lesson	DD	***0.34***
	DD+DI	***0.11***
The change in participants' satisfaction level after second lesson	DD	***0.82***
	DD+DI	***0.34***
The change in participants' satisfaction level after third lesson	DD	***0.02***
	DD+DI	***0.77***

The change in participants' satisfaction level after fourth lesson	DD	***0.32***
	DD+DI	***0.11***
The change in participants' dissatisfaction level after first lesson	DD	***0.13***
	DD+DI	***0.11***
The change in participants' dissatisfaction level after second lesson	DD	***0.15***
	DD+DI	***0.25***
The change in participants' dissatisfaction level after third lesson	DD	***0.08***
	DD+DI	***0.13***
The change in participants' dissatisfaction level after fourth lesson	DD	***0.31***
	DD+DI	***0.08***
PostTestScore	DD	***0.189***
	DD+DI	***0.200***
Well-being level at the end of the experimental session	DD	***0.96***
	DD+DI	***0.50***
LearningGain	DD	***.000***
	DD+DI	***.114***

Appendix H

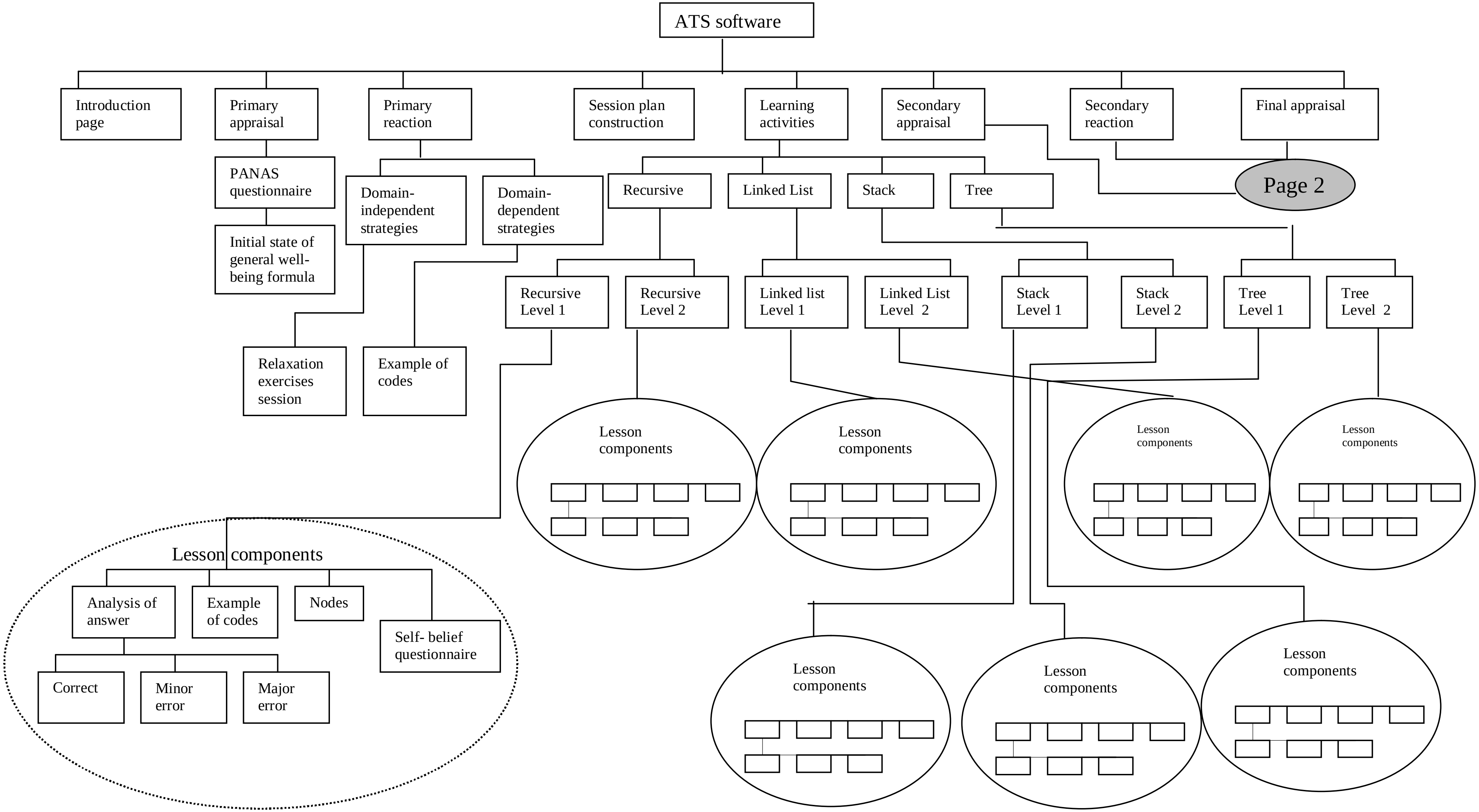

ATS software
Introduction page
Primary appraisal
Primary reaction
Session plan construction
Learning activities
Secondary appraisal
Secondary reaction
Final appraisal
PANAS questionnaire
Initial state of general well-being formula
Domain-independent strategies
Domain-dependent strategies
Relaxation exercises session
Example of codes
Recursive
Linked List
Stack
Tree
Page 2
Recursive Level 1
Recursive Level 2
Linked list Level 1
Linked List Level 2
Stack Level 1
Stack Level 2
Tree Level 1
Tree Level 2
Lesson components
Lesson components
Lesson components
Lesson components
Lesson components
Analysis of answer
Example of codes
Nodes
Self- belief questionnaire
Correct
Minor error
Major error
Lesson components
Lesson components
Lesson components

Figure 1: The functional structure of the ATS software (page 1)

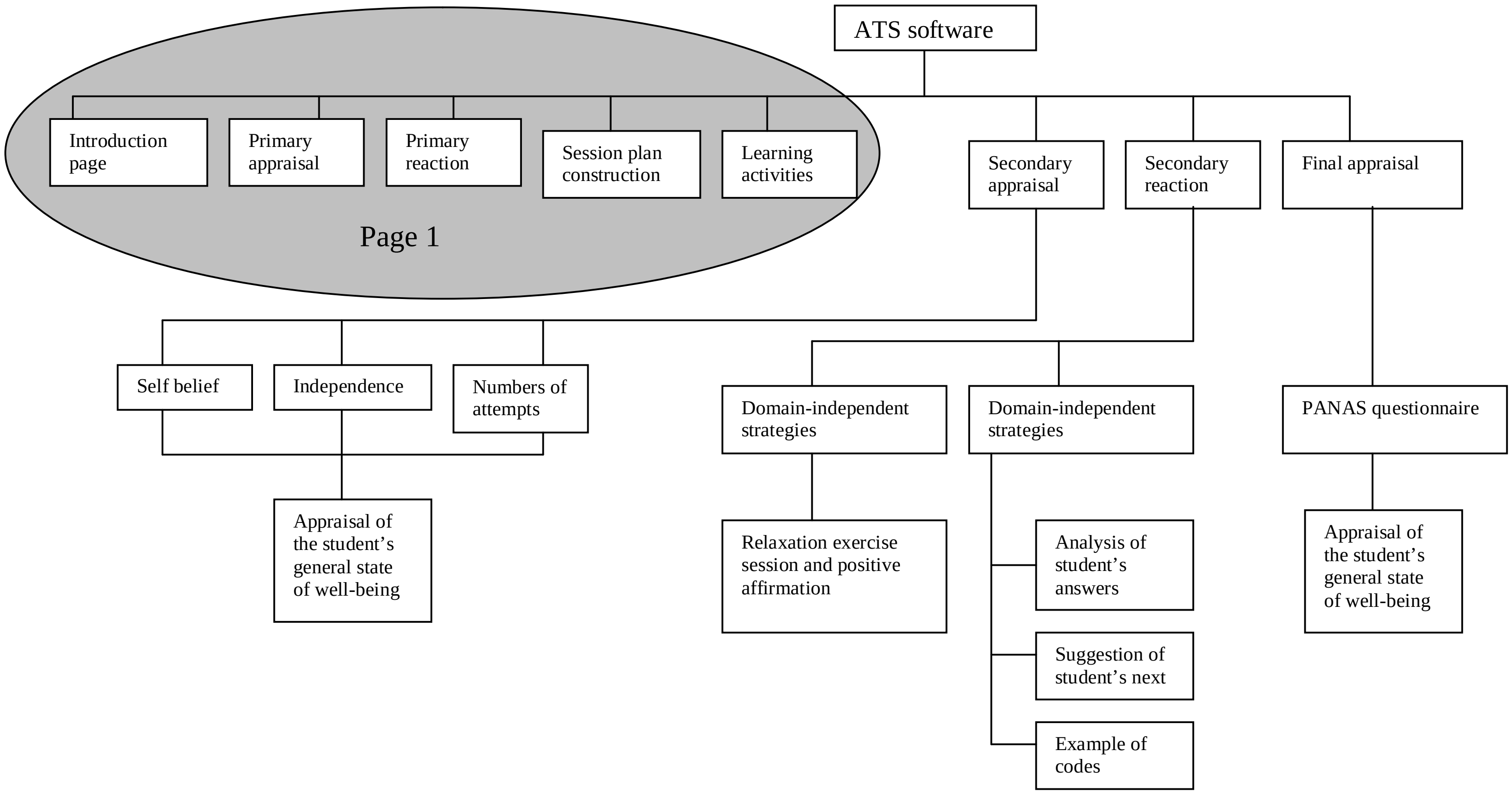


Figure 2: The functional structure of the ATS software (page 2)

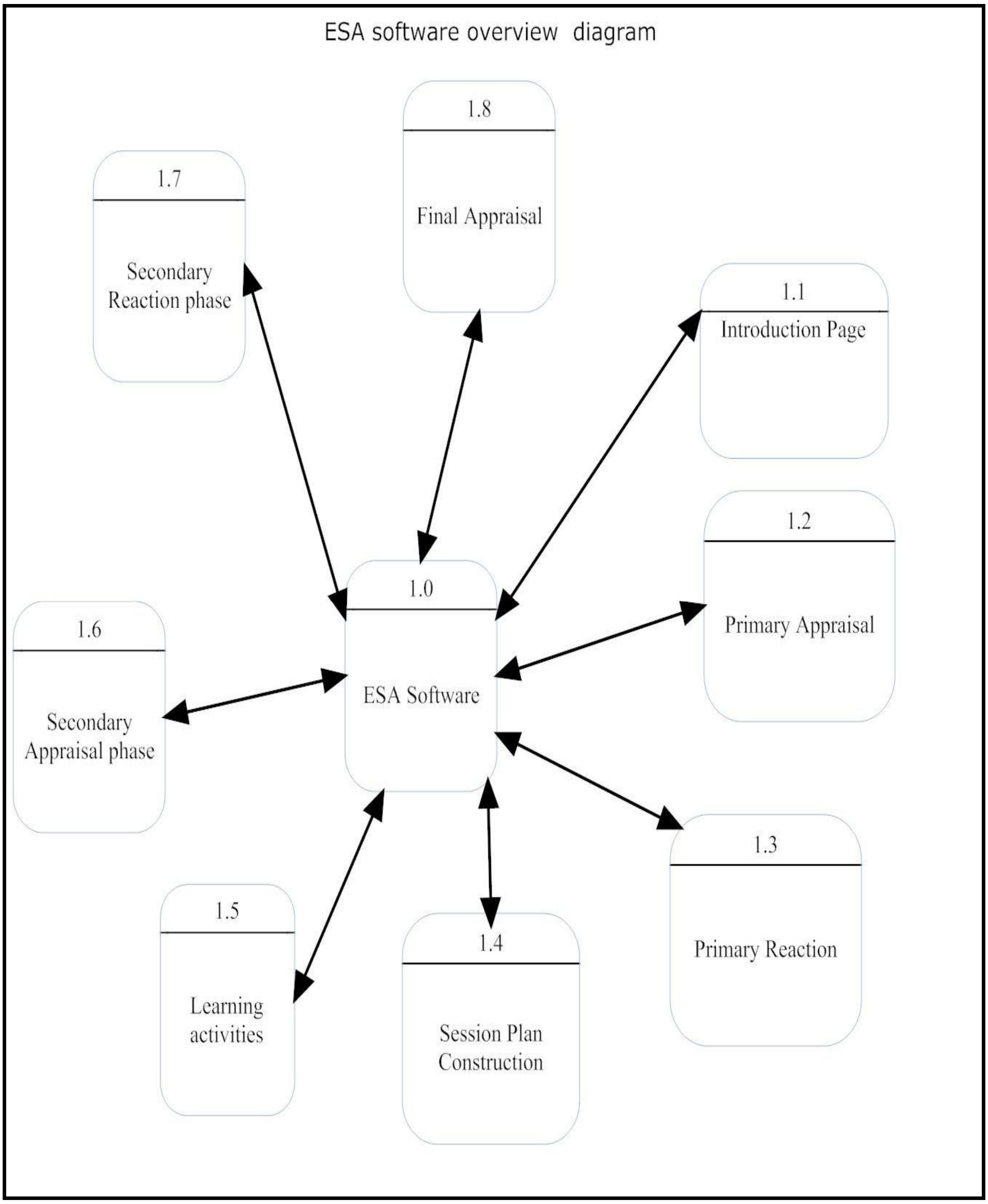


Figure 3: The ATS software overview diagram

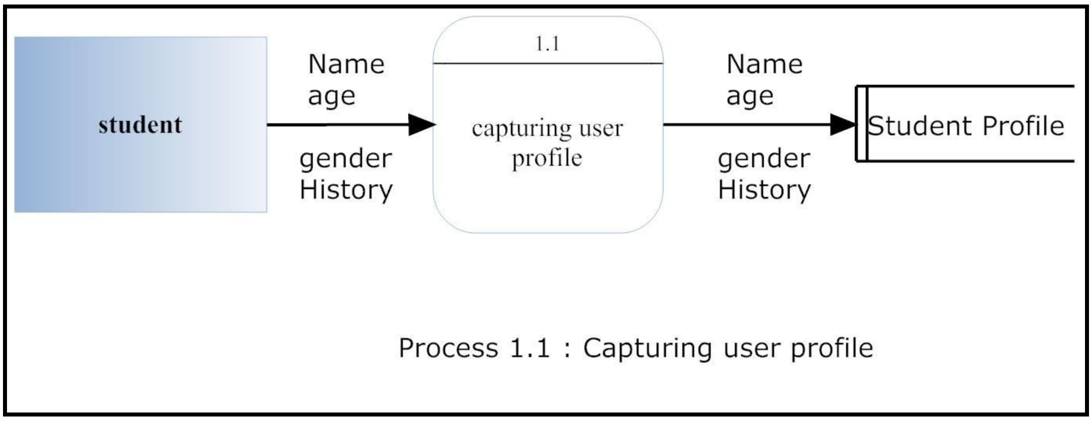


Figure 4: Process 1.1: Capturing the user profile

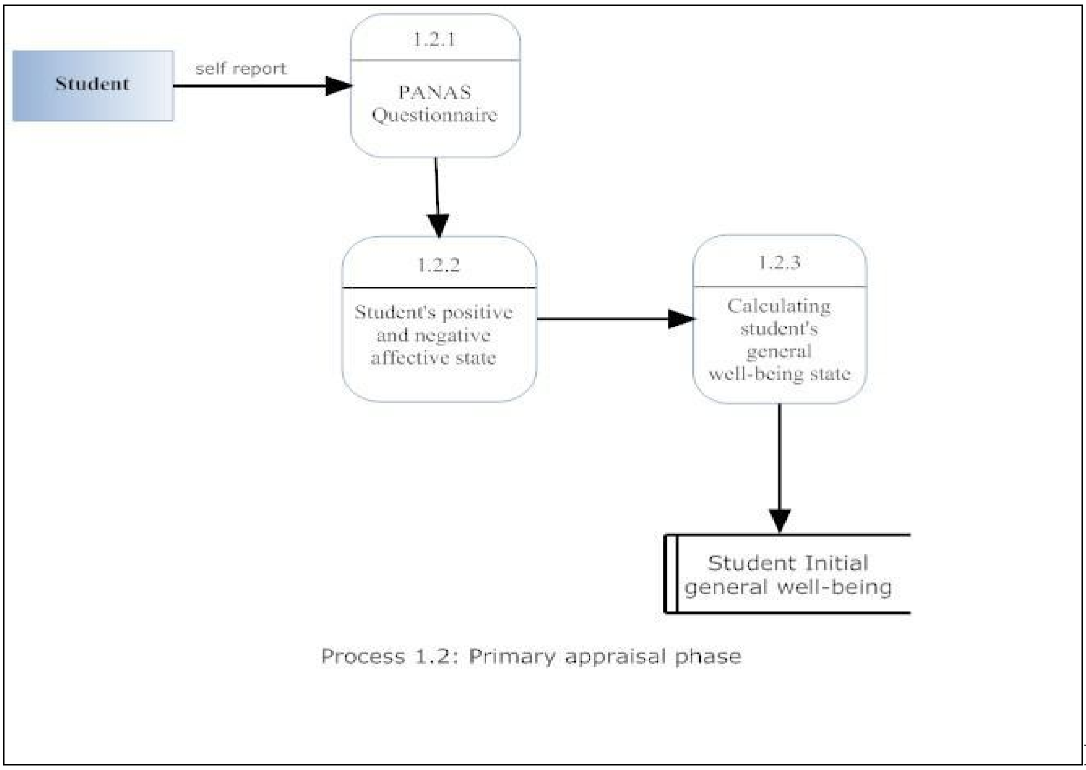


Figure 5: Process 1.2: Primary appraisal phase

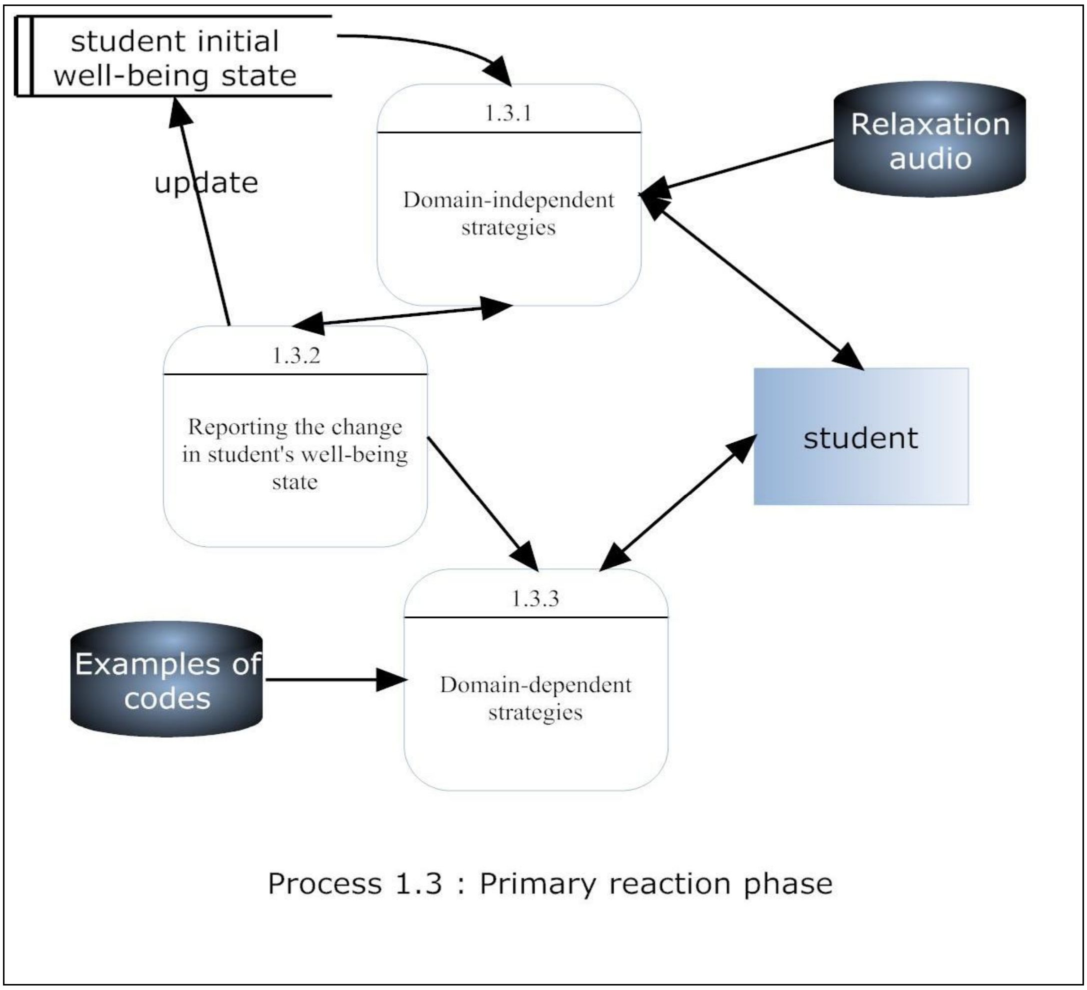


Figure 6: Process 1.3: Primary reaction phase

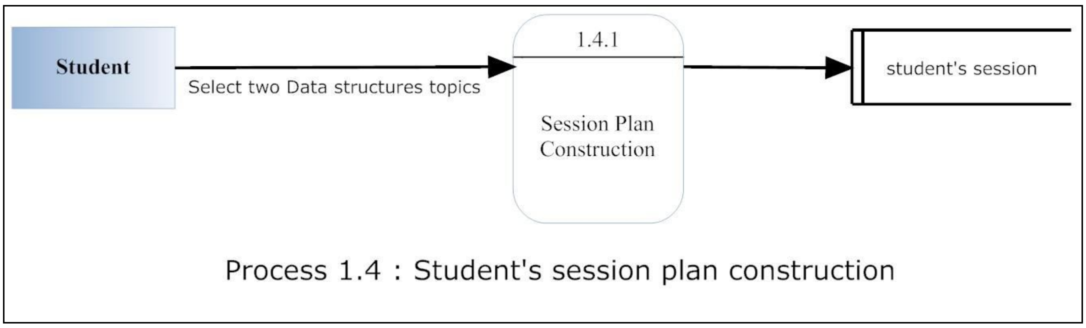


Figure 7: Process 1.4: Student's session plan construction

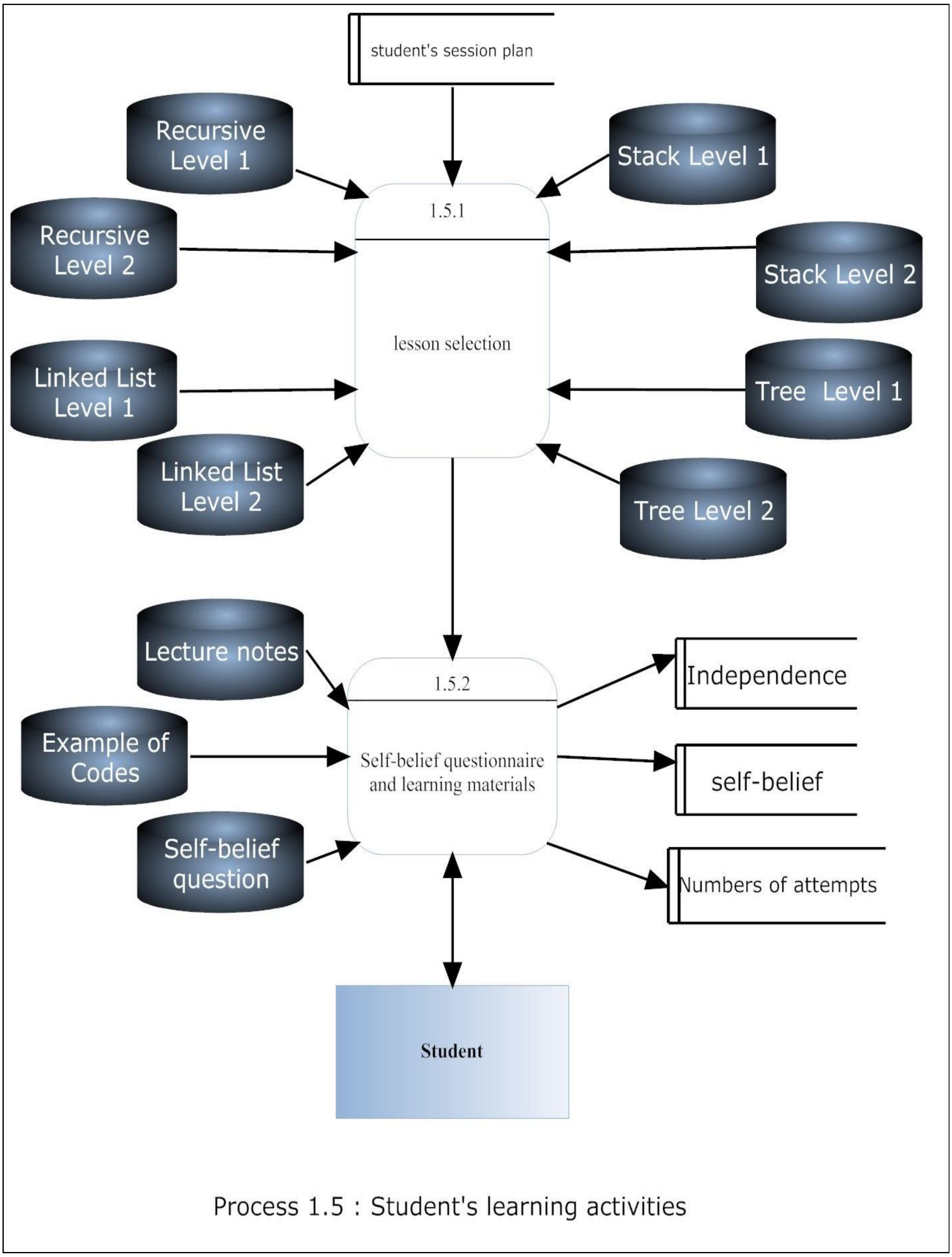


Figure 8: Process 1.5: Student's learning activities

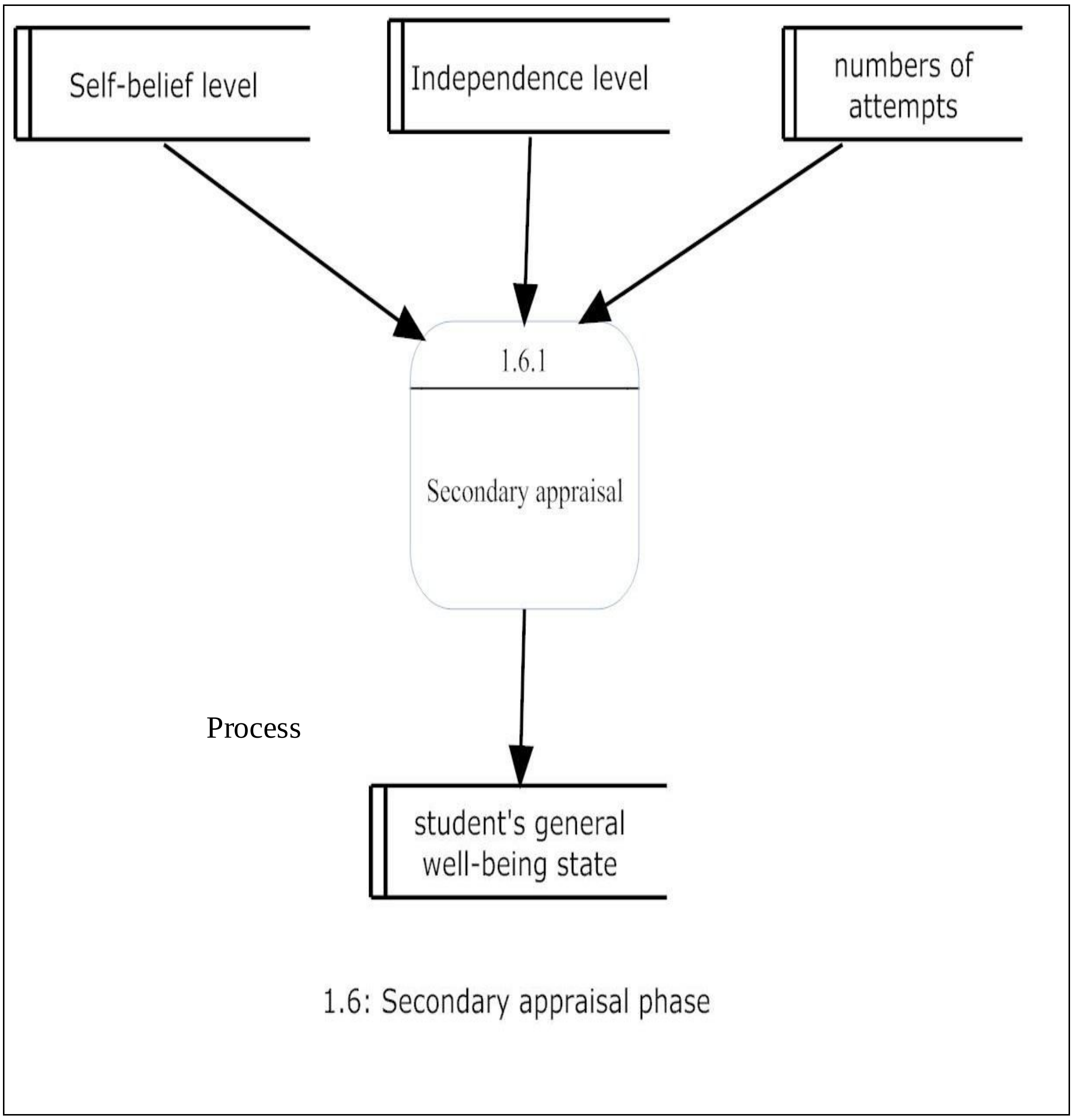


Figure 9: Process 1.6: Secondary appraisal phase

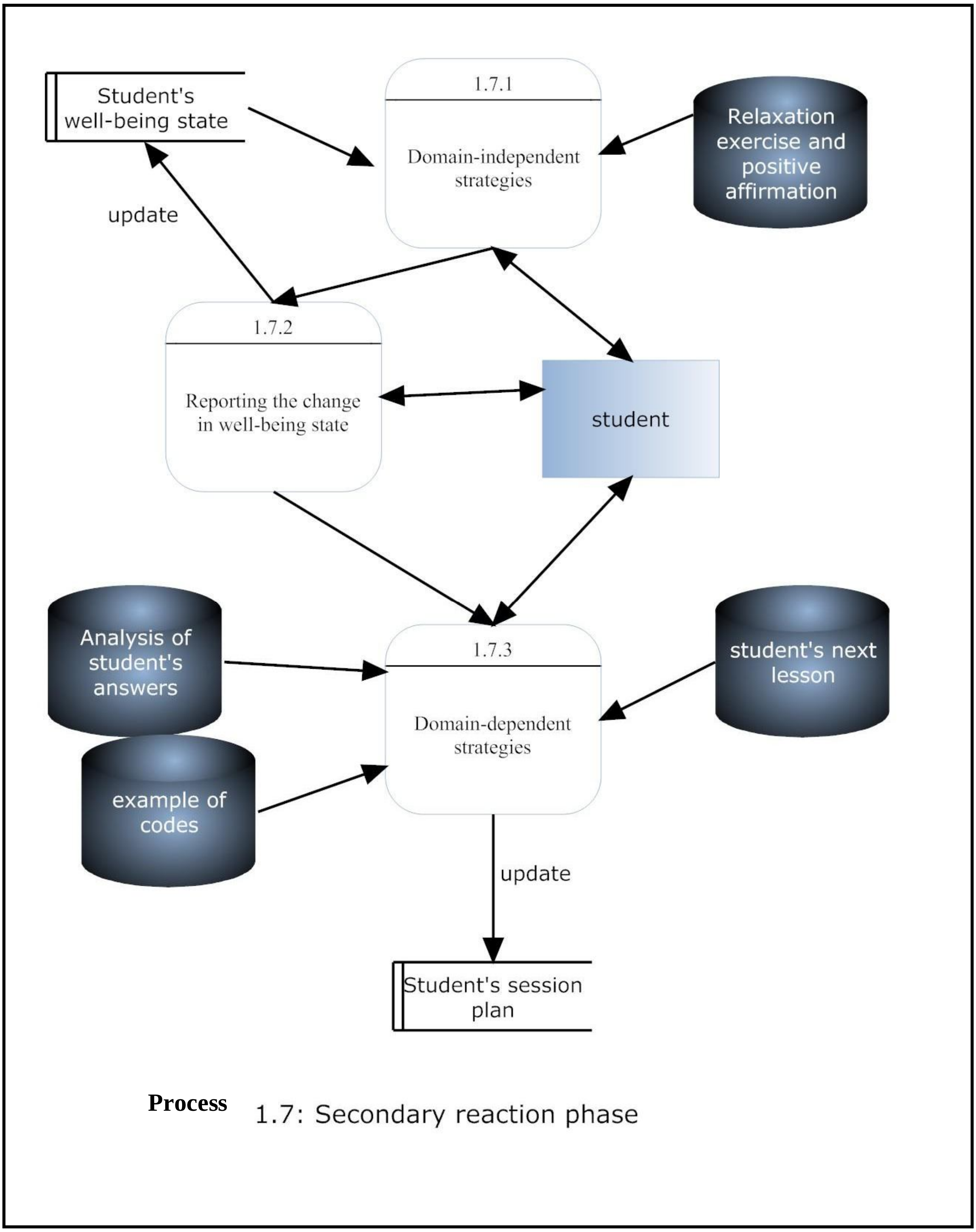


Figure 10: Process 1.7: Secondary reaction phase

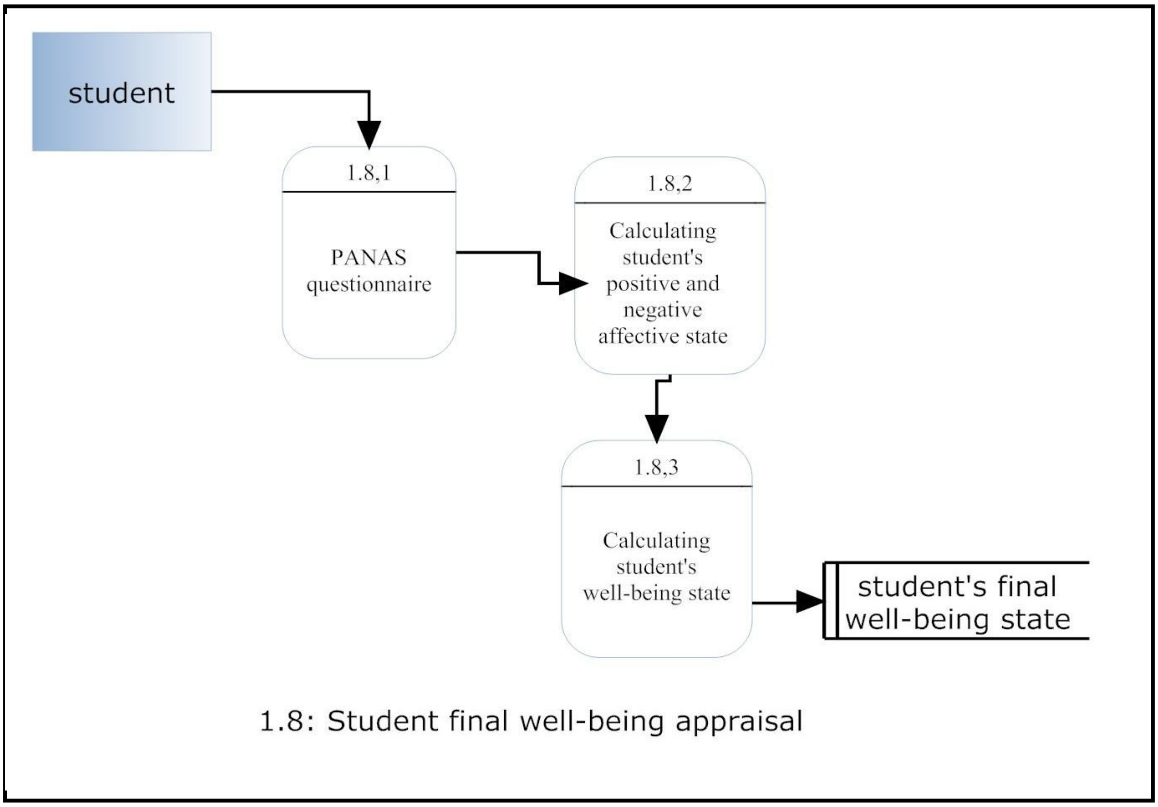


Figure 11: Process 1.8: Student’s final well-being appraisal

Summary of ATS classes

Interface Summary	
DIListener	To detect the change for domain independent strategies
OKListener	To detect the change for OK button
TimerListener	To detect the change for time

Class Summary	
AffectLevelWindow	Window for student's affective state
AffectLevelWindowStartTimer	Window for the start of time
AffectLevelWindowTimer	Window for the end of time
Answer	Class for student's answer
AnswerAnalysis	Class for analysis of student's answer
AnswerRecursiveLevel2	Class for recursive lesson
AudioPlayer	Class for audio player
AudioPlayerOneTime	Class for audio player (use as a flag)
BreathingExerciseAudio	Class for breathing exercise audio
ButtonPanel	Class for button panel
CaptureStudentAnswer	Class to capture student 's answer
CaptureStudentAnswerLinkedListLevel1	Class of students' linked list level 1 answer
CaptureStudentAnswerLinkedListLevel2	Class of students' linked list level 2 answer
CaptureStudentAnswerRecursiveLevel2	Class of students' recursive level 2 answer
CaptureStudentAnswerStackLevel2	Class of students' stack level 2 answer
CaptureStudentAnswerStackLevel3	Class of students' stack level 3 answer
CaptureStudentAnswerTreeLevel1	Class of students' tree level 1 answer
CaptureStudentAnswerTreeLevel2	Class of students' tree level 2 answer
Clock	Class for clock
ClockPanel	Class for clock panel
ConstructingRecursive	Class for constructing recursive lesson
createComponent	Class for creating component
createCorrectAnswer	Class for student's correct answer
createCorrectAnswerLinkedListLevel1	Class for student's correct answer for linked list level 1
createCorrectAnswerLinkedListLevel2	Class for student's correct answer for linked list level 2

createCorrectAnswerRecursiveLevel2	Class for student's correct answer for recursive level 2
createCorrectAnswerStackLevel1	Class for student's correct answer for stack level 1
createCorrectAnswerStackLevel2	Class for student's correct answer for Stack level 2
createCorrectAnswerTreeLevel1	Class for student's correct answer for Tree level 1
createCorrectAnswerTreeLevel2	Class for student's correct answer for Tree level 2
DataStructuresEastWindow	Class for data structure East window
DataStructuresLinkedListLevel1MainWindow	Class for linked list level1 main window
DataStructuresLinkedListLevel2MainWindow	Class for linked list level 2 main window
DataStructuresMainWindow	Class for data structure main window
DataStructuresMainWindowDD	Class for data structure domain dependent's window
DataStructuresMainWindowDDDI	Class for data structure domain dependent and domain independent's window
DataStructuresMainWindowDI	Class for data structure domain dependent's main window
DataStructuresRecursiveLevel1MainWindow	Class for recursive level1 main window
DataStructuresRecursiveLevel2MainWindow	Class for recursive level 2 main window
DataStructuresStackLevel1MainWindow	Class for Stack level1 main window
DataStructuresStackLevel2MainWindow	Class for Stack level 2 main window
DataStructuresTreeLevel1MainWindow	Class for Tree level1 main window
DataStructuresTreeLevel2MainWindow	Class for Tree level 2 main window
DiagramExample	Class for example diagram
DialogDemo	Class for Dialog demoa
DisplayExample1	Class for Example 1
DomainDependentStrategies	Class for Domain dependent strategies
DomainIndependentBreathingExercises	Class for Breathing exercise
DomainIndependentNoBreathingExercises	Class for non breathing excises strategies
DomainIndependentSecondaryReaction	Class for secondary reaction strategies
FindDirectories	Class for finding directories
FindDirectories2	Class for finding directory 2
FindDirectories3	Class for finding directory 2
HelpMenuBar	Class for bar menu for help

JButtonGroup	Class for button group
KeepOnTryingAudio	Class for keep on trying audio
LastVisit	Class for last visit window
LessonPlan	Class for lesson plan page
LessonPlanInstructionPage	Class for constructing Lesson plan
LessonPlanLL	Class for constructing linked list lesson plan
LessonPlanR	Class for constructing recursive lesson plan
LessonPlanR2	Class for constructing recursive 2 lesson plan
LessonPlanStack	Class for constructing Stack lesson plan
LinkedListLevel1DDQuestion	Class for main linked list question page
LinkedListLevel1Question	Class for linked list level 1 question page
LinkedListLevel2DDQuestion	Class for linked list level 2 (domain dependent) question page
LinkedListLevel2Question	Class for linked list level 1 question page
LinkedListMenuBar	Class for menu bar of linked list page
LoginFramemian	Class for login
MainDisplayAreaPanelDD	Class for main area of DD page
MainDisplayAreaPanelDDDI	Class for main panel of DDDI group
MainDisplayEastAreaPanel	Class for main panel East window
MessageDialog	Class for Message Dialog
NegativeDomainDepedendentStrategiesBelow1	Class for students who were inferred to be in negative affective state level 0 (DD group)
NegativeDomainDepedendentStrategiesFinish	Class for students who were inferred to be in negative affective state level 1 (DD group)
NegativeDomainDepedendentStrategiesLevel1	Class for students who were inferred to be in negative affective state level 1 (DD group)
NegativeDomainDepedendentStrategiesLevel2	Class for students who were inferred to be in negative affective state level 2 (DD group)
NegativeDomainDepedendentStrategiesLevel3	Class for students who were inferred to be in negative affective state level 3 (DD group)
NewSoundPlayerOnlyOneAudio	Class for new audio
PanasQuestionnaire	Class for PANAS questionnaire
PanasQuestionnaire2	Class for PANAS questionnaire page 1
PanasQuestionnaire2Finish	Class for PANAS questionnaire last page
PanasQuestionnaire3	Class for PANAS questionnaire page 3
PanasQuestionnaireResult	Class for PANAS questionnaire result

PositiveAffectiveFeedback	Class for positive affective state feedback
PositiveBreathingExercises	Class for Breathing exercise
PositiveDDStrategiesAdviceDD	Class for domain dependent strategies advice
PositiveDDStrategiesAfterBELowerPA	Class for domain dependent strategies for lower positive affective state
PositiveDDStrategiesLevel2	Class for domain dependent strategies for level 2 positive affective state
PositiveDomainDepedendentStrategiesFinish	Class for completing domain dependent strategies
PrimaryReaction	Class for primary reaction
PrimaryReaction1	Class for primary reaction 1
PrimaryReactionConfirmAffectLevel	Class to confirm the primary reaction based on student's affective sate
PrimaryReactionNegativeOver3	Class for primary reaction Level 3 (negative affective state)
PrimaryReactionPositiveBelow3	Class for primary reaction level 2 (positive affective state)
PrimaryReactionPositiveOver3	Class for primary reaction level 2 (positive affective state)
QuitMenuBar	Class for Quit menu bar
RadioButtonMenuItemExample	Class for example of radio button
RecursiveAnswerLevel2Code	Class for recursive level 2 code
RecursiveApplication	Class for recursive application page
RecursiveDemo	Class for recursive demo page
RecursiveExample1	Class for example 1 of recursive lesson
RecursiveExample2	Class for example 2 of recursive lesson
RecursiveLevel1DDQuestion	Class for recursive question level 1
RecursiveLevel1Diagram	Class for recursive diagram level 1
RecursiveLevel1ExampleDiagram	Class for recursive example diagram level 1
RecursiveLevel1Menu	Class for recursive menu level 1
RecursiveLevel1Question	Class for recursive question level 1
RecursiveLevel2DDQuestion	Class for recursive question level 2
RecursiveLevel2Diagram	Class for recursive diagram level 2
RecursiveMenuBar	Class for recursive menu bar
SecondaryReactionNegativeBelow2	Class for secondary reaction for negative affective state level 2
SecondaryReactionNegativeOver2	Class for secondary reaction for negative

	affective state level 1
SecondaryReactionPositiveBelow2	Class for secondary reaction for positive affective state level 1
SecondaryReactionPositiveOver2	Class for secondary reaction for positive affective state level 1
SecondayReactionNegativeAffect	Class for secondary reaction for positive affective state page
SecondayReactionNegativeAffectDDDI	Class for secondary reaction for negative affective state (DD+DI group)
SecondayReactionNegativeAffectDDDIIntoMDAP	Class for secondary reaction for negative affective state (DD+DI group) page
SecondayReactionNegativeAffectDDIntoMDAP	Class for secondary reaction for negative affective state (DD group) page
SecondayReactionNegativeAffectDemo	Class for secondary reaction for negative affective state page demo
SecondayReactionNegativeAffectDemo2	Class for secondary reaction for negative affective state page demo 2
SelectChapter	Class for selecting lesson
SelectEmotionEffortIndependence	Class for calculating student effort
SelectEmotionEffortIndependenceDD	Class for calculating student effort (DD)
SelectEmotionEffortIndependenceDDDI	Class for calculating student effort (DD+DI)
SequenceOfSteps	Class for the sequence of lesson page 1
SequenceStepsToDo	Class for the sequence of lesson page 2
SRNADDIntoMDAP	Class for secondary reaction for DD +DI group
SRPADDIntoMDAP	Class for secondary reaction for DD group
StackIntro	Class for stack information
StackLevel1Question	Class for Stack level 1 question
StackLevel2DDQuestion	Class for Stack level 1 question (DD group)
StackLevel2Question	Class for Stack level 2 question
StackLevel3DDQuestion	Class for Stack level 2 question (DD group)
StackMenuBar	Class for stack menu bar
StartTimer	Class for starting a timer
TabbedPaneDemo	Class for Tabbed Panel Demo
TextClock	Class for Testing clock option
TextEditClass	Class for editing text
TextEditFrame	Class for editing frame

TracingRecursive	Class for tracing recursive
TreeLevel1DDQuestion	Class for Tree level 1 question (DD group)
TreeLevel1Question	Class for Tree level 1 question
TreeLevel2DDQuestion	Class for Tree level 2 question (DD group)
TreeLevel2Question	Class for Tree level 1 question
TreeMenuBar	Class for Tree menu bar
WellDoneAudio	Class for “well done” audio
YouCanDoItAudio	Class for “you can do it ” audio

Appendix I: The categorization of students' answers

Recursive level 1

Question	Correct Answer	Minor Error	Major Error
1	10	12	Others
2	240	8	Others
		40	
		120	
3	48	2	Others
		6	
		24	

Recursive level 2

Question	Correct Answer	Minor Error	Major Error
1	SumOfNumbers	SumOfnumbers	Others
		sumofnumbers	
		Sumofnumbers	
		SumOf	
		SumofNums	
2	n	N	Others
		X	
		x	
		int	
		int X	
3	1	20	Others
		0	
4	1	20	Others
		0	
5	SumOfNumbers	SumOfnumbers	Others
		sumofnumbers	
		Sumofnumbers	
		SumOf	
		SumofNums	
6	x-1	X+1	Others
		x+1	
		N	
		N-1	
		N+1	
		n-1	
		X+1	
		x+1	
		int x	
		int n	

linked list level 1

Question	Correct Answer	Minor Error	Major Error
1	Staff	staff	Others
		STAFF	
		Staf	
		staf	
		sTAFF	
		STaff	
2	Salary	salary	Others
		Salry	
		Salaryy	
		salarY	
		salry	
		SALaRY	
3	HighestSalaryStaff	highestSalarystaff	Others
		Highestsalarystaff	
		highestSalrystaff	
		HighesSalarystaff	
		HighestSalaryStaf	
		HigestSalaryStaf	
4	Staff	staff	Others
		STAFF	
		Staf	
		staf	
		sTAFF	
		STaff	
5	Staff	staff	Others
		STAFF	
		Staf	
		staf	
		sTAFF	
		STaff	
6	next	nExt	Others
		netx	
		nexT	
		NExt	
		nExt	
7	Address	Addrees	Others
		adress	
		ADDRESS	
		addresss	
		Addresss	
		Addreess	

8	ID	id	Others
		Name	
		Salary	
		iD	
		Id	
9	Salary	salary	Others
		Salry	
		Salaryy	
		salarY	
		salry	
		SALaRY	

Linked list level 2

Question	Correct Answer	Minor Error	Major Error
1	List	LIst	Others
		list	
		LISt	
		lisT	
		lis	
2	data1	Data1	Others
		Dat	
		dat	
3	data1	Data1	Others
		Dat	
		dat	
4	1	2	Others
		0	
5	OddList	Oddlist	Others
		*OddList	
		&OddList	
		**OddList	
		odddList	
		oddlist	
		odlist	
6	InsertNode	Insertlist	Others
		insertlist	
		InsetList	
		InsertLis	
		insetlis	
		InsrtLis	
		INsertList	
7	EvenList	Evenlist	Others
		evenlist	
		*EvenList	
		&EvenList	
		**EvenList	
		evenLis	
		EvenLIST	

		EveList	
8	List	LIst	Others
		list	
		LISt	
		lisT	
		lis	
9	next	nExt	Others
		netx	
		nexT	
		NExt	
		nExt	
		nExt	

Stack level 1

Question	Correct Answer	Minor Error	Major Error
1	EmptyStack	Emptystack	Others
		emptyStack	
		emptystack	
		Emtystck	
		EmptyStak	
		Empty	
2	pop	Pop	Others
		poP	
		Push	
		push	
		po	
3	Student	Studen	Others
		student	
		studnt	
		Studet	
4	StudentMark1	Studentmark	Others
		studentMark1	
		studentmark	
		student1	
		studenmark	
5	StudentMark2	Studentmark2	Others
		StudentMark	
		Student	
		studentmark2	
		mark2	
		mark	
6	StudentFinalMark	studentFinalMark	Others
		studendfinalmark	
		StudentMark1	
		StudentMark2	
7	HighestStudentFinalMark	HighestFinalMark	Others
		Mark1	
		StudentMark1	
		StudentMark2	
8	StudentID	studentFinalMark	Others
		studendfinalmark	
		StudentMark1	
		StudentMark2	
9	BestStudentID	BeststudentID	Others
		studendID	
		studentID	
		bestStudentID	
		BestStudentiD	
10	HighestStudentFinalMark	HighestFinalMark	Others
		Mark1	
		StudentMark1	
		StudentMark2	

Stack level 2

Question	Correct Answer	Minor Error	Major Error
1	EmptyStack	Emptystack	Others
		emptyStack	
		emptystack	
		Emtystck	
		EmptyStak	
		Empty	
2	T	t	Others
		stack	
3	T	t	Others
		stack	
4	x	X	Others
		T	
5	push	Push	Others
		Pop	
		PUsh	
		PUSh	
		pusH	
		pus	
6	Temp	temp	Others
		TemP	
		Tem	
		TEmp	
7	while	While	Others
		whilT	
		do	
		Do	
8	Temp	temp	Others
		TemP	
		Tem	
		TEmp	
		temp	
9	pop	Pop	Others
		poP	
		Push	
		push	
10	Temp	temp	Others
		TemP	
		Tem	
		Temp	
		Temp	

11	T	t Stack Stack St	Others
12	Sum	sum SuM sump index	Others
13	index	Index Int Int INdex	Others

Tree level 1

Question	**Correct Answer**	**Minor Error**	**Major Error**
1	char	chaR Char CHAR cha cher	Others
2	Entry2	entry2 entr2 Entry Entry2	Others
3	left	Left lft letf lef Letf	Others
4	right	Right Righ righ rigHt rigt	Others
5	T	t Tree node	Others
6	age	aage Age ag	Others
7	count++	Count Count++ count+ Cout++ count+++ COUNT++	Others

8	left	Left lft letf lef	Others
9	right	Right Righ righ rigHt rigt	Others

Tree level 2

Question	**Correct Answer**	**Minor Error**	**Major Error**
1	Tree	TRee Tre tree TREE trEE *Tree	Others
2	Temp	temp TemP Tem TEmp	Others
3	Rchild	rchild Rchlild *Rchild Rchil	Others
4	Rchild	rchild Rchlild *Rchild Rchil rchild	Others
5	Highest	highest high highesT Hoight Height highesT	Others
6	Mark	mark Marks mar mark	Others

7	Temp	temp	Others
		TemP	
		Tem	
		TEmp	
8	Lchild	lchild	Others
		lchlild	
		*Lchild	
		Lchil	
9	Temp	temp	Others
		TemP	
		Tem	
		TEmp	
10	Lchild	lchild	
		lchlild	
		*Lchild	
		Lchil	
11	Highest	highest	
		high	
		highesT	
		Hoight	
		Height	
		highesT	
12	Lowest	lowest	
		low	
		LoweST	
		Lowrst	
		Lowes	
13	Average	average	
		evarge	
		Aveerage	
		*Average	

Appendix J – Pre and post test materials

<u>Recursive question</u>

Write a recursive program to add the first 20 elements of the series

1 + 1/2 + 1/3 +1/4 + 1/5 + …. + 1/20

by completing the codes of the following ***segment i*** and ***segment ii***

```
#include <stdio.h>

float SumOfNumbers(int);

void main() {
        int n = 20

        printf("sum of the series = %lf",_________);


}

float SumOfNumbers (int x) {

    if (x == _____)
        return ______;
    else
        _______ ( ______ + 1/_______(____));

}
```

Linked list Question

The following linked list structure is used to store staff information of Tenaga Baru company.

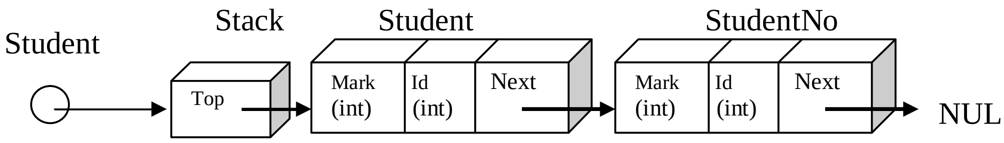
```
struct  Staffnode {
        char[10]   Name;
        char[12]   Address;
        int        ID;
        int        Salary
        struct Listnode  *next;
        }StaffNode;

StaffNode  *Staff;
```

b) Using the above structure, write a function to calculate and display the **average** salary of Tenaga Baru staff.

```
 void  CalADisplaySalary ( StaffNode * staff)
{
    int count;
    float  salary,AvSalary;
    while ( Staff ! = NULL) )
    {
          salary = salary  + Staff-> _____;
          _____;
          __________;
    }
    AvSalary =_______;
    printf(" average Salary of Tenaga Baru staff  = % f", _______);
}
```

Stack question

The stack diagram below is used to store the result of CMPB274 final exam. Based on the stack, do the following:



c) Write the data structure of the stack

```
typedef struct Studentnode {
int Mark;
int Id;
struct Studentnode  * Next;
} StudentNode;

typedef struct stack {
StudentNode * Top;
} Stack;

Stack _______;
```

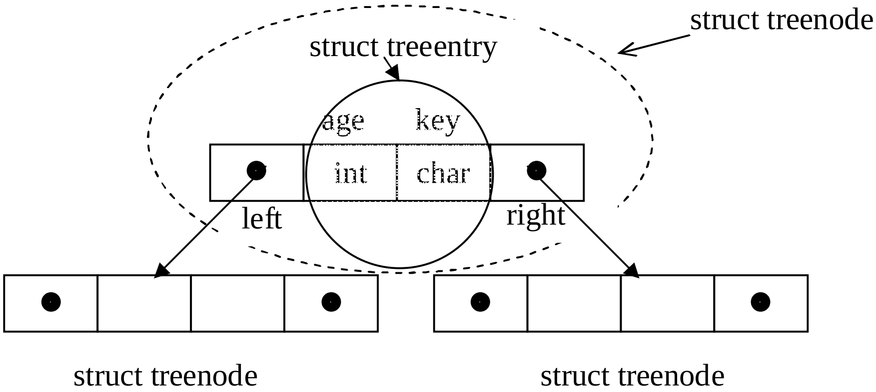
d) Using the basic functions of Stack (pop, push etc), write a function to determine and display the best student's mark and ***Id*** of the CMPB274 final exam.

```
void  DispBesPer ( Stack * Student)
{
        Stack * TopS;
        int HM = 0;
        int M; Char Id;

        while (!EmptyStack(________t))
        {
                pop ( &_,&___,____)
                if ( M > ___)
                push ( _,_, &____);}
        ___ (&M,&Id,Tops);
        printf (_____________________);
}
```

Tree question

Starting time : ___________

c) Write the definition of the binary search tree structure below:




```
typedef struct treeentry{
      int ___;
      ____ key;
} TreeEntry;

typedef struct treenode{
      TreeEntry _______;
      struct treenode ______;
      ______________ * right;
} TreeNode;
```

d) Write the function that counts the number of nodes containing *age* value greater than 50.

```
int  FindBiggerT50t ( StudentTree  * T)
{
      int count;

      if  (> 50)
            ___________;
      FindBiggerT50t (_________);
      _____________ ( T->Rchild);
}
```

Appendix K – Participants' lesson plan

Participant	First lesson	Second lesson	Third lesson	Fourth lesson
1	Recursive Level 1	Recursive Level 1	Recursive Level 2	Linked List level 1
2	Recursive Level 1	Recursive Level 1	Recursive Level 2	Tree level 1
3	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
4	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
5	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
6	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
7	Linked List Level 1	Linked List Level 2	Stack level 1	Stack Level 2
8	Recursive level 1	Recursive Level 2	Tree Level 1	Tree Level 2
9	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
10	Recursive Level 1	Recursive Level 2	Tree Level 1	Tree Level 2
11	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
12	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
13	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
14	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
15	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
16	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
17	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
18	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
19	***Recursive Level 1***	***Linked List Level 1***	***Linked List Level 2***	***Stack Level 1***
20	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
21	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
21	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2

Table 1: Lesson session for the participants of the DD group

Participant	First lesson	Second lesson	Third lesson	Fourth lesson
1	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
2	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
3	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
4	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
5	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
6	Recursive Level 1	Recursive Level 2	Tree Level 1	Tree Level 2
7	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
8	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
9	Recursive Level 1	Recursive Level 2	Tree Level 1	Tree Level 2
10	Recursive Level 1	Recursive Level 2	Tree Level 1	Tree Level 2
11	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
12	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
13	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
14	Recursive Level 1	Recursive Level 2	Linked List Level 1	Linked List Level 2
15	***Recursive Level 1***	***Stack Level 1***	***Stack Level 1***	***Tree Level 1***
16	***Recursive Level 1***	***Linked List Level 1***	***Linked list Level 2***	***Stack Level 1***
17	***Recursive Level 1***	***Stack Level 1***	***Stack Level 2***	***Tree Level 1***
18	Recursive Level 1	Recursive Level 2	Stack Level 1	Stack level 2
19	***Recursive Level 1***	***Linked List Level 1***	***Linked List level 2***	***Stack Level 1***
20	Linked List Level 1	Linked List Level 2	Recursive Level 1	Recursive Level 2

Table 2: Lesson session for the participants of the DD+DI group

Appendix L- Analysis of the duration of time needed by the students to complete their recursive and linked list lessons

1.0 Objective

The aim of this study was to explore the time taken by the student to complete their recursive and linked list lessons. This study was carried out in a fifty minute session classroom. Twenty-eight students of the Collage of Computer Science and Information Technology, University Tenaga Nasional, Malaysia were involved in the study.

3.0 Material

A paper-based recursive and linked list questions were used in the experiments. The learning materials were taken from author's data structure teaching bank. (see Appendix M for details). According to UNITEN data structures syllabus, recursive is considered as an easy topic, and linked list is considered as a difficult topic.

6.0 Procedure

Students were asked to answer two data structures topics: namely recursive and linked list. Each of the topics was divided into two sub-topics which represent different difficulty levels of the topics (i.e. easy and difficult levels). At the beginning of the experiment, students were told to record the start and end time of the each lesson. No supporting materials (e.g. notes) were provided or allowed to be used during the learning sessions.

7.0 Result and discussion

Data from the experiment were analysed using an excel spreadsheet. The detailed analysis of the experiments is presented as in Figure 1 below:

Topic	**Recursive Level 1**	**Recursive Level 2**	**Linked List Level 1**	**Linked List Level 2**
Average time to complete the lesson	7.41	9.76	10.03	12.48
Standard Deviation	1.46	3.16	2.91	4.60

Figure 1: The time taken by the student to complete their lesson in minutes

As expected, students were observed to spend more time on solving the difficult topic (linked list) as compared to the easy topic (recursive). On average students spent 8.59 (SD = 2.72) minutes to complete the recursion lesson as compared to 11.26 (SD = 4.00) minutes for the linked list lesson.

A similar trend was observed within the topics. The time taken by the students to complete the level 2 lesson (difficult level) was longer than the level 1 (easy level) lesson. For instance, students took on average 7.41 (SD 1.46) minutes to complete the recursion level 1 and they needed 9.76 (SD = 3.16) minutes to complete the recursive level 2. Likewise, they spent 12.48 (SD = 2.91) minutes to complete the linked list level 2 as compared to just 10.03 (SD = 4.60) minutes for linked list level1.

8.0 Conclusion

Results of the study indicate that the time taken by the students to complete their lesson is influenced by the difficulty level of the lessons. Moreover, the results were also used as the baseline in setting up the time-limit to the students in learning their lessons in the computer based tutorial system.

Appendix M – Interview sessions

Student name : Syzwani

Version : Domain independent strategies - Student 1 (Z – interviewer, ns- interviewee)

Z: How did you feel when at the beginning of the experiment? And why?
ns: i felt nervous, because i didn't know what to expect from the experiment.

Z: Did the feeling effect your performance?
ns: Yes, the feeling effected my performance.

Z: How did you feel when you got correct answers ?
ns: I felt good for my success, and this had improved my confidence to answer the next question.

Z: How about when you failed in your lesson?
ns: My became less confidence level and I expected that the next lesson would be even tougher.

Z: When were you more effective? After you succeeded or failed in your lesson? And why?
ns: When I succeeded in my lesson, because this uplifted my confident level and I felt more prepared to answer my next questions

Z: How about if you failed to answer the question?
ns: i felt like i want to stop answering the questions and stop thinking about it.

Z: what is your comment on that program?
ns: overall it is ok and good for students as their revision tools.

Z: what is the software feature(s) that you like and dislike most?
ns: I like the notes and examples provided by the system

Z: How did you feel after the relaxation exercise and positive affirmations?
ns: I felt more relaxed and focused and I felt I had a better learning pace after the relaxation exercise.

Z: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?
ns: For me, it was when I was in the negative well-being state. I felt the relaxation exercise had made me become more relaxed and improved my learning focus.

Z; Thanks

student name : Awin

Version : Domain independent strategies - Student 2 (Z – interviewer, aw- interviewee)

Z: How did you feel when at the beginning of the experiment? And why?
aw: i felt nervous but at the same time i felt excited to participate in this experiment

Z: Did the feeling effect your performance?
aw: Yes,

Z: How did you feel when you got correct answers ?
aw: I felt good and relief because I can get the correct answer.

Z: How about when you failed in your lesson?
aw: I felt not good to myself and want to try again until i got the correct answers to the problem.

Z: what is your comment on that program?
aw: overall it is ok and good for students as their revision tools.

Z: what is the software feature(s) that you like and dislike most?
aw: I like the notes and examples provided by the system

Z: How did you feel after the relaxation exercise and positive affirmations?
aw: I felt that the relaxation exercise had reduced my nervousness level and made me more prepared for the upcoming lesson.

Z: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?
aw: I felt the relaxation exercise was more useful for the negative well-being state. For me, the relaxation exercise reduced my anxiety and uplifted my confidence level

Z; Thanks

Student name : Anuar

Version : Domain independent strategies - Student 3 (Z – interviewer, An- interviewee)

Z: How did you feel when at the beginning of the experiment and why?
an: I felt a bit nervous because I did know what to expect from the experiment.

Z: Was the feeling influenced your performance in answering all those questions?
an: a bit, at first, however, after I got familiar with the system, my performance was less affected by my feeling as I felt more comfortable and relax.

Z: How did you feel when you got wrong answer?
an: i felt eager because i want to know why my answer was wrong?

Z: Was the elicited feeling affect your performance ?
an: Yes, at the beginning, bit then after learning from the system, and have better understanding of what to expect from my codes, the effect of elicited feeling became less important.

Z: How did you feel when you got correct answers?
an: i felt happy

Z: Did you confidence level in answering the questions influenced by your previous performance?
An: It depends on the difficulty level and type of the upcoming lesson. If it was of similar type and level, than my confidence level improved. However, if the next question was of higher difficulties level or type, then my confidence would be reduced.

Z: In which situation do you think you can perform better? After you produced wrong or correct answers, and why?
an: After I got a wrong answer, because it motivates me to find the right answer for the problem.

Z: which one is helpful? Note or example?
an: both

Z: which one is more helpful? And why?
an: I prefer examples, because it helps me to see the flow of the program.

Z: When did you need example more? When you succeed or failed in your lesson?
an: When I failed, especially during my first lesson.

Z: Do you have any suggestion to improve the system?
an: i think it might has better impact with better quality of audio was used.

Z: How did you feel after the relaxation exercise and positive affirmations?
an: The pace the relaxation exercises session had made me quite relaxed and reduced my anxiety level.

Z: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?
an: For me, I felt the relaxation exercise was more useful during my negative feeling but did not feel so much different in my positive well-being state after the relaxation exercise activities.

Z: What was the features you like or dislike most ?
an: I like the software and I've no negative comments for the system.

Z: ok thanx

Student Name : Ahmad Irshad

Version : Domain Independent strategies - Student 4 (Z – interviewer, ai- interviewee)

Z: What did you feel at the beginning of the experiment and why?
ai: I felt nothing

Z: I see.. why?
ai: I felt sleepy at that time and cannot focus at that time.

Z: what did you feel when you got the right answer?
ai: I felt great

Z: why?
ai: because I know that the answer was right.

Z: Did the feeling good affected your next lesson?
ai: Yes, if i didn't get the correct answer, i felt down, and i would try to find the correct answer

Z: How about your confidence level in answering the next question after your success?
ai: my confidence level increases

Z: Was your confidence level influenced by your success/failure in answering the previous questions or the upcoming question?
ai: It more on the upcoming questions, if I didn't understand the question, I won't be confidence.

Z: If you're failed to get the correct answer, would it take effect on your confidence level?
ai: yes, it will

Z: what did you feel when you got incorrect answer?
ai: frustrated

Z: why?
ai: because i didn't know what was wrong with my answers

Z: Did this effect your confident level in answering the next question?
ai: It depend on the next question difficulty level , if it is harder, then it will effect

Z: was it easier?
ai: my level of confidence was depended on the previous questions.

Z: how useful were the notes and the examples to you?
ai: very useful

Z: why?
ai: because it explain the concept in great detail
Z: between examples and notes, which one is more helpful to you?
ai: example

Z: why?
ai: because notes didn't explain things in detail, but examples did

Z: How did you feel after the relaxation exercise and positive affirmations?
ai: I felt the relaxation exercise had little impact in reducing my negative affective state..

Z: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?
ai: I felt, the relaxation exercise really helped me to reduce my frustration but not really helpful after I got my answer right..

Z: among all the software features, which feature do you like most, if any ?
ai: none
Z: ok, thank you
ai: your welcome

Student name : Luqman Hakim

Version : Domain independent strategies - Student 5 (Z – interviewer, LH- interviewee)

Z: How did you feel at the beginning of the experiment? And why?
LH: I felt very guilty at first because I failed to come yesterday for the experiment.

Z: Did the feeling affect your performance?
LH: Yes, in the beginning, But after finished my pre-test then i became normal.

Z: How did you feel when you failed to get right answer?
LH: I felt a bit down because I felt my preparation was not enough.

Z: How did you feel when you succeeded in your lesson?
LH: i felt very happy and relief

Z: Did your feeling influence for performance of your next lesson?
LH: Yes, when I failed, I felt like quitting the lesson. But when I succeeded in my lesson, I felt very eager to start my next lesson.

Z: Were the notes and examples helpful to you?
LH: very helpful

Z: How did they help you ?
Lh: For example, it provide clue to the questions i answered, For Notes, it helped me to remind some of the main concept in data structures.

Z: How did you feel after the relaxation exercise and positive affirmations?
LH: At first, it was boring until when i failed in my lesson (linked list). At that time, I felt the relaxation exercise had provided me a way to become more relax. I felt better although i still failed to produce the right answers for all the questions

Z: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?
LH: For me, the relaxation exercises helped me to reduce my anxiety level and improve my confidence after I failed to complete my lesson. Although I felt the relaxation exercise was helpful after I got the right answers, it didn't make me feel much better

Z: Do you have any suggestions to improve the system?
LH: Maybe provide the student with more examples and graphical representation

Z: Thanks for taking part in the experiment

Student name : Yong Liang

Version: Domain independent strategies - Student 6 (Z – interviewer, yyl- interviewee)

Z: How did you feeling at the beginning of the experiment and why?
yyl: just normal

Z: why?
yyl: Because, I don't see the rational to become nervous.

Z: Did the feeling effect your performance later?
yyl: I don't think so

Z: How did you feel when you succeeded in your lesson?
yyl: I was glad, I pretty confident i can answer the questions.

Z: How did you feel when you got wrong answer
yyl: curious and want to know why

Z: How useful were the notes and the example to you?
yyl: They are important and useful in the sense that they help me to recall my lesson.

Z: When were you more effective? After you succeeded or failed in your lesson? And why?
yyl: After I failed because I can learn from my mistake.

Z: Any comment about the system? or the process u have to learn in the system?
Yyl: I think this program is good, because they allow student to have instant feedback from the exercise and this can help student to identify their weaknesses and eventually improve themselves.

Z: How did you feel after the relaxation exercise and positive affirmations?
YYL: I felt the relaxation exercise had little impact in reducing my negative affective state and when It annoyed me when i was asked to repeat it many times.

Z: When were the domain-independent strategies (i.e. the relaxation exercise and positive affirmation) more effective? During a positive well-being or in a negative well-being state? And why?
yyl: I felt the relaxation exercises didn't make any difference to my well-being state during my lesson. I don't use relaxation exercise as a means to regulate my emotions during learning. For me, getting the correct answer was more important.

Z: any comments to improve the system?
yyl: i think maybe having a random question can improve the efficiency of the system.

z: ok thank you

Student Name : Abdul Hadi Abdul Razak

Version : Domain dependent strategies - Student 7 (Z – interviewer, Ah- interviewee)

Z: Ok, Now what is your feeling when you do the experiment?
ah: I'm asking myself, what I'm supposed to do, and what is the software designed for?

Z: why did you say that?
ah: because I never expect of such software

Z: So, did you feel surprise?
ah: Yes, I was surprised

Z: Did the feeling affect your performance?
ah: i think not

Z: What was your feeling when you get wrong answers, (i.e. when you get 'red')
ah: I knew it, it was wrong so I was quiet natural

Z: Did that feeling affected you to answer the next question?
ah: I became more cautious, try to slow down a bit, think wisely.... maybe at i was too quick during my first attempts.

Z: How did you feel when you got the correct answer (the green colour)?
ah: Happy

Z: Why?
ah: because I manage to get correct answers

Z: Did the happy feeling affected your answers for the next question?
ah: yes

Z: Did your judgment on your confidence level was based on the current questions or your past experience?
ah: i just based on current questions

Z: So, your past experience did not influence your judgment.
ah: Not ready perhaps my past experience make me become more careful, Take more before answering the questions.

Z: To you, what are the like and dislike features of the software, if any?
ah: the features that I like was the hint, if the question answered is wrong, then it will tell us what is the correct answer, what i did like about this software was too little of example .
Z: What is your comments about the sitting quietly event?
ah: To me, no effect, the sitting quietly did not have any difference.

Z: last question, do you have any comment?
ah: This software is good, because I can learn by myself, and know the mistakes were

Z: that’s all, thank you so much

Student Name : Aimy Liyana (F)

Version: Domain dependent strategies - Student 8 (Z – interviewer, Ai- interviewee)

Z: what did you feel at the beginning of the experiment and why?
al: I'm a bit nervous because I thought I was an online exam

Z: Did the feeling influence your later work?
al: depends, if Ii was still nervous, it will affect my work

Z: How did you feel when you got a wrong answer?
al: i felt better because the system gave me instant feedback for my wrong answers.

Z: How did you feel when your answer was correct?
al: Satisfied

Z: so, how did your feeling influenced your judgment about your next lesson?
al: I became more careful before submitting my answers.

Z: when you got the right answer, how did your feeling of getting the correct answer influenced your next lesson?
al: i felt more confidence to answer the next question.

Z: How do like to example of a system be ? Detail or general examples?
al: in programming, i prefer details examples

Z: Were the notes helped you ?
al: I think example is more important as it could help me to recall what I have been learned in class
Z: any comment on the software? Did you like the software?
al: There was too many self-reporting session in the software. It is better that if the software could just asked the student once or twice.

Z: what is the best feature? if any
al: I like the feature that allow me to do instant correction and example that related to the questions

Z: what is your comment about the sitting quietly for 2 minutes event?
al: it was ok, because we need to rest a while after answering questions

Z: What your comment when you were asked to sit quietly after your success and after your fail.
al: After succeeded on my lesson , I felt exited and want to quickly answer the next question, So waiting for 2 minutes is not a good option; It is better when I failed, this give time for me to rethink about my submitted answers.

Z: How did you feel when the session was over?
al: Although it took a lot of my time (each question is about 15 minutes) , it wasn't too stress due to the interval session (sitting quietly) and because I can answer few questions.

Z: ok, thank you so much

Student name : Nadhirah

Version : Domain dependent strategies - Student 9 (Z – interviewer, nad- interviewee)

Z: How did you feel at the beginning of the experiment and why?
nad: I was scared because I thought it was a real test

Z: Did the feeling effect your performance?
nad: Yes, it alerted me to recall back my data structures knowledge.

Z: how did you feel when you succeeded in your lesson?
nad: i felt happy

Z: why?
nad: Because i didn't expect to get the correct answers. I was due to my past experience. I failed to answer similar type of question in my last exam.

Z: How did you feel when you failed to get the correct answer?
nad: I felt sad

Z: Did your feeling effect your performance in your next lesson?
nad: For me no. I just focused for my upcoming lesson

Z: When were you more effective? After you succeeded or failed in your lesson? And why?
nad: After succeeded with my lesson

Z: why?
nad: when i got correct answers, I became more confidence. Otherwise, I felt afraid to do my next lesson

Z: Do you have any suggestion to improve the system?
nad: The system must provide complete codes so that the students can understand better. Students sometimes can just guest the answers for the 'fill in the blank' type of question, this could discourage student from learning.

Z: what is your reaction or comment to the 2 minutes sitting quietly events? And why?
nad: i dont like it, i was so boring, and slow my learning past, and i could have finished my session earlier without this session.

Z. Thanks

Student name : Nurulassyikin

Version: Domain dependent strategies - Student 10 (Z – interviewer, Na- interviewee)

Z: What did you feel at the beginning of the experiment last week and why?
na: I felt nervous because i am not good at programming.

Z: Did the feeling effected your performance? And why?
na: yes, the feeling distracted me from focussing on my lesson and this hindered to perform my best.

Z: How did you feel when you got correct answers? And why?
na: very happy, It meant i understood the lesson, for me it was not easy to get the vright answers.

Z: how did that the feeling effect your performance of your next lesson?
na: Yes, it improved my confident level and this changed my perception too. For me if i can answer the first lesson correctly, more likely i can also do well in the next lesson.

Z: How did you feel when you got wrong answer for the questions?
na: A first i wanted to give up, but the provided me some example and this allowed me to recheck my answers, so I tried until i got the correct answers or time up.

Z Did that feeling effected your lesson?
na: yes, I can't do it now, most likely I would no be able to do my next lesson well too.

Z: How did you find the examples and notes?
na: Some of the example were helpful, but some don't. And for me example was more helpful then nodes because the examples were more related to the questions.

Z: When were you more effective? After you succeeded or failed in your lesson? And why?
na: After succeeded in my lesson. I felt much better each time I succeeded. However, each time I failed, I became less confidence and if this effect my performance.

Z: Do have any comment on this software?
na: add more examples and like the features that asked for my feelings. At least for me the system made an effort to understand me.

Z: what is your comment about sitting quietly for 2 minutes? And why
na: it was so good, because two minutes is too long especially after i succeeded in my lesson. I cannot wait for that long before starting with my next lesson. Even when i failed, the two minutes make me tired and this distracted my learning focus. But, sometimes i can make me became relax.

Z: Thanks

Student name : Shakirah

Version: Domain dependent strategies - Student 11 (Z – interviewer, Sha- interviewee)

Z: what do u feel at the beginning of the exercise and why?
sha: I felt puzzle but quit interested to be the participant of the experiment

Z: Did the feeling effected your work?
sha: mmm no..

Z: how did you feel when you got correct answers?
sha: i felt so happy of myself because i was not good in programming. So getting the correct answers improved my confidence.

Z: How did you perform?
sha: I got a both the recursive lesson right and for the linked list, i got few errors at my first attempts.

Z: Did the feeling influence your perception about your next question?
sha: Yes, I was about my confidence, I felt much better and this made me believe that I can perform better in my next lesson.

Z: How did you feel when you got wrong answers?
sha: I didn't give up, for me everyone make mistake and sometime you can learn though your mistake.

Z: how useful did you find the notes and examples, and why?
sha: To me, the notes were too simple, but the examples were helpful because it help me to understand the subject.

Z: When were you more effective? After you succeeded or failed in your lesson? And why?
sha: both of it, when i succeeded, I became more motivated, and even when i failed, I still good to me because i can learn from my mistake.

Z: What your comment on the period of sitting quietly?
sha: During the time, I didn't know what to do especially when I got the correct answers. However, when I failed, it helped me to rethink of about the mistake I made.

Z: any suggestion to improve the system?
sha: The system should provide at least 2-3 minutes for reading.

Z: anything else?
sha: I think it is better if the system can allow user to relook at the past students performance. For example, should be allowed to revisit their lesson 1 results anytime they wish throughout his learning session.
Z: thank you.

Student name : Uzairah

Version: Domain dependent strategies - Student 11 (Z – interviewer, ua- interviewee)

Z: How did you feel at the beginning of the experiment and why?
ua: I felt quite nervous because I'm weak in programming and data structures

Z: what did you get for data structures?
ua: only C+

Z: Did the feeling effected your performance?
ua: Yes, because I felt pressured, and this made me take longer time to complete my lesson.

Z: ok, now, How did you feel when you got wrong answers?
ua: I felt even more depressed.

Z: why?
ua: because I didn't know to find the correct answer

Z: Did the feeling impacted to your performance?
ua: I guess yes.

Z: How did you feel when you succeeded in your lesson? And why
ua: Happy, because I able to complete a lesson.

Z: Did the feeling effect your confidence level?
ua: off course yes.

Z: what is your opinion on the notes and the examples in the program?
ua: they are useful, especially the example because it gave me some clue on how to answer the questions.

Z: When were you more effective? After you succeeded or failed in your lesson? And why?
ua: When I succeeded in my lesson. Because it improves my confident that I can answers my next lesson correctly too.

Z: Any comments about the software ? what are the features that you like most and what are the features that you dislike most, for instance?
ua: The interactivity offered by the system to user was the feature i like most. I allows me to get instant feedback of my answer and this had really helped me in learning

Z: What is your reaction to the 2 minutes sitting quietly?
ua: I was very calm

Z: was it helpful?
ua: I was helpful when I stressed out but not so much when I succeeded in my lesson.
z: ok.. thank you