The Integration of Domain-Independent Strategies into an Affective Tutoring System: Can Students' Learning Gain be Improved?

The Integration of Domain-Independent Strategies into an Affective Tutoring System: Can Students' Learning Gain be Improved?

Mohd Zaliman YUSOFF
Department of Software Engineering
University Tenaga Nasional
Kajang, Malaysia
Zaliman@uniten.edu.my

Benedict DU BOULAY
IDEAS LAB
University of Sussex
Brighton, UK
b.du-boulay@sussex.ac.uk

***Abstract* - Students ordinarily use both domain-dependent (such as seeking specific domain help) and domain-independent (such as trying to relax) strategies in regulating their affective states in learning. By contrast, current affective tutoring systems concentrate on the deployment of domain-dependent strategies only in regulating students' emotional states in learning. This paper reports the results of an experimental study that evaluated students' performance using the proposed framework. In a between-subjects experiment, students used two versions of a system for teaching data structures. The systems differed only in that one supported domain independent strategies, while both system systems supported domain-dependent strategies. Results provide some evidence that the experimental groups (presented with both the domain-dependent and domain-independent strategies) performed better than the control group (presented with only domain-dependent strategy) in learning data structures.**

Keywords- Emotions, Affective tutoring system, Domain-independent strategies

I. INTRODUCTION

Emotions mediated by appropriate attention, self-regulation and motivation strategies can lead to a positive effect on learning and achievement [29]. A growing concern for the vital role of affect in education is evident from the work of academics over the last 10 years [29]. The awareness and interest in emotions and students' achievement is reflected in several special issues on emotion in learning (e.g. [12]).

II. 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 [16] for a review). Fredrickson & Levenson [16] argue that these characteristics allow an individual to build an array of enduring personal resources and, by consequence, initiate an upward spiral towards an increase in the state of well-being. 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 ([22]). In another experiment, Fredrickson & Branigan [15] 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 [31] 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.

Finally, positive emotions have the ability to correct, restore, and undo the after-effects of negative emotions (e.g.[16, 24]). It is hypothesised that positive emotions restore autonomic quiescence following a negative emotional arousal [16]. In one experiment, Fredrickson & Levenson [16] 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 [16] 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.

Pekrun et al. [29] 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. [29,18]). For

Manuscript received 27 April 2009
Manuscript revised 25 May 2009

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 [3] argues that positive emotions can effectively contribute to 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 [21], career aspirations, and occupational choices in specific domains (e.g.[18,36]). For example, Wigfield & Jacquelynne [36] 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. [34]). For example, Tiba & Szentagoi [34] argue that uncontrolled strong positive emotions such pride, joy and contentment can influence individual behaviour to deploy unrealistic expectation [12], cognitive bias leading to inappropriate action and strategies [29], reduce creativity in decision-making [2], and appraisal components [24]. 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 [20].

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 student to focus on the euphoria and underestimate the effort needed to attain a good result [12]. 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.

III. THE EFFECT OF NEGATIVE EMOTIONS IN 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 [17]). 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 [5]. 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 [17]. 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 [17]. 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. 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 [17].

In contrast, there are times when the effects of negative emotions are useful [23]. Anxiety enables one to be vigilant for threat; shame can lead one to monitor others' options and to re-establish one's reputation. There is evidence to show that negative emotions enhance individual performance. For instance, Hanin [20] 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 (e.g [22,13]).

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 [22]. 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 [26]. 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 [22].

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 ([5,29,18]) and self-esteem [19] which increases the level of anxiety and other negative emotions [22]. This suggests that the regulation of the negative emotions within learning environment is an important matter to explore.

IV. DOMAIN INDEPENDENT STRATEGIES AND INTELLIGENT TUTORING SYSTEM

A growing band of researchers is concerned with embedding emotional state reasoning into Intelligent Tutoring Systems and Intelligent Learning Environments (e.g. [8, 9]). The objective of their area of research is to study the effect of emotions on learning. This includes the development of algorithms and tools to improve the accuracy of detection of the student's emotional state while learning (e.g [8]). In addition, it is also concerned with how to regulate and use elicited emotions to enhance the student's attitude to learning (including motivation) and academic achievement (e.g. [25]). The architecture of current affective tutoring 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 that state.

However, the techniques of current affective tutoring systems for regulating do not take into account individuals' normal emotion regulation strategies. Lazarus [24] 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. He argues that 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 [24]. Lazarus [24] 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.

Empirical studies (e.g. [24]) provide strong evidence that individuals use both domain-dependent (such as seeking specific help) and domain-independent (such as seeking to relax) adaptive strategies to regulate or modulate any overly intense affective state. Lazarus [24] 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. 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.

Problem-focused strategies are the second category employed by people in regulating their emotional states. Lazarus [24] 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 [25]. Seeking information about what to do or confronting the person or persons responsible for one's difficulty is examples of such strategies.

For example, Lester et al. [25] report that the deployment of different problem-focused coping strategies (i.e. by scaffolding students using different levels of help) have a positive impact on their affective state and improved their performance. Likewise, Baker & Berenbaum [4] 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 level 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. [8,25]) In addition, Lazarus and his colleagues' longitudinal studies (e.g [14]) provide empirical support for the premise that people use both emotion-focused strategies and problem-focused strategies when coping with a problematic environment.

Current affective ITS system, however, concentrate very largely on the use of domain-dependent strategies as their means to help students regulate their affective state. Thus, there is a need to explore the value of using domain-independent strategies alongside domain dependent ones. Yusoff & du Boulay [38] proposed an affective (ATS) framework that integrates a domain-independent strategy into intelligent tutoring system architecture. In this framework, relaxation exercise and positive affirmation statements are proposed as the domain-independent strategy.

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. [2]). For example, Deffenbacher et al. [11] attributed the ability of patients to control their hostile and aggressive behaviour to the relaxation exercise sessions that the patients undertook.

In another study, Toivanen et al. [35] reported that relaxation exercises significantly reduced physiological tension and depression levels amongst a group of hospital cleaners. Likewise, Ortiz & La Grange, [27] 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. [6] 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 [6]. Recently, there has been an attempt to develop commercial computer-based relaxation exercise software which has produced a positive result [32]. 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.

Thus, in this paper, we present the findings of an experimental study which investigated the effect of a relaxation exercise and positive affirmation (domain-independent) strategy on students' learning performance using the framework proposed by Yusoff & du Boulay [38]. The next section describes the experimental set-up, and the succeeding sections describe and discuss the result.

V. *EXPERIMENTAL SETUP*

The objective of the experiment was to investigate the effect of the use of a domain-independent strategy on students' learning performance in an affective tutoring system (ATS). In addition to looking for effects of the domain-independent strategy, the experiment also investigated potential differential effects of student ability. The students made use of a learning environment that presented problems in data structures and provided feedback on the quality of the students' answers. There were two versions of the system in this between-subjects experiment.

The domain-dependent (DD) version provided a certain amount of adaptive help to each student. The DD+DI (domain independent) version provided the same adaptive help as the DD version but also required students to undertake relaxation exercises and positive affirmation.The experiments were conducted over a two week period in August 2007 in the Department of Computer Science, University of Tenaga Nasional in Malaysia.

In total, 64 non paid second and third year computer science students were involved in the experiment. They were divided into two groups; the experimental group which was presented with both the domain-dependent and domain-independent strategies (referred as DD+DI group), and the control group, which was presented with only the domain-dependent strategies (referred as the DD group). There were 31 (18 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.

A. *Materials and procedure used in the experiment*

The pre-and post tests and learning materials were derived from the first author's personal question bank for a course on Data Structures which follows the University of Tenaga Nasional syllabus. It covers two topics; the recursive and the linked list. As for the relaxation exercise, a shorter version of Jacobson's and Benson's relaxation techniques which concentrates only on the upper limbs body part was used. The experiment consisted of 13 stages. The complete flowchart of the experimental design is presented in Figure 1. Note that each student undertook the same four lessons in total: an introductory and a more advanced lesson on recursive and on link-list data structures. Students were classified, post hoc, into "low" and "high" ability, depending on their score on the pre-test.

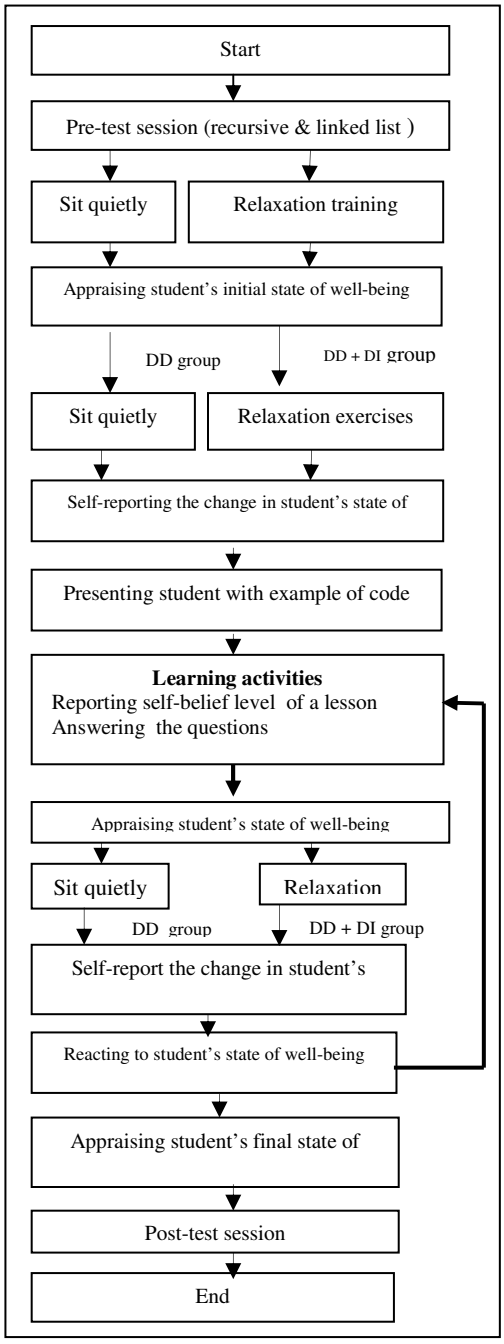

Figure 1. The experimental design flowchart

VI. RESULTS

Students' performance was assessed at two learning stages: - by the end of the overall session and during each lesson itself. 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 who did not successfully complete the lesson was used to examine students' performance during each lesson itself.

A. *Students' learning performance by the end of the overall session*

To calculate the students' learning gain, the comparisons of the pre- and post-tests between the DD and DD+DI groups' were used. The average of post-test scores (out of 100) for the DD group was 45.69% and was 67.37% for the DD+DI group. As for the pre-test score (out of 100), the DD group's score was 26.23% and the DD+DI group's score was 36.26% as shown in (Figure 3).

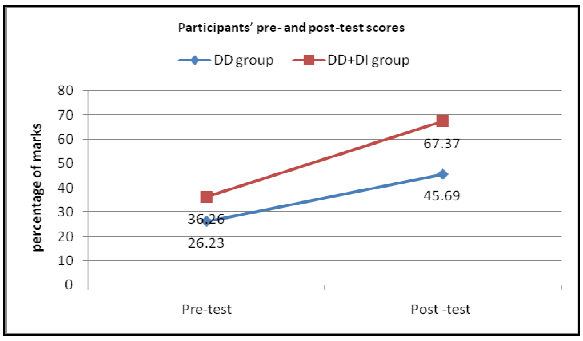

Figure 2. Participants' pre- and post-test scores

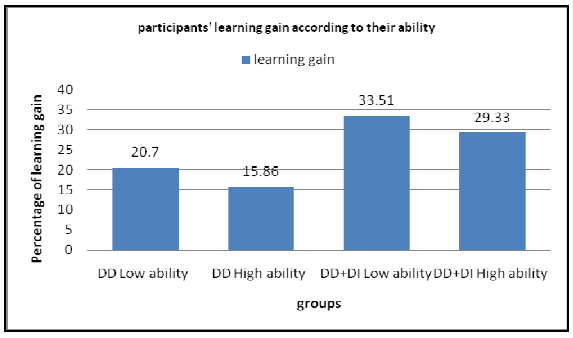

Figure 3. Participants' learning gain

Figure 2 depicts that the DD+DI group registered a 31.6% learning gain as compared to 19.5% learning gain for the DD group. This difference is significant ($p < 0.05$). The participants' learning gain was further classified according to their ability (see Figure 3). The low ability students of the DD+ DI group were observed to register a higher learning gain of 33.5% as compared to 20.7% by the low ability students of the DD group. Moreover, the difference was observed to be significant ($p < 0.05$). Also, the high ability students of the DD+DI group were noted to register a slightly higher learning gain of 29.3% as compared to 15.8% for the low ability students of the DD group.

While the difference between the DD+DI and DD group for the low ability students was significant ($p < 0.05$), the difference observed for the high ability students was not significant ($p > 0.05$). In conclusion, results from the experiment suggest that students of the DD+DI performed significantly better in both, learning gain and post-test scores than the DD group. Also, no significant difference between the two groups for the pre-test was noted which indicated that the students of both groups were of same proficiency level at the beginning of the experiment.

B. *Participants' learning performance during the lessons*

The percentage of students who completed each of the 4 lessons (L1-L4) successfully was used as an indicator to evaluate students' learning performance during each lesson and the quality of the partial answers was used as a second indicator.

I) The percentage of students who completed their lessons successfully

Table 1 shows the comparison between the percentages of members of the DD and the DD+DI who completed each lesson successfully. In general, the DD+DI group had a higher percentage of students who completed their lessons successfully. Note that the table indicates that the percentage of the low ability students of the DD+DI group who completed their lessons successfully was consistently (but not significantly) higher than the DD group. However, the percentage was observed to be quite low at L1 for both groups compared to L2 and L3.

TABLE 1. PERCENTAGE OF STUDENTS WHO COMPLETED THEIR LESSONS SUCCESSFULLY

Ability	Group	L1	L2	L3	L 4	Average	
		%	%	%	%	%	Sig. test
Low	DD (23)	39.13	30.43	34.78	8.70	28.26	N
	DD+DI (18)	44.44	61.11	61.11	27.78	48.61	
High	DD (8)	87.50	50.00	37.50	37.50	53.13	N
	DD+DI (15)	73.30	60.00	60.00	60.00	63.33	
All students	DD(31)	51.61	35.48	35.48	16.13	34.68	Y
	DD+DI (33)	57.68	60.61	60.45	45.45	56.06	

One possible reason was that the low ability students were slow to adjust to the new software environment (i.e. use of notes and examples) during their first lesson. As for L4, the low percentage for both groups was a reflection of the lesson difficulty level itself (i.e. L4 was the most difficult lesson to complete successfully). For the high ability students, the DD group participants were observed to perform better than the DD+DI group for L1 (see Table 1). However, as the lessons got harder, the DD+DI group's students were noted to consistently outperform those in the

DD group; the percentage of students who completed their lessons (i.e. L2, L3 and L4) were and significantly higher.

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

Findings of the study show that participants of the DD+DI group produced better quality incomplete or incorrect answers for L1, L2 and L3 as compared to the DD group's participants. Only at L4, did participants of the DD group produce slightly better quality. A similar trend was observed among the high ability students. The participants of the DD+DI group were noted to have a better quality of incomplete and incorrect answers than the DD group across all four lessons. However, as an overall comparison, looking at the score of all students who failed to complete their lesson successfully across all four lessons revealed that the difference between the DD and the DD+DI groups was significant (Table 2). This is a further indicator that the DD+DI group had a better learning performance as compared to the DD group.

TABLE 2. ANALYSIS OF THE QUALITY STUDENTS' ANSWER WHO FAILED TO COMPLETE THEIR LESSONS SUCCESSFULLY

Ability	Group	L1	L2	L3	L4	Av	Sig test
Low	DD (23)	1.66	1.96	1.72	1.79	1.78	N
	DD+DI (18)	1.76	2.54	2.77	1.51	2.15	
High	DD (8)	2.18	2.28	2.17	1.90	2.13	N
	DD+DI(15)	2.31	2.82	2.91	1.92	2.49	
All students	DD(31)	1.72	2.06	1.90	1.80	1.90	Y
	DD+DI (33)	1.85	2.62	2.53	1.65	2.11	

VII. DISCUSSION

There is evidence to show that the use of domain-independent strategies improved students' performance. For instance, the DD+DI students obtained a higher learning gain than the students of the DD group by the end of the experiment (see Table 3). Also, the DD+DI group outperformed the DD group for both the low and high ability students (see Figure 3). The low ability students of both groups registered a higher learning gain than the high ability students. While the low ability students of the DD+DI groups recorded the highest learning gain (33.51%), the high ability students of the DD registered the lowest learning gain (15.86%). However, there are factors that could have influenced the results of the study; namely a possible ceiling effect and the small sample size for the high ability students of the DD group. The ceiling effect (maximum limit) might have hindered students especially for the high ability group from achieving a better learning gain. In addition, having a small sample size of the high ability of the DD groups (just eight students) would certainly have influenced the result of the significance test (i.e. more likely to be not significant) on the learning gain between the two groups.

TABLE 3. 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

Hypothesis	Measures	Significance test outcome comparing the DD and the DD+DI groups
Did the use of domain-independent strategies improve students' learning performance in the affective tutoring system (ATS)	Learning gain	DD = 19.5% DD+DI = 31.6% (Significant)
	Pre-test score	DD = 26.20 DD+DI = 36.26 (Insignificant)
	Post- test score	DD = 45.69 DD+DI = 67.87 (Significant)
	Percentage of students who completed their lessons successfully	DD = 34.68% DD+DI = 56.06% (Significant)
	The quality of answers of those who failed to complete their lessons successfully	DD = 1.90 DD+DI = 2.11 (Significant)

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. Results of the study indicate that students of both groups were of similar proficiency level. 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 3).

This evidence supports the notion that the integration of domain-independent strategies within the ATS contributed to the enhancement of students' achievement. Moreover, analysis of two performance indicators (i.e. the percentage of the students who completed their lesson successfully and the quality of answers for those who failed to complete their lesson successfully) during their learning session (see Table 3) indicates that the DD+DI group performed better than the DD group and this provides further evidence to this premise.

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® [32], domain-independent strategies software, records a 35% improvement in math scores and a 14% improvement in reading scores. In a similar vein, the work of Carlson et al., [7] and other recent studies (e.g. [10,33]) 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. [6]). Besides, the effective use of domain-independent strategies has been reported in various other studies and test anxiety. Within the ITS community, there are

also studies that indicate that use of domain-independent strategies has improved students' achievement (e.g. [1, 25]).

Cognitive self-perception theories (e.g [2, 13]) 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 ([28, 18]). Cognitive self-perception theories (e.g. [5, 24 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 Consequently, these students become more motivated [5], more likely to try harder, persist longer and be more creative [16], put in a higher degree of effort [25] 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.

VIII. CONCLUSION

We have briefly described an experiment where two versions of a system to teach data structures were compared. They differed only in the inclusion of domain-independent strategies to assist the students manage their emotions in one version of the system. There is evidence from this study to support the hypothesis that the integration of the domain-independent strategies in this affective tutoring system improved students' performance in learning.

REFERENCES

[1] Andre, E., Rist T, & Muller, J. (1999). Employing AI method to control behaviour of animated interface agents. *Applied Artificial Intelligence*, 13, 415-448.

[2] 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.

[3] Aspinwall, L. G. (1998). Rethinking the role of positive affect in self-regulation. *Cognition and Emotion*, 22, 1-32.

[4] Baker, J. P., Berenbaum,H. (2008). The Efficacy of Problem-Focused and Emotional Approach Interventions Varies as a Function of Emotional Processing Style: *Cogn Ther Res* 32, 66-82.

[5] Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W. H. Freeman.

[6] Benson, H. (2000). *The relaxation response*. New York: William Morrow.

[7] 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.

[8] 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

[9] Del Soldato, T., & du Boulay, B. (1995). Implementation of motivational tactics in tutoring system. *Journal of Artificial Intelligence in Education*, 4(6), 337-378.

[10] 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.

[11] 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.

[12] Efklides, A., & Volet, S. . (2005). Feelings and emotions in the learning process [Special issue] *Learning and Instruction, 15*(5), 1-10.

[13] Eysenck, M. (1998). *Psychology, an Integrated Approach* Harlow: Longman.

[14] Folkman, S., & Lazarus, R. S. . (1988). *Manual for the Ways of Coping Questionnaire*. Palo Alto, CA: Consulting Psychologists Press.

[15] Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19*, 313-332.

[16] Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion*, 12, 191-220.

[17] 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).

[18] 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.

[19] 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.

[20] Hanin, Y. L. (2000). *Emotions in sport*: Human Kinetics.

[21] Ireson, J., Hallam, S. (2008). Academic self-concepts in adolescence: Relations with achievement and ability grouping in schools. *Learning and Instruction* (in press)

[22] 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.

[23] Kay, R. H., Loverock, H. (2008). Assessing emotions related to learning new software: The computer emotion scale: *Computers in Human Behavior*, 24, 1605-1623.

[24] Lazarus, S. R. (1991). *Emotion and Adaptation*: Oxford U. Press.

[25] 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.

[26] 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.

[27] 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

[28] 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.

[29] 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.

[30] 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,

[31] 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.

[32] TestEdge®. (2003). Retrieved September, 20,2003 from http://www.heartmath.org/education/testedge/why.php

[33] 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.

[34] 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.

[35] 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.

[36] Wigfield, A. L., and Jacquelynne S. Eccles. . (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109-132.

[37] Yusoff M.Z. & Hamid, N. (2009) The integration of emotional intelligence into tutoring system: Formulation and challenges ahead**,** National seminar of ICT in education, 2009, UPSI, Malaysia.

[38] 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.