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A Tutoring System Using an Emotion-Focused Strategy to Support Learners

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Abstract: Many tutoring systems have employed problem-focused strategies for helping students regulate their emotional states. This paper describes an affective tutoring system that added an emotion-focused strategy (a relaxation exercise) to a standard problem-focused strategy (programming advice and feedback) in order to help students better regulate their emotional states when learning about data structure manipulation.. The evaluation indicated that this additional strategy improved learning outcomes and was helpful in emotionally supporting students with both good and poor performance.
Keywords: e-learning, affective tutoring system, emotion-focused strategies

1. Emotions and learning

Theories of achievement and motivation argue that emotions are central to learning because they affect cognitive function as well as motivation and engagement [9]. Emotions mediated by appropriate attention, self-regulation and motivational strategies can lead to positive effects on learning and achievement [10]. Emotion regulation is the process of modulating and managing an individual's emotional state [7]. Regulation activities, ideally, are directed towards achieving the person's goals and remediating or moderating any overly intense of negative or positive emotions. Lazarus classified the strategies used by individuals to deal with their emotional state into two categories [7]:

- An *emotion-focused strategy* refers 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 aimed to just make the person feel better [7].
- A *problem-focused strategy* is the second category employed in regulating emotional states. [7] Refers to problem-focused strategies as active or as direct cognitive or adaptive behavioural efforts to work on the problem itself. They involve attempting to change the problem by generating and implementing options and steps to solve or make the problem less problematic [10].

2. How effective is an emotion-focused strategy applied by a tutoring system?

Many tutors have employed emotion regulation strategies, see e.g. [3]. The goal of this study was to explore whether the simple addition of an emotion-focused strategy to a tutor for undergraduate level data-structures produced enhanced learning outcomes and/or an enhanced sense of well-being in the students.

The study used a between-subjects methodology (N = 68) based on an experimental and a comparison group. Both groups were exposed by the tutoring system to the same problem-focused strategies (e.g. help and advice), but only the experimental group was exposed to the emotion-focused strategy. The experimental group is thus referred as the EF+PF group (emotion-focused *and* problem-focused strategies) and the comparison group is referred as the PF (problem-focused *only*) group. The relaxation exercise undertaken by the EF+PF group was a shorter version of Jacobson's and

Benson's relaxation techniques [2] which concentrated on the upper limbs only. Here we report only on the affective outcomes of the evaluation, *as the increased learning gains* for the EF+PF group have already been described [11].

There was a period of pre-testing for (i) skill in solving data-structure problems and (ii) to establish the initial sense of well-being of the students using the PANAS questionnaire [12]. As an initial part of the EF strategy, the EF+PF experimental group were trained in relaxation methods and undertook a relaxation exercise while the comparison PF group sat quietly. Both groups were asked whether they had experienced any change in their sense of well-being and then they worked through the same four lessons on data-structures in the same order. Each lesson posed a data-structure based programming problem that the students had to complete within a fixed time, and both groups received the same kind of problem-focused feedback on the quality of their answers. At the end of each lesson the experimental group undertook another relaxation exercise while the comparison group again sat quietly. After that both groups were again asked whether there had been any change in their sense of well-being since the previous lesson. After the four lessons were completed, both groups were post-tested for their skill in solving data-structure problems and for their final state of well-being, again using the PANAS questionnaire.

3. Results

Pre-Post: The sense of well-being of both groups as measured by the PANAS questionnaire declined over the course of the experiment, but there was no significant difference in the degrees of decline between the EF+PF group (mean= -0.38, SD 0.68) and the PF group (Mean -0.19, 0.48), (Mann-Whitney test U =1502.0, $p > 0.05$, $r = 0.36$).

Table 1: Changes in the students' reported states of well-being during the experiment

Measures of change of state of well-being (during the experiment) all based on answers on a 5 point scale	**Comparison of the PF and EF+PF groups**
After the primary reaction stage after the initial relaxation exercise	PF = 0.14, EF+PF = 0.43, **Significant (**U =450.0, $p < 0.05$, $r = 0.26$)
After the secondary reaction stage at the end of each lesson for those who **completed their lessons successfully**	PF = 0.20 EF+PF = 0.76, **Significant** (U=1421.0, $p < 0.05$, $r = 0.23$)
After the secondary reaction stage at the end of each lesson for those who **failed to complete their lessons successfully**	PF = -0.21, EF+PF = 0.77, **Significant** (U=4325.0, $p < 0.05$, $r = 0.43$)

During the experiment: At the start of the experiment, but before the data structure lessons began, the EP+PF students were trained in and undertook the relaxation exercise while the PF group sat quietly doing nothing. Following this both groups were asked to report any change in sense of well-being on a 5 point scale (-2 to +2). The EF+PF group reported (mean 0.43, SD 0.46) a significantly better ($p < 0.05$) change in their state of well-being than the PF group (mean 0.14, SD 0.36), see Table 1.

At the end of each lesson, any change in state of well-being was again requested using the same online question. Because students had different degrees of success with their lessons, some completing a lesson successfully and some not, the following analysis

examined each outcome separately. We had assumed that a student who completed lessons successfully would generally be in a more positive state of well-being and might not improve further as result of the EF strategy. We had also assumed that one who did not complete a lesson successfully would generally be in a more negative state of well-being, but might be cheered by the EF strategy. In fact both those in the EF+PF group who completed their lessons successfully and those in the EF+PF group who did not complete their lessons successfully showed significant positive changes in their self-reported sense of well-being, see Table 1.

4. Conclusion

Students in the EF+PF group showed greater learning gains than those in the PF group [11]. While there was no overall difference in pre-post change of well-being between the two groups by the end of the experiment as measured by the PANAS scale, there were differences between the two groups for each actual lesson, both for those students who had completed a lesson successfully and for those had done badly in that lesson. In other words doing the relaxation exercise to some extent improved the positive effects of completing lesson successfully as well as mitigated the negative effects of having done badly through failing to write the program correctly.

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