# The Role of Affect in Personalized Learning

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## Abstract

*Research on modelling affect and on interfaces adaptation based on affective factors has matured considerably over the past several years. Emotions are considered to play a central role in guiding and regulating learning, performance, behaviour and decision making, by modulating numerous cognitive and physiological activities. The basic objective of this paper is to analyse the way that individuals process their emotions and how they interact with other elements of their information-processing system. It will further underpin their significance taking into consideration the notion of emotion regulation, based on which users expect to receive the most apt personalized provider's content. Special emphasis will be given in dispositional trait affect that serves as an overall estimation of an individual's affective state and statistical evidence will be provided which suggest that mood can have both informational and processing effects on cognition.*

## 1. Introduction

Web-based information systems are increasingly being used for learning and decision support applications. Computers are becoming better and more sophisticated every day. They can already perceive information related to user needs and preferences [1, 2]. One possible implementation of a Web-based system's interface that can appraise human needs is through the use of a set of parameters which influence the environment according to the emotional condition of the user [3]. An emotionally tense or unstable individual will be able to receive the contents of a webpage based to what he considers appropriate for his working or learning profile. A certain emotional condition demands a personalization of equivalent proportions. The user will have the capability to respond emotionally either after being asked or after a question from the system. Another important aspect of a related system should be the ability to inform the content presentation module about the user preferences and inclinations [4].

Such a system should be designed in a way that it can create a detailed profile for every user and can provide two basic services. One application-based that will have to do with the interface and one content-based that will have to do with the presented information. The first service will extract user preferences based on aesthetics or usability aspects and will shape the interface in a way that it will be perceived from the user as functional and/or aesthetical, while the second will gather data about the user such us his personal options, his preferences, his interests, his mental state and adapt the presented information accordingly. Using these, the interface will take the form that the user wishes so that he can work in it more efficiently and less anxiously.

In order for a personalization system to work, it is necessary to have a solid and grounded theory and a set of personalization rules that will truly respond to user needs and change the environment to their benefit [5]. The area of emotions is a sensitive one even in pure psychological studies. Affective processing is a mechanism that is not fully researched and the implications from the various studies that exist in the field are often contradictory [6]. Therefore, it is of great importance to formulate a theory and a model of affect and then implement a platform which takes into

consideration both traditional profile as well as affective data of the user and develop suitable system's architecture and its personalization rules.

In this paper we will present our adaptive system in which we are implementing a set of parameters based on the user's cognitive and affective profile. We accept the notion that a user with emotional needs or with an affective state that is not aiding him educationally, is in need of environmental enhancements to work more efficiently. His emotional needs alter his behaviour and create different informational and processing demands. For this reason we support our theory on affection with a personalization model based on content appearance and processing facilitation. The personalization rules were devised after the construction of a theory of affect.

Affect is a term that includes a range of feelings that individuals experience, including discrete emotions, moods and traits such as positive and negative affectivity. There is an ongoing debate in whether emotions have a vital role in people's performance, judgement and decision making process [7, 8]. Many researchers are trying to recognize and manipulate emotions like fear, happiness and anger using a variety of methods (statistical tools, questionnaires and neurophysiological measurements). Others are trying to embody personality characteristics in emotions research and correlate personality types with specific emotional behaviour [9]. There is of course the notion of mood which is a global positive or negative feeling that lasts from a few moments to a few weeks, in contrast to emotions that are relatively intense and very short in duration. Finally there is the matter of disposition which is an overall personality tendency to respond to situations in a specific and stable manner [10]. The borders between the three dimensions are foggy and we cannot be certain in many occasions about the nature of the affective process. Emotions can sometimes transform into a mood and moods in a range of time can be indicative of a person's dispositional affect.

## 2. Model of Affect

An in-depth model that grasps the complexity of these underlying concepts is the first purpose of our research. Instead of selecting one area of implementation we are trying to combine these three levels of analyses and form a typology that will help us circle effectively the affective mechanisms of the brain. In order to apply a purely psychological construct to a digital platform based on personalization rules we adjust the various theories concerning emotions having in mind to make our model flexible and applicable to users' profiles, needs and preferences. Our model has three base elements:

a) Emotional Arousal is the capacity of a human being to sense and experience specific emotional situations. An effort to construct a model that predicts the role of specific emotions is beyond the scope of our research, due to the complexity and the numerous confounding variables that would make such an attempt rather impossible. We focus on arousal as an emotional mechanism and not on a number of basic emotions because emotional arousal can provide some indirect measurement of general emotional mechanisms since it manages a number of emotional factors like anxiety, boredom effects, anger etc.

b) Mood is an affective state that lasts longer than an emotion and is not as specific as an emotion can be. Moods generally have either a positive or negative valence.

c) Dispositional affect is a stable trait and tendency towards positivity or negativity. Individuals with positive affectivity tend to be cheerful and energetic and experience positive moods across a variety of situations as compared to people who tend to have low energy and be melancholic. Individuals with negative affectivity have a negative view on self and tend to be distressed and upset in relation to people who are calm and relaxed.

These basic elements that constitute the affective state of an individual play an important role in the emotionally-charged information that a person is receiving. Apart from that, our model would be problematic without a regulatory mechanism of affect. For this reason we constructed the measure of emotion regulation that is comprised from terms like emotional intelligence, self-efficacy, emotional experience and emotional expression. Emotion regulation is the way in which an individual is perceiving and controlling his emotions. Individuals attempt to influence which emotions they have, when they have them and how they experience and express them.

By combining the affective state of the individual with his regulatory mechanism we can reach a conclusion of how affect infuences his performance and the outcome of his behaviour (figure 1). We cannot accept in advance that high emotional reactions have a negative effect on the individual since through regulation emotionality can be manifested as motivation and/or extra effort. Another key point in our rationale is that an affective instance cannot be described as a discrete and separate emotion but it is a more complex state in which various emotions can coexist and we can only extract a general idea of the individual's general affective state. Affective

information can be analysed in many consecutive emotional bursts that can easily be theoretically contradictory. A stimulus for example can trigger the emotion of fear which through immediate processing can result in becoming hope and happiness for the desirable outcome and lead the individual to put some extra effort on the task. Therefore we accept three principles:

a) Various emotions and affective reactions of different (or the same) valence can exist at the same time or alternate in great speed that is difficult to grasp.

b) Due to the complexity of the individual's affective state it is wise to form a typology and speak of affective types and categories and not to look for specific emotions.

One possibly wrong assumption in emotion research is that discrete emotions occur in isolation. In fact, we believe that emotional reactions frequently involve more than one discrete emotion.

c) Emotion regulation is of great importance because it can alter the outcome of the individual's behaviour from negative to positive.

As a typology we are using the affective circumplex (adapted from Feldman Barrett, L., & Russell, J.A., 1998) [11] that includes four dimensions and can be shown below in figure 2.

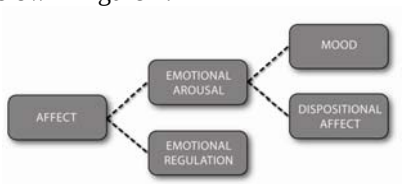



Figure 1. Our proposed model

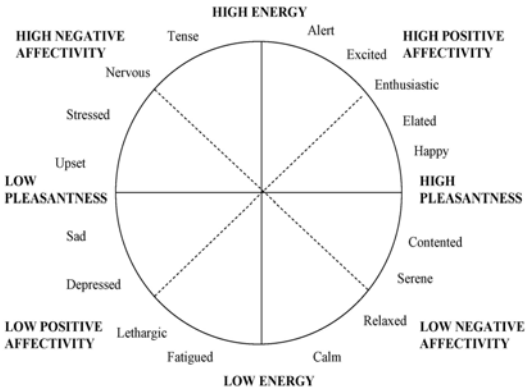



Figure 2. The circumplex model of Affect

## 3. Incorporating Affective Factors in User Modeling

### 3.1. Theory and personalization

In the first step of our research we examined the immediate and synchronous affective user reactions and behaviour which are covered in our model by the terms of emotional arousal and emotion regulation [12]. We hypothesized that by combining the level of arousal of an individual with the moderating role of emotion regulation, it is possible to clarify, at some extent, how affectional responses of the individual hamper or promote learning procedures. Thus, by personalizing on this concept of affect the educational content that our already developed adaptive system provides [13], we can avoid stressful instances and take full advantage of the users' cognitive capacity at any time. At a practical level, our personalization rules were based in the assumption that users with high arousal levels lacking the moderating role of emotion regulation are in a greater need of enhancing the aesthetic aspects of our system, while users with low arousal levels focus more on usability issues. Another hypothesis was that emotion regulation and arousal are negatively correlated. It was proposed that an individual with high emotion regulation would usually have low arousal levels because of his ability to control and organize his emotions [14].

In this next step we are interested in clarifying the role of dispositional trait affect which is a global and general mood (positive or negative) and its relationship with the construct of emotion regulation. After the construction and standardization of our instruments we are currently trying to find the weighting, the importance and the implications of dispositional affect [15, 16]. Our second hypothesis is that a user with negative affect and low regulation potential will be keener to accept and make greater use of the personalization tools that we offer him. The personalization is based on the aesthetic enhancement of the interface and on the better provision of content. The former tool aids his informational needs and the latter his processing needs. These two tools are embedded in the interface and our goal is to measure how users with specific profiles will perform with or without personalization.

In order to manipulate the parameters of our adaptive system according to user characteristics, our research has to go through the stage of extracting quantified elements that represent deeper psychological and emotional abilities. The latter cannot be directly used in a web environment, but a numerical equivalent can define a personalization parameter.

### 3.2. Sampling and procedure

All participants were students from the University of Athens; the part of the study concerning affect was

conducted with a sample of 124 students. 40% of the participants were male and 60% were female, and their age varied from 17 to 22 with a mean age of 19. The environment in which the procedure took place was an e-learning course on algorithms. The course subject was chosen due to the fact that students of the department where the experiment took place, had absolutely no experience on computer science, and traditionally perform poorly. By controlling the factor of experience, we divided our sample in two groups: almost half of the participants were provided with information matched to their Perceptual Preferences (aesthetic and processing facilitation), while the other half were taught in a mismatched way. We expected that users in the matched condition, would outperform those in the mismatched condition.

In order to evaluate the effect of matched and mismatched conditions, participants took an online assessment test on the subject they were taught (algorithms). This exam was taken as soon as the e-learning procedure ended, in order to control for long-term decay effects. The dependent variable that was used to assess the effect of adaptation to users' preferences was participants' score at the online exam.

Apart from the investigation on the role of personalization in general we measured performance in four categories of affection that came up from a combination of dispositional affect (positive or negative) and emotion regulation (high or low) and we asssumed that users with positive affect and high regulation would perform better than users with negative and low.

### 3.3. Results

The results of experiments conducted within the actual learning environment, as we hypothesized, show that users with negative affect, lacking the moderating role of emotion regulation, are in greater need of enhancing the aesthetic aspects of our system and the provision of additional help (processing), in order to perform similarly with users with positive mood and regulation skills (see Graph 1). Additionally as it can be seen in table 1, the two notions of dispositional affect and emotion regulation were found to be as hypothesized significantly statistically different. A user with high regulation ability has a tendency towards positive mood and a user with low regulation ability is resilient to negative mood [17, 18].

Table 1. Analysis of Variance (ANOVA) between Users' dispositional affect (positive or negative) and emotion regulation

**ANOVA**

reg_means

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 2.245 | 1 | 2.245 | 13.171 | .000 |
| Within Groups | 20.796 | 122 | .170 | | |
| Total | 23.041 | 123 | | | |

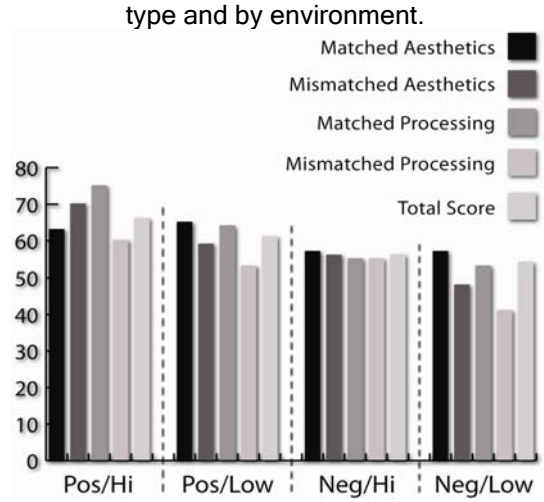
Table 2. Analysis of Variance (ANOVA) between Users' affective state (based on dispositional affect and regulation) and scores.

**ANOVA**

Score %

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 2203.378 | 3 | 734.459 | 2.699 | .049 |
| Within Groups | 32649.589 | 120 | 272.080 | | |
| Total | 34852.968 | 123 | | | |

Graph 1. Overall scores categorized by affective type and by environment.




A significant finding is that the affective state of the user is having an effect on his score (Table 2 and Graph 1). Participants with positive affect perform better than participants with negative affect in both matched and mismatched environments. Additionally, the match-mismatch factor is extremely important for user performance. Participants with matched environments scored highly while participants with mismatched environments had poor performance.

Overall we can say that affect is greatly related to performance. Of equal importance is the notion of regulation that acts as a moderating factor to negative affect and as a reinforcement to positive affect [19]. The personalization techniques were proven beneficial for all users, and especially for those with negative affect. This group of users requires specific help on the interface as well as the structure and appearance of information. In our design, their informational and processing needs were met by the personalization tools

of aesthetic enhancement, navigation support and content re-allocation.

## 4. Conclusion

Emotions influence the cognitive and physiologic processes of the individual [20], and therefore have an effect in any educational setting. Bibliographic research has shown that negative affect is often correlated with academic performance [21], as well with performance in computer mediated learning procedures. We support the notion that by combining the level of arousal of an individual with the moderating role of emotion regulation, taking into consideration his mood and disposition it is possible to clarify, at some extent, how emotional responses of the individual hamper or promote learning procedures. Thus, by personalizing web-based content, taking into account affect, we can avoid stressful instances and take full advantage of his cognitive capacity at any time.

We intend to use all these methods of measurement, as the main direction of our work, controlling at the same time confiding or correlated variables (verbal ability, IQ). We primarily aim to ground our hypothesis that personalizing web content according to the participants' affective characteristics (an individual's capability or incapability to control his emotions and use affect in a constructing way), is of high significance in optimizing computer mediated learning processes.

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