The Role of Affect in Personalized Learning

Zacharias Lekkas¹, Nikos Tsianos¹, Panagiotis Germanakos²³, Constantinos Mourlas¹, George Samaras⁵

¹Faculty of Communication and Media Studies, National & Kapodistrian University of Athens, 5 Stadiou Str, GR 105-62, Athens, Hellas
zlekkas@gmail.com, {ntsianos, mourlas}@media.uoa.gr
²Department of Management and MIS, University of Nicosia, 46 Makedonitissas Ave., P.O.Box 24005, 1700 Nicosia, Cyprus
³Computer Science Department, University of Cyprus, CY-1678 Nicosia, Cyprus
{pgerman, cssamara}@cs.ucy.ac.cy

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 affect 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 responds emotionally after being asked 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 personalization services. These services are application-based (changes in the interface) and content-based (changes in the way that information is presented). Application-based services extract user preferences based on aesthetics or usability aspects and shape the interface in a way that it will be perceived from the user as functional and/or aesthetical, while the content-based services gather data about the user such as his personal options, his preferences, his interests, his mental state and adapt the presented information accordingly. Using these, the user can work 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 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 the traditional profile and the
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 affective profile. A user with a negative affective state requires environmental enhancements to work more efficiently. His emotional needs alter his behaviour and create different informational and processing demands. We support our theory on affect with a personalization model based on content appearance and processing facilitation. The personalization rules were devised after the construction of a theory of affect and include the aesthetic enhancement of the interface and the better provision of content. The former tool aids the informational needs and the latter the processing needs of the users.

Affect is a term that includes a range of feelings that people 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 transform into mood which 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 (emotions, mood, disposition) 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 includes three basic constructs that correspond to the aforementioned elements (affective categories that divide affect by the criterion of emotional duration):

a) Emotional Arousal (EA) 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 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 (DA) 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 constructs 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 (ER) that is comprised from terms like emotional intelligence, self-efficacy, emotional experience and emotional expression. ER 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 see how affect influences 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. A 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. 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) ER 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 (adopted from Feldman Barrett, L., & Russell, J.A., 1998) [11] that includes four dimensions and can be shown below in figure 2. The specific diagram is a general but adequate classification of emotions that is suitable for our model because it is in accordance with our construct of EA and at the same time it is easy for us to assign the various emotional bursts in the axes.

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 EA and ER [12]. We hypothesized that by combining the level of arousal of an individual with the moderating role of ER, 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 ER are in a greater need of enhancing the aesthetic aspects of our system. Another hypothesis was that ER and EA are negatively correlated. It was proposed that an individual with high ER would usually have low EA levels because of his ability to control and organize his emotions [14].

In this study we want to clarify the relationship between DA (positive, negative) and ER (high, low). Our first hypothesis supports the idea that dispositional trait affect and ER will be negatively correlated. After the construction and standardization of our instruments we are currently trying to find the weighting, the importance and the implications of DA [15, 16]. Our second hypothesis is that a user with negative DA and low ER potential will be keener to accept and make greater use of the personalization tools that we offer him, than the user with positive DA. In the first phase of our research, users in the matched condition with moderate and high levels of anxiety received aesthetic enhancement of the content and navigational help and in the mismatched condition users with moderate and high levels of anxiety received no additional help or aesthetics.

In the second experiment, which is presented in this paper, again half of the participants were provided with information matched to their affective preferences (aesthetic and processing facilitation), while the other half were taught in a mismatched way. Apart from the investigation on the role of personalization we measured performance in four categories of affect. Our hypothesis was that again (like EA) DA would be negatively correlated with ER, and that personalization tools will help users to raise their performance especially those with negative DA and low ER skills. In this second phase apart from the aesthetic enhancement tool, participants in the negative DA category received the additional help of personalized
content, because according to theory individuals with negative DA process information with a different manner (usually worse) and that is why they have extra processing needs.

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 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. All participants are characterised as inexperienced and for this reason experience as a factor was controlled for. The sample was divided 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 (users received a non personalised environment). 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.

Performance was measured in four categories of affect through a combination of DA (positive or negative) and ER (high or low). We assumed that users with positive DA and high ER would perform better than users with negative DA and low ER.

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>
<thead>
<tr>
<th>ANOVA</th>
<th>Score %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of Squares</td>
<td>df</td>
</tr>
<tr>
<td>Between Groups</td>
<td>2635.378</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3949.589</td>
</tr>
<tr>
<td>Total</td>
<td>32145.968</td>
</tr>
</tbody>
</table>

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). As it can be seen in the graph, participants with positive DA perform better than participants with negative DA 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.
We can argue that DA is greatly related to performance. ER is acts as a moderating factor to negative DA and as a reinforcement to positive DA [19]. The personalization techniques were proven beneficial for all users, and especially for those with negative DA. 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 believe that by combining the level of EA of an individual with the moderating role of ER, 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 these methods of measurement, as the main direction of our work, controlling at the same time confounding or correlated variables. We aim to ground our hypothesis that personalizing web content according to affective characteristics (an individual’s capability to control his emotions and use affect in a constructing way), is of high significance in optimizing computer mediated learning processes.

5. References