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Personalized Learning in Hypermedia Environments

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1. Introduction

Distance learning (or eLearning) is considered one of the most rapidly evolving application areas of the Web that improves the traditional educational processes and methodologies of knowledge transfer. In recent years, there has been significant research and experimentation around the adaptation and personalization of the eLearning hypermedia that mainly concerns the timely delivery and adjustment of the content to user's needs and perceptual characteristics. This chapter provides a new comprehensive approach of reconstructing eLearning content; by creating a user profile based on specific metrics of cognitive processing parameters (such as cognitive style, cognitive processing speed efficiency, working memory factors and affective parameters) that have specific impact into the information space. Such approach may be proved to be very useful in assisting and facilitating a student to better understand eLearning content and therefore increase his / her academic performance. In view of that, an adaptation and personalization Web-based environment has been developed. It is detached into a number of interrelated components, each one representing a stand alone Web system. An evaluation of the proposed environment is presented with the results being highly promising and encouraging for the continuation of our research, since there has been identified significant increase of learners' academic performance when interacting with the personalized eLearning environment that is matched to their cognitive and affective parameters as well as visual working memory span capabilities.

Adapting to user context, individual features and behaviour patterns is a topic of great attention nowadays in the field of Web-based learning. A challenge is to design personalized interfaces and software enabling easy access to the learning content while being sufficiently flexible to handle changes in user's context, perception and available resources. One of the key technical issues in developing personalization applications is the problem of how to construct accurate and comprehensive profiles of individual users and how these can be used to identify a user and describe the user behaviour. The objective of user profiling is the creation of an information base that contains the preferences, characteristics and activities of the user.

There are some noteworthy applications in the area of Web personalization that collect information with various techniques from the users based on which they adapt the services content provided. Such systems, mostly commercial, are amongst others the Broadvision's One-To-One (www.broadvision.com), Microsoft's Firefly Passport (developed by the MIT

Media Lab), the Macromedia's LikeMinds Preference Server, Apple's WebObjects, etc. Other, more research oriented systems, include ARCHIMIDES (Bogonicolos et al. 1999), WBI (Maglio & Barret 2000; Barret et al. 1997), BASAR (Thomas & Fischer 1997) and mPERSONA (Panayiotou & Samaras 2004). Significant implementations have also been developed with regards to the provision of adapted educational content to students using various adaptive hypermedia techniques. Such systems are amongst others, INSPIRE (Papanikolaou et al. 2003), ELM-ART (Weber & Specht 1997), AHA! (De Bra & Calvi 1998), Interbook (Brusilovsky et al. 1998), and so on.

This chapter introduces a new approach in the field of adaptive hypermedia, which integrates cognitive and mental parameters and attempts to apply them on a Web-based learning environment. The goal of the proposed approach is to improve learning performance and, most importantly, to personalize Web-content to users' needs and preferences, eradicating known difficulties that occur in traditional approaches. Based on the abovementioned considerations, an adaptive Web-based environment is overviewed trying to convey the essence and the peculiarities encapsulated. This system is an innovative Adaptation and Personalization Web-based System that is based on the proposed approach and a Comprehensive User Profile, mentioned above.

In the proposed system, the notion of the user profile is extended, incorporating the *User Perceptual Preferences*, that serve as the primal personalization filtering element. This approach emphasizes on human factors that influence the visual and mental processes that mediate or manipulate new information that is received and built upon prior knowledge, respectively different for each user or user group. These characteristics, which have been primarily discussed in previous publications (Germanakos et al. 2005; Germanakos et al. 2007), have a major impact on visual attention and cognitive processing that take place throughout the whole process of accepting an object of perception (stimulus), until the comprehensive response to it.

A corresponding adaptive hypermedia system has been built following this approach (Germanakos et al. 2007a) and there is a continuing process of evaluating our methods and reforming both the theoretical model and the system. This chapter presents the results that are gathered from experiments conducted throughout the assessment procedure, in order to clarify at some extent whether such a combination of human factors is of importance in the area of educational adaptive hypermedia.

Section 2 presents the theoretical background for the personalization research and introduces our new approach in the field of adaptive hypermedia, which integrates cognitive and mental parameters and attempts to apply them on a Web-based learning environment. Section 3 presents our adaptive hypermedia system which has been built following the approach given in the previous section. Section 4 presents the empirical evaluation of the proposed approach and the results from experiments that were conducted in the context of an educational Web-setting, which support our approach in terms of optimizing users' performance in the sense of information comprehension. Section 5 includes the conclusion and our possible future work.

2. Theoretical background

Web personalization is the process of customizing the content and structure of a Web site to the specific needs of each user by taking advantage of the user's navigational behaviour.

Being a multi-dimensional and complicated area a universal definition has not been agreed to date. Nevertheless, most of the definitions given to personalization (Cingil et al. 2000; Blom 2000; Kim 2002) agree that the steps of the Web personalization process include: (1) the collection of Web data, (2) the modelling and categorization of these data (pre-processing phase), (3) the analysis of the collected data, and (4) the determination of the actions that should be performed.

One of the main challenges in Personalization research is alleviating users' orientation difficulties, as well as making appropriate selection of knowledge resources, since the vastness of the hyperspace has made information retrieval a rather complicated task (De Bra et al. 2004). Adaptivity is a particular functionality that distinguishes between interactions of different users within the information space (Eklund & Sinclair 2000; Brusilovsky & Nejdl 2004).

A system can be classified as personalized if it is based on hypermedia, has an explicit user model representing certain characteristics of the user, has a domain model which is a set of relationships between knowledge elements in the information space, and is capable of modifying some visible or functional parts of the system, based on the information maintained in the user model (Brusilovsky & Nejdl 2004; Brusilovsky 2001). In further support of the aforementioned concept of personalization, when referring to information retrieval and processing, one cannot disregard the top-down individual cognitive processes (Eysenck & Keane 2005), that significantly affect users' interactions within the hyperspace, especially when such interactions involve educational or learning, in general, goals.

Consequently, besides "traditional" demographic characteristics that commonly comprise the user model in personalized environments, we believe that a user model that incorporates individual cognitive characteristics and triggers corresponding mechanisms of adaptivity, increases the effectiveness of Web- applications that involve learning processes.

2.1 User perceptual preferences

In search of a model that combines the construct of cognitive style with other human information processing parameters, a three dimensional model is proposed (Tsianos et al., 2007): Cognitive Style, Cognitive Processing Efficiency and Emotional Processing. The first dimension is unitary, whereas Cognitive Processing Efficiency is comprised of (a) Visual Working Memory Span (VWMS) (Baddeley, 1992) and (b) speed and control of information processing and visual attention (Demetriou et al., 1993). The emotional aspect of the model focuses on different aspects of anxiety (Cassady & Jonhson 2002, Cassady 2004, Spielberger 1983), and self-regulation.

The model contains all the visual attention and cognitive psychology processes (cognitive and emotional processing parameters) that completes the user preferences and fulfils the user profile. User Perceptual Preference Characteristics could be described as a continuous mental processing starting with the perception of an object in the user's attentional visual field and going through a number of cognitive, learning and emotional processes giving the actual response to that stimulus, as depicted in Fig. 1, below. It is considered a vital component of the user profiling since it identifies the aspects of the user that is very difficult to be revealed and measured but, however, might determine his / her exact preferences and lead to a more concrete, accurate and optimized user segmentation.
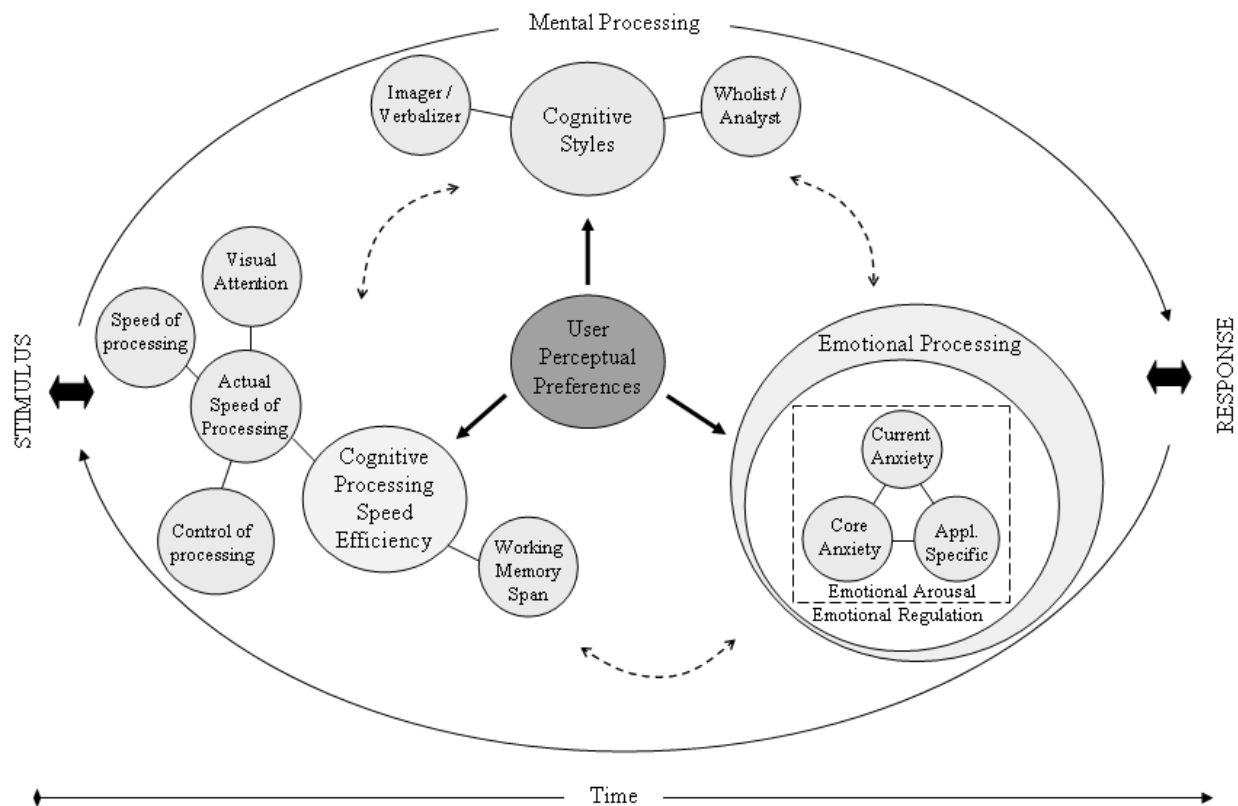
Fig. 1. User Perceptual Preference Characteristics – Three-Dimensional Approach

This "perceptual preferences" component / dimension of the user profile contains cognitive and emotional processes, aiming to enhance information learning efficacy. This model's primary parameters formulate a three-dimensional approach to the problem (Germanakos et al. 2007b) outlined below:

2.1.1 Cognitive processing efficiency

The cognitive processing parameters (Demetriou & Kazi, 2001) that constitute the first dimension of our model consist of the:

a. Actual speed of processing, that is further composed of the, (i) Control of processing (refers to the processes that identify and register goal-relevant information and block out dominant or appealing but actually irrelevant information); (ii) Speed of processing (refers to the maximum speed at which a given mental act may be efficiently executed); and (iii) Visual attention (based on the empirically validated assumption that when a person is performing a cognitive task, while watching a display, the location of his / her gaze corresponds to the symbol currently being processed in working memory and, moreover, that the eye naturally focuses on areas that are most likely to be informative).

b. As mentioned above, in search of a more coherent approach, the term of working memory (Baddeley, 1981) has also been introduced as a personalization factor. (Visual) working memory span (VWMS), which refers to the processes that enable a person to hold visual information in an active state while integrating it with other information until the current problem is solved. A brief description of the working memory system

is that is consisted of the central executive that controls the two slave systems (visuo-spatial sketchpad and phonological loop), plus the episodic buffer that provides a temporary interface between the slave systems and the Long Term Memory (Baddeley, 2000). We are mainly interested in the notion of the working memory span, since it can be measured and the implications on information processing are rather clear. Due to the visual form of presentation in the web, we have focused especially on the on visual working memory (Loggie et al., 1990). In any case, each individual has a specific and restricted memory span. As to decrease the possibility of cognitive load in hypermedia educational environments (DeStefano & Lefevre, 2007), our system takes into account each users' visual working memory span (VWMS), by altering the amount of simultaneously presented information.

We measure each individual's ability to perform control/speed of processing and visual attention tasks in the shortest time possible, with a specific error tolerance, while the working memory span test focuses on the visuo-spatial sketch pad sub-component (Baddeley 1992), since all information in the Web is mainly visual.

2.1.2 Cognitive style

We prefer the construct of cognitive rather than learning style because it is more stable (Sadler-Smith & Riding, 1999), and to the extent that there is a correlation with hemispherical preference and EEG measurements (McKay, 2003; Glass & Riding, 1999), the relationship between cognitive style and actual mode of information processing is strengthened. Moreover, the learning style is "a construct that by definition is not stable- it was grounded in process and therefore susceptible to rapid change" (Rayner, 2001). In addition, we are research-wise interested in individual information processing parameters, whereas the social implications of other learning typologies are not examined.

More specifically, Riding and Cheema's Cognitive Style Analysis (CSA) has been opted for. The CSA is derived from a factor analytic approach on previous cognitive style theories, summarizing a number of different yet highly correlated constructs into two distinct independent dimensions (Riding & Cheema, 1991). This covers a wide array of the former cognition based style typologies, without going into unnecessary depth- for the needs of hypermedia education that is. The dimensions is the holist/analytic and the imager/verbalizer; the former alters the structure and amount of learner control, while the latter affects the type of resources that are presented to provide the necessary educational information.

Cognitive styles represent an individual's typical or habitual mode of problem solving, thinking, perceiving or remembering, and "are considered to be trait-like, relatively stable characteristics of individuals, whereas learning strategies are more state-driven…" (McKay, 2003). Amongst the numerous proposed cognitive style typologies (Cassidy, 2003; Kolb & Kolb, 2000; MyersBriggs et al., 1998) we favour Riding's Cognitive Style Analysis (Riding, 2001), because we consider that its implications can be mapped on the information space more precisely, since it is consisted of two distinct scales that respond to different aspects of the Web. The imager/verbalizer axis affects the way information is presented, whilst the wholist/analyst dimension is relevant to the structure of the information and the navigational path of the user. Moreover, it is a very inclusive theory that is derived from a number of pre-existing theories that were recapitulated into these two axes.

2.1.3 Emotional processing

In our study, we are interested in the way that individuals process their emotions and how they interact with other elements of their information-processing system. Emotional processing is a pluralistic construct which is comprised of two mechanisms: *emotional arousal*, which is the capacity of a human being to sense and experience specific emotional situations, and *emotion regulation*, which is the way in which an individual is perceiving and controlling his emotions. We focus on these two sub-processes because they are easily generalized, inclusive and provide some indirect measurement of general emotional mechanisms. These sub-processes manage a number of emotional factors like anxiety and boredom effects, anger, feelings of self efficacy, user satisfaction etc. Among these, our current research concerning emotional arousal emphasizes on anxiety, which is probably the most indicative and present in educational cases, while other emotional factors are to be examined within the context of a further study. Anxiety is an unpleasant combination of emotions that includes fear, worry and uneasiness and is often accompanied by physical reactions such as high blood pressure, increased heart rate and other body signals (Kim & Gorman, 2005; Barlow, 2002).

Accordingly, in order to measure emotion regulation, we are using the cognominal construct of emotion regulation. An effort to construct a model that predicts the role of emotion, in general, is beyond the scope of our research, due to the complexity and the numerous confounding variables that would make such an attempt rather impossible. However, there is a considerable amount of references concerning the role of emotion and its implications on academic performance (or achievement), in terms of efficient learning (Kort & Reilly, 2002). Emotional intelligence seems to be an adequate predictor of the aforementioned concepts, and is a grounded enough construct, already supported by academic literature (Goleman, 1995; Salovey & Mayer, 1990). Additional concepts that were used are the concepts of self-efficacy, emotional experience and emotional expression (Schunk, 1989).

3. System design implications: A high level correlation diagram

The greatest challenge is of course to extrude from the abovementioned theories the corresponding implications for an educational hypermedia environment. For a better understanding of the three dimensions' implications and the UPPC model as well as their relation with the information space a diagram that presents a high level correlation of these implications with selected tags of the information space (keywords used in Web languages to define a format change or hypertext link) is depicted in Figure 2 (Germanakos et al., 2008a; Germanakos et al, 2007a).

These tags (images, text, information quantity, links - learner control, navigation support, additional navigation support, and aesthetics) have gone through an extensive optimization representing group of data affected after the mapping with the implications. The main reason we have selected the latter tags is due to the fact that represent the primary subsidiaries of a Web-based content. With the necessary processing, mapping and / or alteration we could provide the same content with different ways (according to a specific user's profile) but without degrading the message conveyed.

The particular mapping is based on specific rules created, liable for the combination of these tags and the variation of their value in order to better filter the raw content and deliver the most personalized Web-based result to the user. As it can be observed from the diagram

above each dimension has primary (solid line) and secondary (dashed line) implications on the information space altering dynamically the weighting of each factor on the creation of the environment.
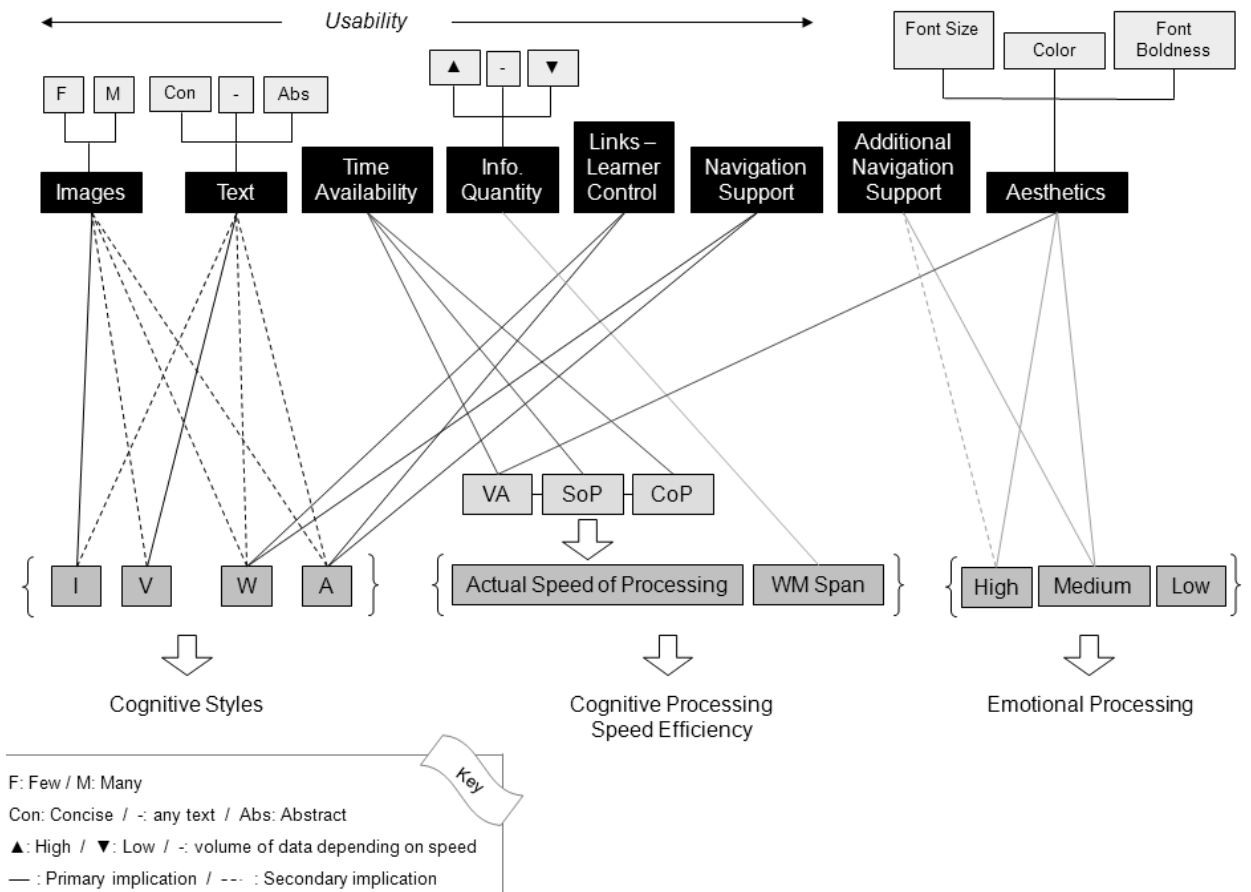

Fig. 2. Data – Implications Correlation Diagram

According to theory, with regards to learning styles for example, the number of images (few or many) to be displayed has a primary implication on imagers, while text (more concise or abstract) has a secondary implication. The analytic preference has a main effect on the links (learner control and navigation support tag). Moreover, actual speed of processing parameters (visual attention, speed of processing, and control of processing) as well as working memory span primarily affect time availability during interaction process and information quantity respectively (see an example in Fig. 3). At this point it should be mentioned that in case of internal correlation conflicts primary implications take over secondary ones.

Henceforth, with regards to the cognitive style, the number of images (few or many) for example to be displayed has a primary implication on imagers, while text (more concise or abstract) has a secondary implication. An analyst may affect primarily the links - learner control and navigation support tag, which in turn is secondary affected by high and medium emotional processing, while might secondary affect the number of images or kind of text to be displayed, consequently. Actual speed of processing parameters (visual attention, speed of processing, and control of processing) as well as working memory span are primarily affecting information quantity. Eventually, emotional processing is primarily affecting additional navigation support and aesthetics (the aesthetic enhancement of the

system was expected to have a positive effect on highly anxious learners), as visual attention does, while secondary affects information quantity (see Fig. 4). In order to experimentally assess the effect of individuals' cognitive processing efficiency, we necessarily imposed time limitations within the learning process. By manipulating time limits, we examine how learners perform (level of comprehension).
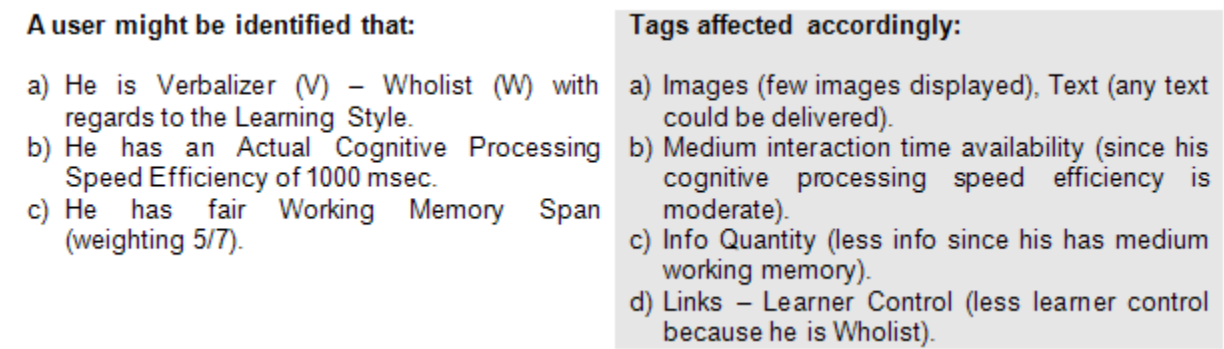
A user might be identified that:

a) He is Verbalizer (V) – Wholist (W) with regards to the Learning Style.
b) He has an Actual Cognitive Processing Speed Efficiency of 1000 msec.
c) He has fair Working Memory Span (weighting 5/7).

Tags affected accordingly:

a) Images (few images displayed), Text (any text could be delivered).
b) Medium interaction time availability (since his cognitive processing speed efficiency is moderate).
c) Info Quantity (less info since his has medium working memory).
d) Links – Learner Control (less learner control because he is Wholist).

Fig. 3. A practical example of the Data – Implications Correlation Diagram
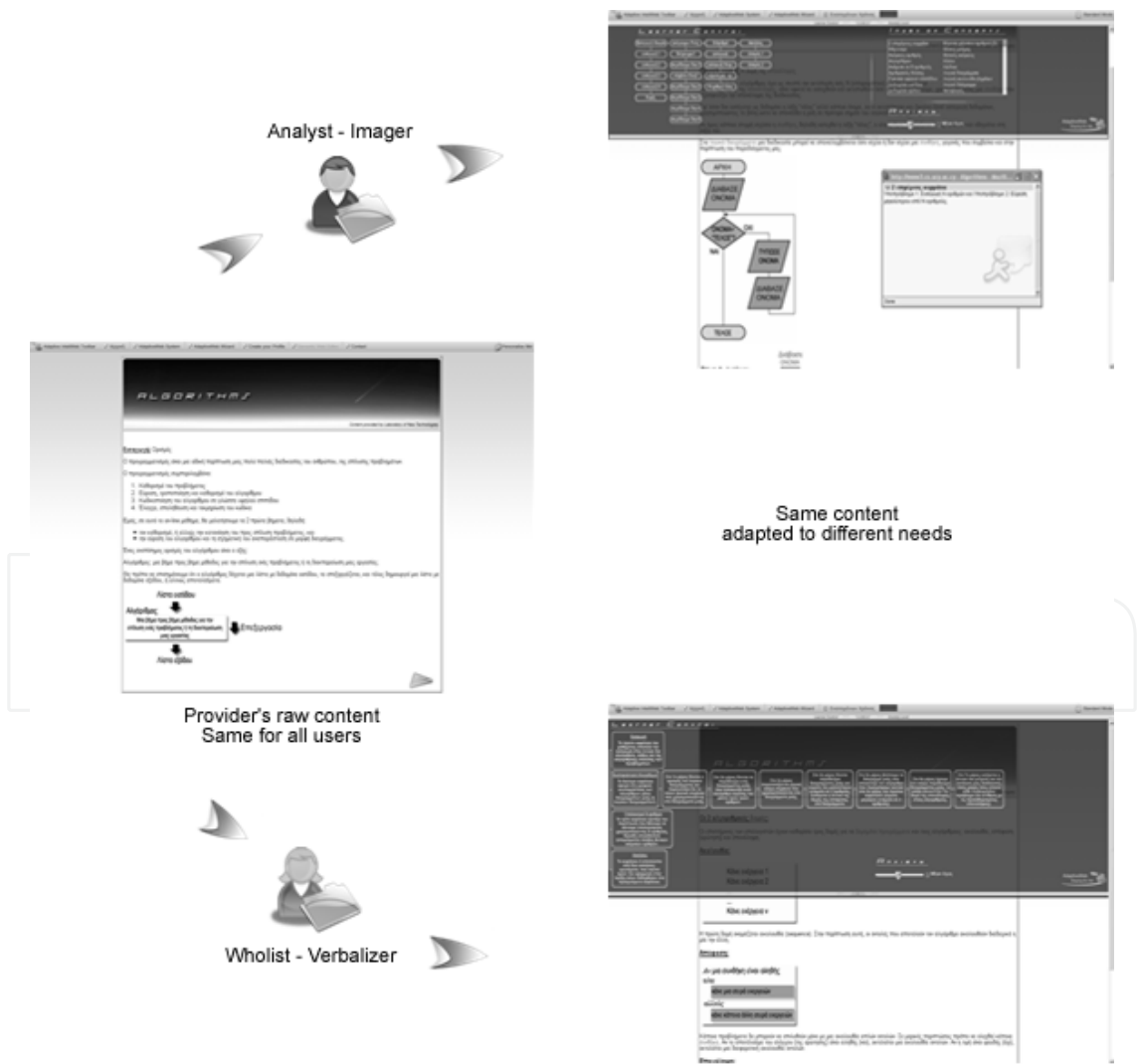

Fig. 4. Content adaptation according to user's comprehensive profile

Additionally, since emotional processing is the most dynamic parameter compared to the others, any changes occurring at any given time are directly affecting the yielded value of the adaptation and personalization rules and henceforth the format of the content delivered.A short description of the way that our system adapts to users' preferences is needed in order to provide the reader an insight to our research framework.

a. Cognitive style: There are two dimensions of users' cognitive style that are mapped in the educational environment: the holist/analyst scale affects the structure and the amount of learner control, whereas the imager/verbalizer is related to the textual or graphical representation of information (where possible of course).

b. VWMS: Each users' visual working memory span is measured and classified. Users that have low levels of VWMS receive segmented content that is unfolded gradually. The main idea is to alleviate the possibility of cognitive overload, and is based on the notion that information processing is not sequential but parallel- therefore, the segmentation in clear-cut chunks may assist users' with low VWMS.

c. Cognitive Processing Efficiency: Since the term efficiency refers mainly to speed, in order to distinguish whether there is a relationship between users' ability and the time required to complete an online course, we set different time limits for each category.

d. Anxiety: In our experiments, if there were high levels of anxiety (on behalf of the user), we provided aesthetical enhancement of the environment and further annotations; in a sense, the aesthetical aspect predominates over functionality (in terms of font size, colours, annotations).

Based on the abovementioned considerations an adaptive Web-based learning environment has been developed, trying to convey the essence and the peculiarities encapsulated. The current system, AdaptiveWeb[1] is a Web application that can be ported both to desktop computer and mobile devices. The actual system, the psychometric tests and the course can be reached at http://www3.cs.ucy.ac.cy/adaptiveweb/. It is composed of four interrelated components, each one representing a stand-alone Web-based system (Germanakos et al., 2008b). The AdaptiveWeb system is currently at its final stage. All the components, except the Semantic Web Editor have been developed and smoothly running. For this reason, all the tests implemented so far, to prove components efficiency as well as the effect of our cognitive three-dimensional model described above into the Web, have been based on predetermined online contents in the field of eLearning. The current system has been evaluated both at system's response time performance and resources consumption, as well as with regards to users' learning performance, with really encouraging results as it is described into the following sections.

For experimental purposes, we have currently authored an e-learning multimedia environment with a predefined content for adaptation and personalization. This environment includes a course named "Introduction to Algorithms" and is a first year e-learning course environment that aims to provide students with analytic thinking and top-down methodology techniques for further development of constructive solutions to given problems.

To get a better insight of the adaptation process and how data flows, we hereafter depict how the personalized content (the "Introduction to Algorithms" predefined environment) interacts with the Comprehensive User Profile, using specific mapping rules. Fig. 5 shows

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[1] http://www3.cs.ucy.ac.cy/adaptiveWeb

Comprehensive User Profile

```
<userProfile ID=896996>
    <traditionalChars> … </tradiotionalChars>
    <actualSpeedOfProcessing>1.2sec</actualSpeedOfProcessing>
    <workingMemory>Medium</workingMemory>
    <learningStyles>Imager/Wholist</learningStyles>
</userProfile>
```

XML Instance

Data – Implications Correllation:
Images / 60% Content / Bold / Font 12

Mapping

webPage_Y.xml

XML Objects

Format and Position Information

```
<object_X>
    <ID>12345</ID>
    <category>Algorithms</category>
    <type>Text</type>
    <format>Theory</format>
    <structure>
        <division>Introduction</division>
        <complexity>2</complexity>
    </structure>
    <content> … </content>
    …
</object_X>
```

```
<object_Y>
    <ID>98765</ID>
    <category>Algorithms</category>
    <type>Image</type>
    <format>Example</format>
    <structure>
        <division>MainBody</division>
        <complexity>1</complexity>
    </structure>
    <content>
        <imageSource src='image.gif' />
    </content>
    …
</object_Y>
```

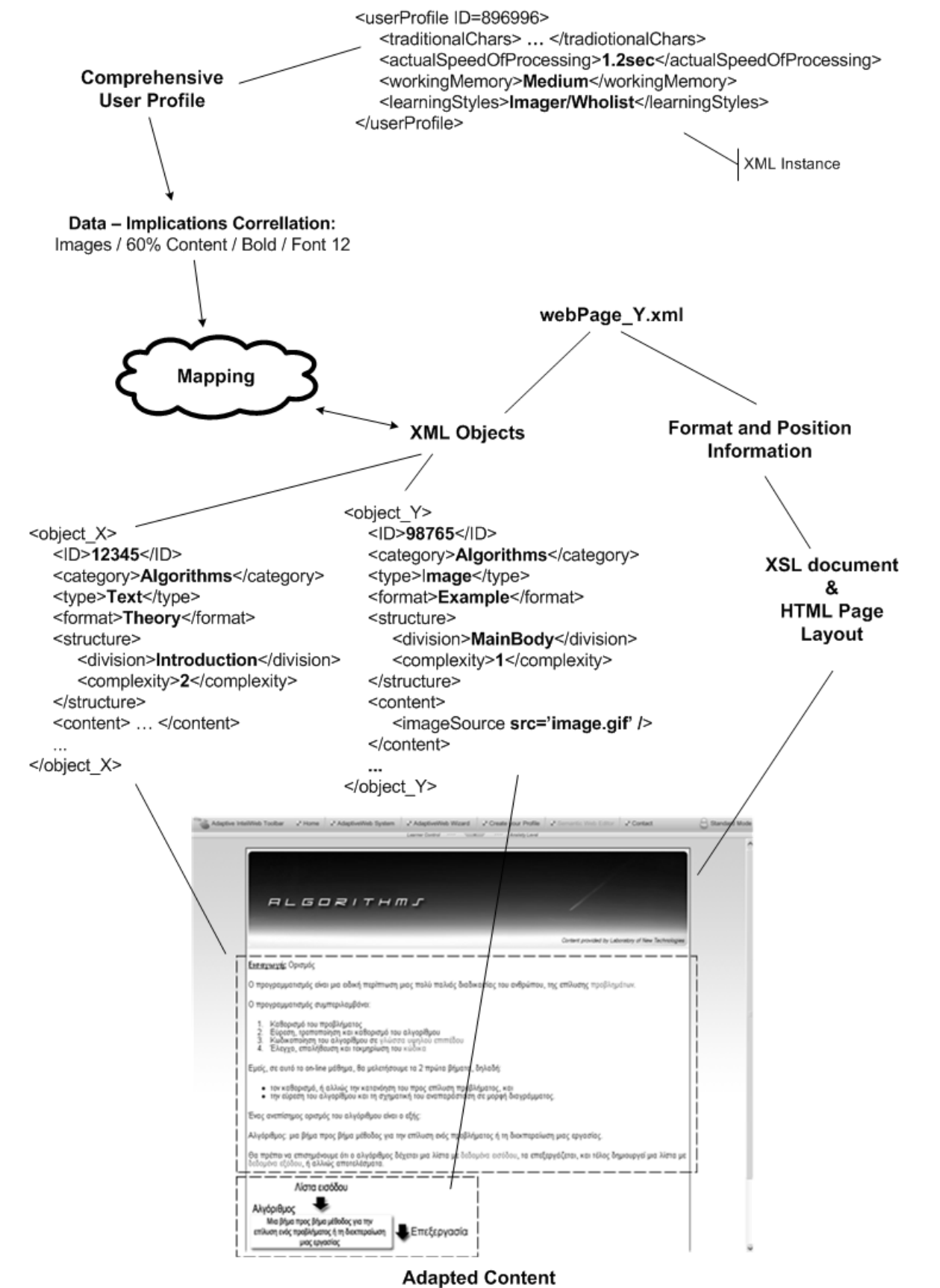**XSL document & HTML Page Layout**

Adapted Content

Fig. 5. The Adaptation Process

the whole adaptation process. The system's adaptation engine initially retrieves the actual profile characteristics of the user and then interprets the profile to conclude what implications the user's characteristics have in the information space; what adaptation techniques to use on the content. Every Web-page is detached into standalone objects, each one having special characteristics (i.e. image diagram for Imagers or text object for Verbalizers).

At this point the system has all the information necessary for adapting the content; the data - implications correlation diagram based on the user's comprehensive profile and the content description of the particular Web-page. The next step is to map the implications with the Web-page's content, for assembling the final version of the provider's content. The content adapts according to the users' preferences. The new, adapted content loads then onto the users' device.

Users log in the system providing their username and password to see adapted content. The corresponding profile loads onto the server and in proportion with their cumulative characteristics the content of the provider maps with the "Mapping Rules", as described before. Based on theory (Sadler-Smith & Riding 1999), Analysts have a more analytic way of think; thus the navigation support provided (analytic description of definitions) is in popup windows, so they can manage the entire lesson, along with its definitions by themselves. In the learner control support (that is, the slide-in help panel from the top of the page) is a linkable sitemap of the whole e-learning lesson, plus the entire lesson's definitions in alphabetic order.

On the other hand, Wholists tend to have a wholistic approach of learning (Sadler-Smith & Riding 1999); thus the navigation support and learner control support is more restricted and is specifically provided for guidance. The analytic description of a definition is only shown in a tooltip when they move their mouse over it and the learner control shows them only the current chapter's pages they learn and lets them navigate only to the next and the previous visited pages.

4. Empirical evaluation of the proposed model in an educational environment

This section presents the results from experiments that were conducted in the context of an educational Web-setting, which support our approach in terms of optimizing users' performance in the sense of information comprehension.

Sampling and Procedure

All participants were students from the Universities of Cyprus and Athens with a sample of 138 students. 35% of the participants were male and 65% 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 undergraduate course on algorithms. The course subject was chosen due to the fact that students of the departments where the experiment took place had absolutely no experience of computer science, and traditionally perform poorly. By controlling the factor of experience in that way, we divided our sample in two groups: almost half of the participants were provided with information matched to their cognitive style, 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 memory decay effects. The dependent variable that was used to assess the effect of adaptation to users' preferences was participants' score at the online exam.

At this point, it should be clarified that matching and mismatching instructional style is a process with different implications for each dimension of our model. These are described below:

- Matched Cognitive Style: Presentation and structure of information matches user's preference
- Mismatched Cognitive Style: Presentation and structure of information does not coincide with user's preference
- Matched VWMS: Low VWMS users are provided with segmented information
- Mismatched VWMS: Low VWMS users are provided with the whole information
- Matched CPSE: Each user has in his disposal the amount of time that fits his ability
- Mismatched CPSE: Users' with low speed of processing have less time in their disposal (the same with "medium" users.
- Matched Emotional Processing: Users with moderate and high levels of anxiety receive aesthetic enhancement of the content and navigational help
- Mismatched Emotional Processing: Users with moderate and high levels of anxiety receive no additional help or aesthetics

Questionnaires

In this specific e-learning setting, Users' Perceptual Preferences were the sole parameters that comprised each user profile, since demographics and device characteristics were controlled for. In order to build each user profile according to our model, we used a number of questionnaires that address all theories involved.

- Cognitive Style: Riding's Cognitive Style Analysis, standardized in Greek and integrated in .NET platform
- Cognitive Processing Speed Efficiency: Speed and accuracy task-based tests that assess control of processing, speed of processing, visual attention and visuospatial working memory. Originally developed in the E-prime platform, we integrated them into our platform.
- Core (general) Anxiety: Spielberger's State-Trait Anxiety Inventory (STAI) – 10 items (Only the trait scale was used).
- Application Specific Anxiety: Cassady's Cognitive Test Anxiety scale – 27 items (Cassady, 2004).
- Current Anxiety: Self-reported measures of state anxiety taken during the assessment phase of the experiment, in time slots of every 10 minutes – 6 Time slots.
- Emotion Regulation: This questionnaire was developed by us; cronbach's α that indicates scale reliability reaches 0.718.

Results

As expected, in both experiments the matched condition group outperformed those of the mismatched group. Table 1 shows the differences of means (one way ANOVA) and their

statistical significance for the parameters of Cognitive Style (CS), Cognitive Processing Speed Efficiency (CPSE), and Emotional Processing (EM).

As hypothesized, the mean score of those that received matched to their cognitive style environments is higher than the mean score achieved by those that learned within the mismatched condition ($F_{(2,113)}$=6.330, p=0.013). This supports the notion that cognitive style is of importance within the context of Web-education and that this construct has a practical application in hypermedia instruction. The same applies with the case of Cognitive Processing Speed Efficiency: $F_{(2,\ 81)}$=5.345, p=0.023). It should at least be of some consideration the fact that in case designers' teaching style mismatched learners' preference, performance may be lowered.

In the case of Emotional Processing, results show that in case an individual reports high levels of anxiety either at the Core Anxiety or the Specific Anxiety questionnaire, the matched condition benefits his/her performance ($F_{(2,\ 81)}$=4.357, p=0.042).

	Match Score	Match n	Mis-match Score	Mis-match n	F	Sig.
CS	66.53%	53	57.79%	61	6.330	**0.013**
CPSE	57.00%	41	48.93%	41	5.345	**0.023**
EP	57.91%	23	48.45%	29	4.357	**0.042**

Table 1. Differences of means for Cognitive Style and Cognitive Processing Speed Efficiency

The relatively small sample that falls into each category and its distribution hamper statistical analysis of the working memory (WM) parameter.
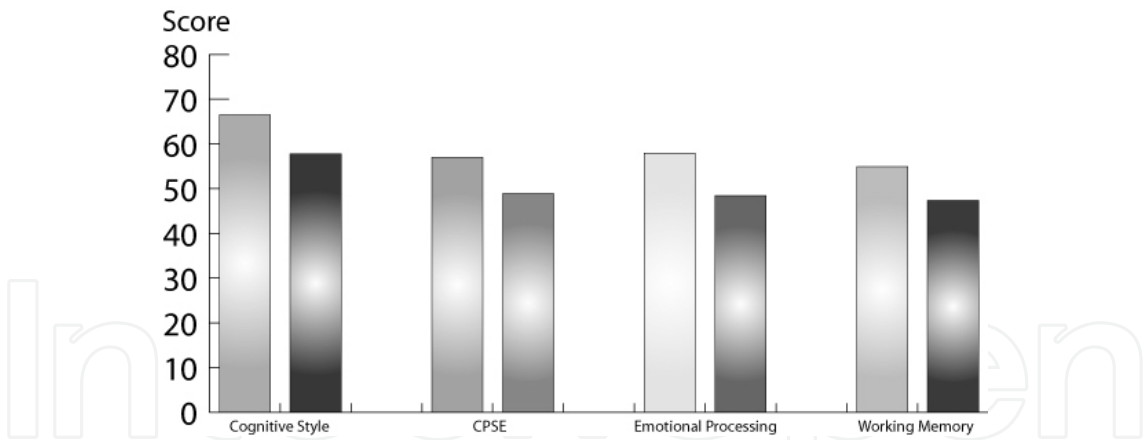

Fig. 6. Differences of matched and mismatched condition regarding each personalization parameter

In any case, the difference between those with high WM and those with low WM, when both categories receive non-segmented (whole) content, approaches statistical significance: 57.06% for those with High WM, 47.37% for those with Low WM, Welch statistic= 3.988, p=0.054. This demonstrates that WM has indeed some effect on an e-learning environment. Moreover, if those with low WM receive segmented information, then the difference of means decreases and becomes non-significant (57.06% for High WM, 54.90% for those with Low WM, Welch statistic=0.165, p=0.687). All the aforementioned differences between the matched and the mismatched condition are illustrated in Figure 6.

Correlations and Statistics of Emotional Processing Constructs

The emotional processing factor is discussed further due to the fact that it can be applied in various environments that relate to performance but do not require extended use of cognitive resources.

It is observed in Table 2 that all types of anxiety are positively correlated with each other and are negatively correlated with emotion regulation. These findings support our hypothesis and it can be argued that our theory concerning the relationship between anxiety and regulation has a logical meaning. There is also an even stronger relationship between emotion regulation and core ($F_{(2,92)}$=18.554, sig.=0.00) and specific anxiety ($F_{(2,92)}$=15.226, sig.=0.00) respectively. This statistically significant analysis of variance for each anxiety type shows that if participants are categorized according to their emotional regulation ability, then the anxiety means vary significantly with the high regulation group scoring much higher than the low one. Finally, table 3 demonstrates that the two conditions (matched aesthetics/mismatched aesthetics) are differentiating the sample significantly always in relation with performance. Participants in the matched category scored higher than the ones in the mismatched and additionally lower anxious (core or specific or both) scored higher than high anxious, always of course in relation to match/mismatch factor.

	Core Anxiety	Application Specific Anxiety	Current Anxiety	Emotion Regulation
Core Anxiety	1	**.613(**)**	**.288(**)**	**-.569(**)**
Application Specific Anxiety	.613(**)	1	**.501(**)**	**-.471(**)**
Current Anxiety	.288(**)	**.501(**)**	1	-.094
Emotion Regulation	-.569(**)	**-.471(**)**	-.094	1

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

Table 2. Correlations of types of anxiety and emotion regulation

Dependent Variable: Score %

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
	(a)				
Matched Aesthetics	1097.361	1	1097.361	4.238	**.043**
core_groups* specific_groups* Matched Aesthetics	983.259	1	983.259	3.797	.055

(a) R Squared = .102 (Adjusted R Squared = .017)

Table 3. Multifactorial ANOVA (Factors - Core Anxiety, Application Specific Anxiety and Aesthetics)

We also found that participants with low application specific anxiety perform better than participants with high specific anxiety in both matched and mismatched environments. Additionally, in categories that a certain amount of anxiety exists, match-mismatch factor is extremely important for user performance. Participants with matched environments scored highly while participants with mismatched environments had poor performance. Emotion regulation is negatively correlated with current anxiety. High emotion regulation means low

current anxiety and low emotion regulation means high current anxiety. Finally, current anxiety is indicative of performance. High current anxiety means test scores below average while low current anxiety means high scores.

5. Conclusion and future work

Considering the user as a vital part of computer-mediated systems may improve the quality of services offered, especially if the aim is learning or higher order information processing is involved. It makes sense that if one examines the characteristics of a device or the location of the user in providing eServices, the same should be applied with the case of human factors. In the same way that a device has a certain processing ability, individuals differ in their perceptual and processing preferences and abilities. Therefore, it could be supported that an essential part of HCI are the users themselves.

In this chapter a new approach in the field of adaptive hypermedia is described, which integrates cognitive and mental parameters and attempts to apply them on a Web-based learning environment. The approach emphasizes on human factors that influence the visual and mental processes that mediate or manipulate new information that is received and built upon prior knowledge, respectively different for each user or user group. The goal of the proposed approach is to improve learning performance and, most importantly, to personalize Web-content to users' needs and preferences, eradicating known difficulties that occur in traditional approaches. An innovative Adaptation and Personalization Web-based System has been build and presented in the chapter incorporating the *User Perceptual Preferences*, that serve as the primal personalization filtering element. This chapter also presents the results that are gathered from experiments conducted throughout the assessment procedure, in order to clarify at some extent whether such a combination of human factors is of importance in the area of educational adaptive hypermedia.

The empirical study on the field of e-learning presented above demonstrates that an "intrinsic" context aware application (in our perspective) is proven helpful for users and an actual benefit is objectively measured. All things considered, such a statistically significant effect that is consistent to the psychological theories supporting it is rather encouraging for the notion of expanding individual differences theories to various research areas.

The next step of our work, is the integration of the remaining parameters of our proposed model as personalization factors in e-learning environments. With regards to emotional processing, we are setting out a research framework that involves the use of sensors and real-time monitoring of emotional arousal (Galvanic Skin Response and Heart Rate) (Psaltis & Mourlas, 2011).

Thus, describing the user, he/she requires a multi dimensional model of representation, which should incorporate cognitive and emotional characteristics that seem to have a main effect in interacting with applications that involve information processing. It is not argued of course that demographical and "traditional" profiling characteristics are of lesser importance; our proposed model could have a modular role in a setting that defines context in a variety of ways, by adding another dimension focused on intrinsic processes.

At this point of research, it seems that these differences are indeed important, and the way that theory was put into practice in our system did seem to be functional. There are of course many

considerations regarding the generalization of this approach, and further experimental evaluation is required; still, especially within an educational environment, we have clear indications that user's intrinsic characteristics may be used in a meaningful manner.

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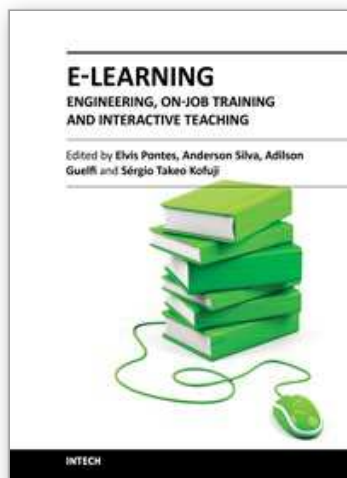
E-Learning - Engineering, On-Job Training and Interactive Teaching

Edited by Dr. Sergio Kofuji

Adaptive E-learning was proposed to be suitable for students with unique profiles, particular interests, and from different domains of knowledge, so profiles may consider specific goals of the students, as well as different preferences, knowledge level, learning style, rendering psychological profile, and more. Another approach to be taken into account today is the self-directed learning. Unlike the adaptive E-learning, the Self-directed learning is related to independence or autonomy in learning; it is a logical link for readiness for E-learning, where students pace their classes according to their own needs.This book provides information on the On-Job Training and Interactive Teaching for E-learning and is divided into four sections. The first section covers motivations to be considered for E-learning while the second section presents challenges concerning E-learning in areas like Engineering, Medical education and Biological Studies. New approaches to E-learning are introduced in the third section, and the last section describes the implementation of E-learning Environments.

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