

## **Personalizing the Web Content on User Perceptual Preferences**

**Nikos Tsianos, Panagiotis Germanakos, Zacharias Lekkas, Costas Mourlas**

(Department of Communication and Mass Media, University of Athens, Greece  
{ntsianos,pgerman,mourlas}@media.uoa.gr)

**Abstract:** This paper introduces a new model of personalized usage of the internet that is based on technologies of user representation, artificial intelligence and semantic augmentation of the content. By taking advantage of internet's unprecedented dynamics, compared to traditional media, this user representation model incorporates cognitive, mainly, psychology theories, combined with parameters that constitute more traditional approaches in user profiling (such as demographics, expertise, etc).

The purpose of this research is to alleviate difficulties that massive approaches impose on areas such as education and information processing, by integrating intelligent adaptive characteristics into web applications; this can lead to a highly adapted to each user's needs content and more effective, in our case, learning.

**Keywords:** Hypermedia systems, Web-based services, XML, Semantic Web, Multimedia

**Categories:** E.1, J.4, H.5.2, H.5.4

### **1 Introduction**

It is a fact nowadays that the number of web-pages and information available in the internet is such that it has gradually become very difficult for users to reach information they actually seek out [De Bra, Aroyo & Chepegin, 04]. As a result, designers of intelligent systems have introduced the term of Adaptive Hypermedia, in order to optimize navigation and content provision processes, as a response to the aforementioned innate difficulties.

A system can be classified as an Adaptive Hypermedia System 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 part of the system based on the information maintained in the user-model [Eklund & Sinclair, 00; Brusilovsky & Nejd, 04; Brusilovsky, 96b].

In 1996, Brusilovsky identified four user characteristics to which an Adaptive Hypermedia System should adapt [Brusilovsky, 96b; Brusilovsky, 01]. These were user's knowledge, goals, background and hypertext experience, and user's preferences. In 2001, further two sources of adaptation were added to this list, user's interests and individual traits, while a third source of different nature having to deal with the user's environment had also been identified.

---

The project is co-funded by the European Social Fund and National Resources (EPEAEK II) PYTHAGORAS

Generally, Adaptive Hypermedia Systems can be useful in application areas where the hyperspace is reasonably large and the user population is relatively diverse in terms of the above user characteristics [Brusilovsky, 01; Brusilovsky, 96a; Brusilovsky & Nejd, 04; Brusilovsky, 96b]. A review by Brusilovsky has identified six specific application areas for adaptive hypermedia systems since 1996 [Brusilovsky, 01]. These are educational hypermedia, on-line information systems, information retrieval systems, institutional hypermedia and systems for managing personalized view in information spaces. Educational hypermedia and on-line information systems are the most popular, accounting for about two thirds of the research efforts in adaptive hypermedia.

Furthermore, speaking in terms of traditional media, generalizing in the level of an Adaptive Web, such architecture makes possible the personalization of each “message”; this is undoubtedly an important step ahead if compared to a general classification of similar user groups that an audience reception theory [Morley, 80] from traditional media studies would perhaps lead to. The main difference is that in the case of personalized content provision, users not only project their personal characteristics on information, but actually receive what they actually are interested in; even more importantly, when more implicit cognitive and emotional processes are involved, users are provided with content and navigational tools that match their individual traits and preferred (consciously or not) ways of receiving and processing information.

The goal of our research is to integrate individual cognitive and emotional characteristics, which we refer to as User Perceptual Preferences Characteristics, as main parameters into the adaptive system we have already developed. Our system, though it concerns web personalization in general, focuses on educational purposes for experimental reasons, and its personalization mechanism relies exactly on mapping the provided content and navigational patterns on each user’s preferences and inclinations.

## 2 User Perceptual Preferences Characteristics

User Perceptual Preferences Characteristics is the new (as compared to traditional approaches) component / dimension of a comprehensive user profile we have built and are in the process of evaluating. This model embraces visual attention and cognitive processes (including emotional parameters) that could be described as user “perceptual and information processing preferences or abilities”, aiming to enhance learning efficacy.

User Perceptual Preferences could be described as a continuous mental process, which starts with the perception of an object in the user’s attentional visual field, and involves a number of cognitive, learning and emotional processes that lead to the actual response to that stimulus [Germanakos et al, 07] (figure 1).

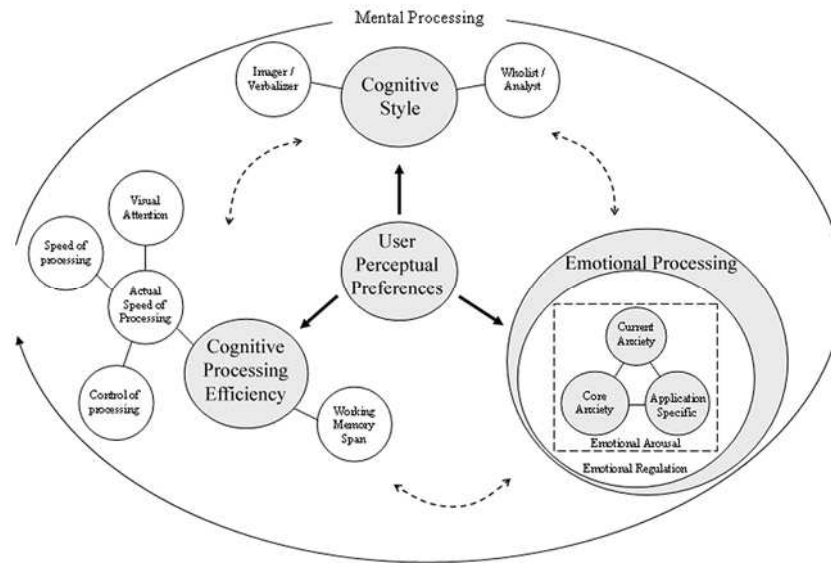


Figure 1: User Perceptual Preference Characteristics – Three-Dimensional Approach

This model's primary parameters formulate a three-dimensional approach. The first dimension investigates the visual and cognitive processing of the user, the second his / her learning style, while the third captures his / her emotionality during the interaction process with the information space.

## 2.1 Learning Styles

Within the context of educational psychology, theories of learning and cognitive styles have been developed, addressing the issue of individual differences in learning, or more specifically, the perception, processing and retaining of information. Cognitive styles have been defined by Messick as “consistent individual differences in preferred ways of organising and processing information and experience”, while by Sternberg and Grigorenko as “a bridge between what might seem to be two fairly distinct areas of psychological investigation: cognition and personality” [Sadler-Smith & Riding, 99]. Learning styles, as a term, are frequently used interchangeably with cognitive styles, but in general are broader concepts that incorporate a greater number of not mutually exclusive characteristics, and focus on learning than cognitive tasks [Cassidy, 04].

Taking into account individual cognitive and learning styles is of high importance, since such an approach “can lead to new insights into the learning process, a greater knowledge of individual differences, and an expanding repertoire of methods for the teacher” [Banner & Rayner, 00].

Regarding the hypermedia information space, amongst the numerous proposed theories of individual style, we consider that Riding's Cognitive Style Analysis [Riding, 01] and Felder / Silverman's Index of Learning Style [Felder & Silverman, 88] implications can be mapped on the information space more precisely, since they

are consisted of distinct scales that respond directly to different aspects of the Web space. Still, one must be cautious about reliability and validity issues of such psychometric tools, since many of them often fail to exhibit satisfactory results; that may be true for the case of Felder/Silverman's ILS, that perhaps should be further evaluated [Markham, 04], without of course neglecting the authors' reliability and validity reports [Felder & Spurlin, 05].

On the other hand, learning style theories that define specific types of learners, as Kolb's Experiential Learning Theory [Kolb & Kolb, 05], have far more complex implications, since they relate strongly with personality theories, such as the MBTI [Myers Briggs et al, 98], and therefore cannot be adequately quantified and correlated easily with Web objects and structures. For example, being a "converger" according to Kolb's typology or a "judging" person (from a personality psychometric tool aspect) has implications that are more dominant in a traditional social learning environment than in a hypermedia environment. The case of collaborative learning may provide the basis for assessing the role of such learning styles in performance, but is the beyond the scope of our present research.

As part of our research, we did find significant correlation between academic performance and adaptation on specific learning style [Tsianos, Germanakos & Mourlas, 06], though we now have implemented Riding's typology implications in our current hypermedia application, rather than Felder's that we firstly used. Part of our research is to examine whether such results can be repeatedly found, in order to support the importance of learning and cognitive styles.

We use Riding's CSA since it can be applied on most cognitive informational processing tasks (rather than strictly educational), the implications are quite clear in terms of hypermedia design (visual/verbal content presentation and wholist/analyst pattern of navigation), and is probably one of the most inclusive theories, since it is actually derived from the common axes of a number of previous theories.

## 2.2 Cognitive Parameters

We refer to the term visual attention in the sense of tracking user's eye movements, and in particular scanning his / her eye gaze on the information environment [Gulliver & Ghinea, 2004]. Our prime concern is identifying the parts of information that are of main interest to the user, depending on his prior knowledge.

Visual attention is composed of two serial phases: the pre-attentive and the limited-capacity stage. The pre-attentive stage of vision subconsciously defines objects from visual primitives, such as lines, curvature, orientation, colour and motion and allows definition of objects in the visual field. When items pass from the pre-attentive stage to the limited-capacity stage, these items are considered as selected. Interpretation of eye movement data is 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. Regarding the role of visual attention, we intend to extent our research to that direction with the use of the eye tracking tool.

Cognitive Processing parameters could be primarily summarised in (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) working memory (refers to the processes that enable a person to hold information in an active state while integrating it with other information until the current problem is solved) [Demetriou et al., 93; Demetriou & Kazi, 01].

At this point, we have calibrated the psychometric tools that we use to measure these parameters, and we have preliminary results that show statistically significant correlations with academic performance. As expected by theory, proper personalizing techniques (like reducing the volume of information in case of low memory and processing abilities) have indeed optimized performance.

### 2.3 Emotional Processing

On the basis of the research conducted by Goleman [95], as well as Salovey & Mayer [90], who have introduced the term, we developed an Emotional Control questionnaire that examines the 3 out of 5 scales that comprise the Emotional Intelligence construct (according to Goleman), since factors that deal with human to human interaction (like empathy) are not present in our Web- applications - at least for the time being.

However, this indirect measurement of a (moderated) person's emotionality does not address emotions and their effect on performance. In terms of actual emotions that affect academic performance, bibliographic research has shown that anxiety is often correlated with academic performance [Cassady, 04], as well with performance in computer mediated learning procedures [Smith & Caputi, 05; Chang, 05]. Subsequently, different levels of anxiety should have also a significant effect in cognitive functions.

The concept of general anxiety is indicative of a person's tendency to exhibit lower performance in information processing tasks, but not all circumstances are the same. For that reason, we measure not only one's general (core) anxiety, but also application specific anxiety and his current self-reported anxiety. In our experimental case, application specific anxiety is measured by a questionnaire that refers to educational test anxiety, while users can self-report their levels of anxiety using an indicative bar that is embedded in the interface.

Thus, we refer to anxiety as the basic component of the generalized concept of Emotional Arousal. However, we do not by any means consider anxiety as the sole predictor of the effects of emotions on academic performance; this is why figure 1 illustrates Emotional Arousal as an area, that even though it is dominated (research wise) by the aforementioned concepts of anxiety, the role of additional emotions is also implied.

Moreover, we believe that combining the level of anxiety of an individual with the moderating role of Emotional Control, it is possible to clarify, at some extent, how affectional responses of the individual hamper or promote learning procedures. By personalizing the educational content that our already developed adaptive system provides on the basis of this concept of emotionality, we can avoid stressful instances and take full advantage of his / hers cognitive capacity at any time.

Emotional Control and Emotional Regulation (generalized concept) maintain the same relationship that characterizes Emotional Arousal and anxiety. Emotional Regulation is not a process that can be completely analyzed with tools derived from EQ theories; consequently, though the concept of Emotional Control offers a practical

and useful tool, the area of Emotional Regulation (see figure 1) represents wider and more elaborate processes, that in terms of psychometrics can be indirectly measured through the concept of Emotional Control.

At a practical level, we assume that users with high anxiety levels lacking the moderating role of Emotional Control are in a greater need of enhancing the aesthetic aspects of our system, while users with low anxiety levels focus more on usability issues.

The empirical research we conducted provided us with indications that Emotional Control and Anxiety correlate in a way that supports our assumptions [Lekkas et al, 07]- moreover, unpublished results provide even greater support to our approach, though at this point we are in the phase of analysis and interpretation of the data.

### 3 User Profiling and Data- Implication Correlation

The construction of users' profiles includes a series of psychometric instruments that reveal their perceptual characteristics. As mentioned above, we use:

- Riding's CSA for the Learning/ Cognitive Styles dimension
- A series of real-time measurements for the Cognitive Parameters (Speed of Processing, Control of Processing, Working Memory and Visual Attention), similar to tests developed on the E-prime platform.
- The Emotional Control 27 item questionnaire we have developed (Cronbach's alpha 0.76), and i) the Test Anxiety Inventory [Spielberger & Vagg, 95] to measure application specific anxiety (educational process in our case) and ii) the State-Trait Anxiety Inventory [Spielberger, 83] to measure general (core) anxiety.

Moreover, while users navigate through our application, they can make use of an anxiety bar, which is part of the interface, in order to self-report feelings of inconvenience and high levels of anxiety that burdens their cognitive effort. This self-report measure will be correlated with general and application specific levels of anxiety in order to clarify the extent of their correlation, and the further optimization of the psychometric process.

The representation of the user model requires the use of meta-data that provide hierarchically structured information about users' characteristics [Germanakos et al, 07]. The tree-structured approach we have adapted is shown in figure 2. It should be mentioned that this diagram focuses on cognitive and emotional characteristics, rather than the traditional ones, that may have a high degree of application specific flexibility and are presented here synoptically.

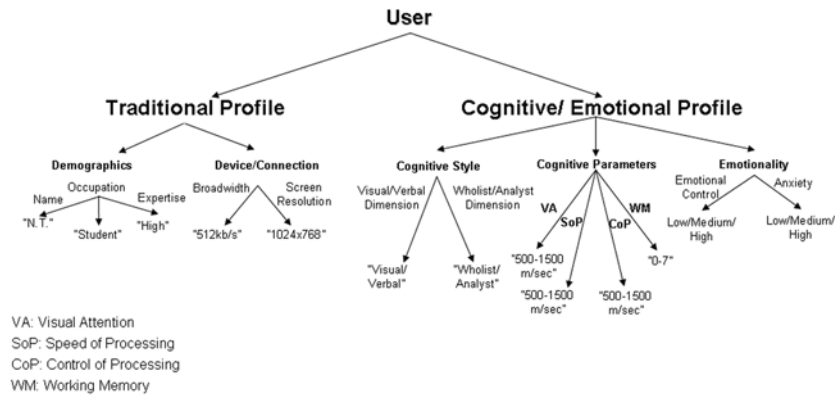


Figure 2: Tree Structure of User Profile

A practical example of data-implications correlation could be as follows, a user might be identified that is: Verbalizer (V) – Wholist (W) with regards to the Learning Style, has an Actual Cognitive Processing Speed Efficiency of 1000 msec, and a fair Working Memory Span (weighting 5/7), with regards to his / her Cognitive Processing Speed Efficiency, and (s)he has low Emotional Processing. The tags affected, according to the rules created and the Data – Implications Correlation, for this particular instance are: *Images* (few images displayed), *Text* (any text could be delivered), *Info Quantity* (less info since his / her cognitive speed is moderate), *Links – Learner Control* (less learner control because (s)he is Wholist), *Additional Navigation Support* (significant because (s)he has low emotional processing), and high *Aesthetics* (to give more structured and well defined information, with more colors, larger fonts, more bold text, since (s)he has low emotional processing).

At this point it should be mentioned that in case of internal correlation conflicts primary implications take over secondary ones. Primary implications are those correlated with high degrees of anxiety and the lack of Emotional Control, that by definition interfere with cognitive processing at all levels, regardless of the aforementioned perceptual inclinations. Additionally, since emotional processing is the most dynamic parameter compared to the others (users may take advantage of the anxiety bar if they wish), 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.

#### 4 Adaptive IntelliWeb and Future Work

In support of the aforementioned concepts and user profiling model, we have implemented our theoretical approach into a web application that we refer to as Adaptive IntelliWeb. This is the main component of our AdaptiveWeb System<sup>1,2</sup>,

<sup>1</sup> <http://www3.cs.ucy.ac.cy/adaptiveweb/>

<sup>2</sup> The system will be demonstrated in the UM 2007 Conference



responsible for adapting the content according to users' profiles (personalization). Using this framework, users can navigate through all personalized web sites; it also provides extra navigation and learner control tool to help users comprehend the personalized content in the most optimized way.

The Semantic WebEditor is an equally important component of the system, since it provides an interface for building web-sites that offer personalization. At this point, this editor is still under development. The Profile Construction application includes all the psychometric tools mentioned above, plus the traditional profile building procedure, and automatically creates the meta-data enriched user profile, necessary for the mapping process that takes place in the Adaptive IntelliWeb. Our system has been developed on the .Net framework.

As depicted above, we have focused on the educational aspect of personalization, since it provides an excellent basis for examining in depth the role of cognitive and emotional parameters, and the success of the personalizing process can be assessed in terms of learning performance, rather than simply measuring user satisfaction.

The Data- Implications Correlation that we have described above defines in fact the adaptation rules that alter the content presentation and navigational tools and support within the context of our e-learning application.

Consequently, our future work focuses on conducting a number of experiments for further assessing the weight of each factor involved in the learning process, and the actual impact of personalization in optimizing learner performance.

## 5 Conclusions

User profiling is a basic prerequisite for exploiting internet technologies that, by allowing a new way of distributing information, enhance the effectiveness of this medium. Towards perhaps a new form of the Web, we argue that when information processing (at a considerable extent) is involved, users' intrinsic perceptual preferences should be taken into account, in order not only to alleviate navigational difficulties, but to ensure the effective role of this medium in multiple information-based activities.

In any case, intelligent systems seek out to bridge human to human with human to computer interaction, and educational or learning computer-mediated processes should move to this direction. The one-size-fits-all approach seems rather obsolete when adaptation techniques have been developed at a level that permits the implementation of psychology theories that deal with individual differences and preferences. Consequently, if within the context of a traditional classroom learners are dealt as individuals, an absolutely massive approach in the hyperspace seems less pedagogical viable.

The main challenge, of course, is the quantification of the value each user characteristic takes both in personalization and academic achievement weights; empirical research on the basis of our AdaptiveWeb platform is expected to provide such answers.



## References

- [Banner & Rayner, 00] Banner, G. & Rayner, S., Learning language and learning style: principles, process and practice. *Language Learning Journal*, Summer 2000, 21: 37-44.
- [Brusilovsky, 01] Brusilovsky P., Adaptive Hypermedia, *User Modeling and User-Adapted Interaction* 11: 87-110.
- [Brusilovsky, 96a] Brusilovsky P., Adaptive Hypermedia: an attempt to analyse and generalize, In P. Brusilovsky, P. Kommers, and Streitz (Eds.), *Multimedia, Hypermedia, and Virtual Reality*, Berlin: Springer-Verlag, 288-304.
- [Brusilovsky, 96b] Brusilovsky P., Methods and techniques of adaptive hypermedia, *User Modeling and User Adapted Interaction*, 1996, v6, n 2-3: 87-129.
- [Brusilovsky & Rayner, 04] Brusilovsky P. & Nejdil W., *Adaptive Hypermedia and Adaptive Web*, © 2004 CSC Press LLC.
- [Cassady, 04] Cassady, C.C., The influence of cognitive test anxiety across the learning-testing cycle, *Learning and Instruction* 14: 569-592.
- [Cassidy, 04] Cassidy, S., Learning Styles: An overview of theories, models, and measures. *Educational Psychology*, 24 (4): 419-444
- [Chang, 05] Chang, S. E., Computer anxiety and perception of task complexity in learning programming-related skills, *Computers in Human Behavior* 21: 713-728.
- [De Bra, Aroyo & Chepegin, 04] De Bra, P., Aroyo, L. & Chepegin, V., The Next Big Thing: Adaptive Web-Based Systems, *Journal of Digital Information*, 5 (1), article n. 247, <http://jodi.tamu.edu/Articles/v05/i01/DeBra>.
- [Demetriou et al, 93] Demetriou, A., Efklides, A. & Platsidou, M., The architecture and dynamics of developing mind: Experiential structuralism as a frame for unifying cognitive development theories. *Monographs of the Society for Research in Child Development*, 58 (Serial No. 234), 5-6.
- [Demetriou & Kazi, 01] Demetriou, A. & Kazi, S., Unity and modularity in the mind and the self: Studies on the relationships between self-awareness, personality, and intellectual development from childhood to adolescence. London: Routledge.
- [Eklund & Sinclair, 00] Eklund J. & Sinclair K., An empirical appraisal of the effectiveness of adaptive interfaces of instructional systems. *Educational Technology and Society* 3 (4), ISSN 1436-4522.
- [Felder & Silverman, 88] Felder, R.M. & Silverman, L.K., Learning and Teaching Styles in Engineering Education, *Engineering Education* 78: 674-681.
- [Felder & Spurlin, 05] Felder, R.M. & Spurlin, J., Applications, Reliability, and Validity of the Index of Learning Styles, *International Journal of Engineering Education*, v. 21, n. 1: 103-112.
- [Germanakos et al, 07] Germanakos P., Tsianos N., Lekkas Z., Mourlas C., & Samaras G, Capturing Essential Intrinsic User Behaviour Values for the Design of Comprehensive Web-based Personalized Environments, *Computers in Human Behavior Journal*, Special Issue on Integration of Human Factors in Networked Computing. (to appear)
- [Goleman, 95] Goleman, D., *Emotional Intelligence: why it can matter more than IQ*, New York: Bantam Books.

- [Gulliver & Ghinea, 04] Gulliver, S.R. & Ghinea, G., Stars in their Eyes: What Eye-Tracking Reveals about Multimedia Perceptual Quality, *IEEE Transactions on Systems, Man and Cybernetics, Part A*, 34(4): 472-482.
- [Kolb & Kolb, 05] Kolb, A. Y. & Kolb, D. A., *The Kolb Learning Style Inventory – Version 3.1 2005 Technical Specifications*. Experience Based Learning Systems Inc.
- [Lekkas et al, 07] Lekkas Z., Tsianos N., Germanakos P. & Mourlas C., Integrating Cognitive and Emotional Parameters into Designing Adaptive Hypermedia Environments, In *Proceedings of the Second European Cognitive Science Conference (EuroCogSci'07)*, Delphi, Hellas, May 23-27, 2007. (to appear)
- [Markham, 04] Markham, S., *Learning Styles measurement: a cause for concern*, Technical Report, Computing Educational Research Group.
- [Morley, 80] Morley, D., *The 'Nationwide' Audience: Structure and Decoding*, London: BFI.
- [Myers Briggs et al, 98] MyersBriggs, I., McCaulley, M. H., Quenk, N. L. & Hammer, A. L., *MBTI Manual (A guide to the development and use of the Myers Briggs type indicator)*. Consulting Psychologists Press.
- [Riding, 01] Riding R., *Cognitive Style Analysis – Research Administration*, Published by Learning and Training Technology.
- [Sadler-Smith & Riding, 99] Sadler-Smith, E., Riding, R., *Cognitive Style and instructional preferences*, *Instructional Science*, 27, (3): 355–371.
- [Salovey & Mayer, 90] Salovey, P. & Mayer, J.D., *Emotional intelligence, Imagination, Cognition, and Personality*, 9, (3): 185-211.
- [Smith & Caputi, 05] Smith, B. & Caputi, P., *Cognitive interference model of computer anxiety: Implications for computer-based assessment*, *Computers in Human Behavior* 21, 713-728.
- [Spielberger, 83] Spielberger, C. D., *Manual for the State-Trait Anxiety Inventory (STAI)*. PaloAlto, CA: Consulting Psychologists Press.
- [Spielberger & Vagg, 95] Spielberger, C. D., & Vagg, P. R., *Test anxiety: A transactional process model*, In C. D. Spielberger and P. R. Vagg (Eds.), *Test anxiety: Theory, assessment, and treatment* (pp. 3-14). Washington, DC: Taylor & Francis.
- [Tsianos, Germanakos & Mourlas, 06] Tsianos, N., Germanakos, P. & Mourlas, C., *Assessing the Importance of Cognitive Learning Styles over Performance in Multimedia Educational Environments*, In *Proceedings of the 2nd International Conference on Interdisciplinarity in Education (ICIE2006)*, Athens, May 11-13: 123-130.