A LIGHT-WEIGHT FRAMEWORK FOR INCLUDING INDIVIDUAL STYLES IN E-LEARNING TOOLS

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ABSTRACT

Despite the advances in the context of Adaptive and Intelligent Web-Based Educational Systems, currently, almost all software for e-learning usually present contents in exactly the same fashion to all users, without taking into account their different learning styles. As a result, unstructured teaching models might gradually lead users to a chronic process of exclusion from the traditional approach to learning based on the interaction between the preceptor and the student. This paper introduces a novel approach that includes individuals' psychological characteristics in e-learning, so that applications can adapt the information presentation layer to the cognitive, perceptual and attitudinal requirements of each user. The design of the proposed framework is based on three major psychological theories, and it is consisent with current models of Adaptive e-learning applications. Our system aims at enriching the interaction dialogue by tailoring applications on individual styles. This may allow users enhance their learning performances and it may help them achieve better results, more quickly.

KEYWORDS

Advanced Distributed Learning, Experiential Learning, Learning styles, User Centred design.

1. INTRODUCTION

In conventional learning, teachers modulate both their interaction style and their language in order to provide each student with contents delivered in the most appropriate fashion for them. Conversely, e-learning lacks the guidance of a preceptor that shapes the way in which information is delivered to the individual user. Unfortunately, cognitive requirements are among the last characteristics that are considered in the design of computer-based instruction tools. Consequently, educational software rarely exploit the full potential offered by adaptation, which is typical of traditional teaching. Although current applications are highly customizable in terms of both higher-level interaction dynamics (e.g., interactive simulations) and features of the Graphical User Interface (e.g., look & feel), less attention is given to the inherent cognitive diversity within users' psychological profiles. Indeed, computer-based instruction may achieve better results by tailoring the way in which information is presented according to students' needs.
In this paper, we introduce a lightweight framework that incorporates Kolb's Experiential Learning Theory (ELT) (Kolb, 1984) in e-learning software. The proposed system recognizes the heterogeneity of users' psychological requirements, and it simultaneously reconfigures the interface in real-time, accommodating the cognitive, attitudinal and perceptual profiles of each user, and implementing a dedicated delivery strategy for the provision of educational contents.

2. USER MODEL

The first stage of our system is the identification of the main psychological characteristics of individuals, so that the application can segment users' population accordingly. In our design, the user model incorporates learning styles, perceptual preferences, and attitudinal behaviors (see Figure 2). Nonetheless, the challenge consists in realizing a coherent matching between such features. To this end, we employ Kolb's ELT, which

is based on Jung’s theory of types (Cambray). Kolb’s taxonomy of learning styles (i.e., Diverger, Assimilator, Converger, and Accommodator) defines a cycle of four stages (i.e., Concrete Experience - CE, Reflective Observation - RO, Abstract Conceptualisation - AC, and Active Experimentation - AE) which is the combination of the preferential cognitive pathways exploited by the learners’ mind in perceiving (i.e., acquiring) and processing (e.g., elaborating) information. The processing continuum corresponds to the introversion (I) – extraversion (E) and to the judging (J) – perceiving (P) dimensions of Jung’s theory; the perception continuum is associated to the sensing (S) – intuition (N) and to the feeling (F) – thinking (T) Jungian dimensions. In addition, the user model of our system includes the Visual Auditory Kinesthetic (VAK) model (Hawk et al., 2007), that represents the privileged sensory channels exploited by individuals in perceiving or processing the information.
Figure 1 shows the mapping between Kolb’s ELT, the VAK model, and Jungian personality dimensions. Although some people have a mixed and balanced blend of attitudes, usually, individuals have a dominant style that defines their personality, especially in learning (e.g., inductive or deductive). According to Kolb’s ELT, regardless of the phase in which students starts their experience (i.e., the preferred stage), all the other styles should be utilized to complete the learning process.

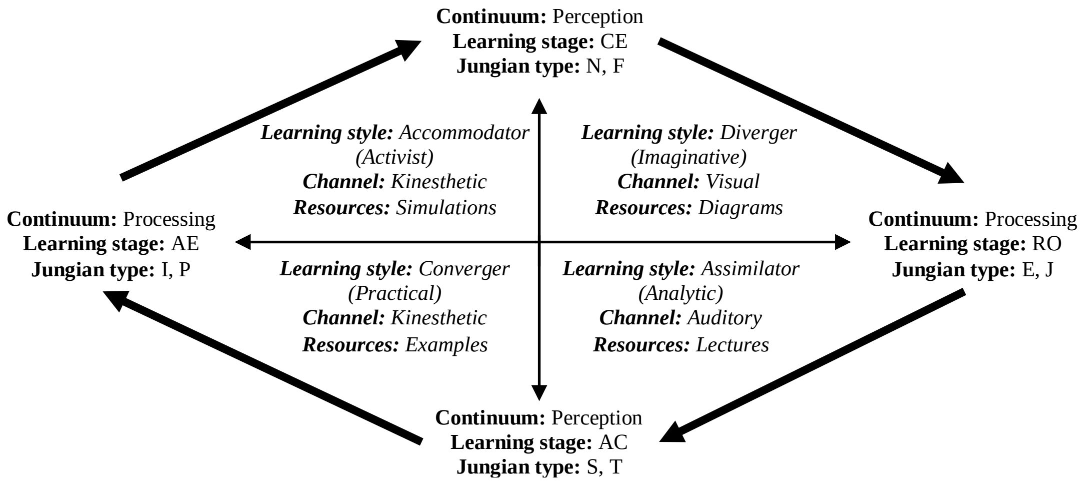

Figure 1. Kolb’s ELT integrates Jungian dimensions (such as sensing, judging, and perceiving) and sensory channels in a theoretical framework that defines an iterative process for enhancing students’ learning behavior.

3. SYSTEM ARCHITECTURE

Our work aims at designing applications that automatically adjust both the interaction semantic and the syntactic structure of the information presentation layer to the needs of the user. To this end, the proposed system for Personality-Aware Adaptive Distributed Learning consists of three components (see Figure 3):

- the Learning Content (i.e. conventional learning material such as texts, diagrams, images). It includes modular informative resources (Learning Objects, either individual or aggregated) tagged with metadata containing attributes whose values describe specific psychological dimensions of the target audience on a normalized scale (see Figure 2). Therefore, it is possible to associate a set of identifiers to each resource. For instance, lecture, papers, and analogies (i.e., text, speech, detailed descriptions) will be associated to individuals who prefer abstract conceptualization; conversely, case studies and demonstrations (i.e., simulations and games) will be tagged as contents for students who learn from active experimentation.
- the Learning Container (i.e., the macroscopic structure of the e-learning application). It specifies the high-level requirements of the e-learning application in terms of presentation style (e.g., user-driven or system-driven interaction, deductive or inductive teaching style). In addition, the Learning Container consists of Template Learning Objects (TLO) that define the interaction style of the virtual teacher (e.g., the teaching model, that can be user driven or system driven) and the page layout (i.e., the structural organization of Learning Objects on the computer screen) that are more

suitable for the learning attitude of each user. For instance, a Template layout designed for deductive visual learners will give more space to videos and images.

- the Learning Manager (i.e., the "intelligent" component of the system). It plays three crucial roles in our system. First, it elicits the psychological characteristics of the user. Then, it extracts learning resources from the contents repository according to the cognitive, the perceptual, and the attitudinal dimensions specified by the user model. Finally, it simultaneously reconfigures the interface and adapts it to the learning requirements of the student (see Figure 3).

In our system, annotations in the form of tags identify characteristics of both Learning Contents and TLOs. To this end, we employ an XML-based language for associating metadata to each resource (see Figure 2). Attributes represent the psychological dimensions of the potential target users for each informative resource in the contents repository. Contents are tagged by the multidisciplinary team of that contributes to the design of the learning material.

```
<LO ID="LP_video_04" name="Loan procedure" type="video" URL="/videos/LP_video_04.flv">
...
<audience ...>
  ...
  <measure dimension="cognitive" type="Kolb">
    <attribute type="Diverger">40</attribute>
    <attribute type="Assimilator">30</attribute>
  </measure>
  <measure dimension="attitudinal" type="MBTI">
    <attribute type="Intrroversion">-70</attribute>
    <attribute type="Intuition">20</attribute>
    <attribute type="Feeling">-10</attribute>
    <attribute type="Judging">40</attribute>
  </measure>
  <measure dimension="perceptual" type="VAK">
    <attribute type="Visual">90</attribute>
    <attribute type="Auditory">50</attribute>
    <attribute type="Kinesthetic">10</attribute>
  </measure>
  ...
```

Figure 2. Example of metadata describing a video file. All the attributes in each psychological dimension (measure) are represented as a percentage, and they describe the characteristics of the learning content.

4. RECONFIGURATION STRATEGY

Although inventories and questionnaires are widely utilized for psychological assessment, there are contrasting views about the reliability of self-reporting techniques (Caprara et al., 2000). Moreover, they might not be suitable for e-learning, as they introduce cognitive overhead, and individuals may feel uncomfortable with being tested. On the contrary, our system contains a preamble (i.e., a brief introduction) in which a carefully designed choice of different contents is presented on the screen in a mutually exclusive fashion (e.g., by showing resources on mouse over actions, and by blinding all other parts of the page). Thus, it is possible to track user's choices during the navigation. Features such as the time spent on each resource are evaluated, and contents' attributes (i.e., XML tags) are ranked according to users' preferences. Using this information, the Learning Manager disambiguates among learning styles, attitudes and perceptual preferences, and infers the user profile. Conversely, during the course, the Learning Manager applies a reconfiguration strategy to the information presentation layer so that users are provided with different instructional materials (i.e., Learning Content) that are selected and assembled into the most suitable Template Learning Objects according to the learning preferences elicited in the preamble. For instance, the Learning Manager will provide introverted-visual convergers with a different template with respect to extraverted-auditory assimilators. Specifically, it will present a choice of materials in parallel, using a student-driven approach, to convergers. Conversely, it will propose a teacher-driven sequence of concrete examples starting from a theoretical model, in the case of assimilators.

The objective of the system is two-fold: it aims at accommodating users' preferential styles and at improving their less utilized learning abilities. Therefore, the Learning Manages will modify the organization of the course so that the learning experience will start from users' preferred stage. Nonetheless, the layout of each page will be selected in order to encompass contents that enhance all the other less developed characteristics of individual users.

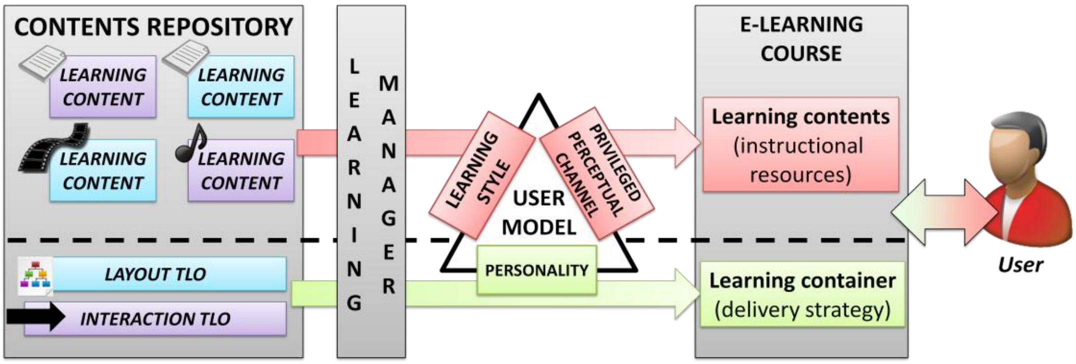

Figure 3. Overview of the architecture of the system. The Learning Manager plays the role of a filter that extracts the most appropriate resources from the contents' repository according to the model of the current user. Moreover, it reconfigures the information presentation layer of the learning container to provide learners with a delivery strategy which is specifically tailored for them.

5. CONCLUSION

Cognitive theories affirm that, by including users' learning styles, perceptual preferences and personality types in e-learning applications, it is possible to establish a more effective communication with students. Results of experimental studies (Caporusso, 2009) confirm that the proposed system can improve students' performances. The solution discussed in the present paper incorporates users' diversity, and includes psychological dimensions in e-Learning applications. Moreover, it has a modular structure that extends Brusilovsky's model adaptive hypermedia (Brusilovsky, 2004). Furthermore, the proposed system is compatible the IEEE LTSC Learning Object Metadata (LOM) (REFERENCE) and with the Audience tag of the Sharable Content Object Reference Model (SCORM) (Simões et al., 2004). Although we focused on e-learning, the collection of design patterns in our system can be applied to other domains without any change. The ultimate goal of our work is the development of a new generation of e-learning tools implementing virtual teachers based on empathetic agents that emulate humans. Moreover, such systems might be employed in the context of ambient assistive living, to provide company or assistance to the elderly or to subjects with impaired mobility.

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