

INCORPORATING LEARNING STYLES INTO THE USER MODEL

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In this paper, we show the main definitions of learning styles, and a summary of the opinions about the efficacy of learning styles. In addition, this paper explores the application of the Felder-Silverman learning style model to adaptive training courses delivered via the "World Wide Web". Due to the newness of the Web, its features, benefits, limitations and requirements as a delivery medium for distance learning are largely unstudied and unverified. This paper presents an attempt to incorporate learning styles in adaptive web-based systems and links it to the larger context of web-based education. In sum, this piece of research offers new ideas concerning an Adaptive Web-based Education system, which includes the extraction of student's learning styles preferences and then modifying the course presentation. We have implemented a prototype that adapts the course structure to the student learning style. We suggest the application of the results of the ILS questionnaire to automatically adapt some dimensions of the Felder-Silverman model to the course content and structure. The underlying idea of adaptive hypermedia based on learning styles is quite simple: adapt the presentation of course material so that it is more conducive to each student learning the course. This tailoring should allow for student learning in the shortest possible period of time. This approach has the effect of removing the impact of the instructor's learning and teaching style and allowing the student to see the material through the clear lenses of his own perspective and learning style.

1 From Teaching Style to Learning Style

In 80s, some experts in psycho-pedagogy began to place emphasis upon working with individuals' learning styles, and it is within this sub-category of design considerations that we find many notable examples. Among them we can select the work of Myers-Briggs (Myers-Briggs Type Indicator), Kolb (Kolb's Learning Style Model), Herrmann (Herrmann Brain Dominance Instrument), and Felder-Silverman (Felder-Silverman Learning Style Model), because of their significance.

In recognition of the fact that individuals learn in different ways, a body of research and technique has been developed that attempts to categorize individual variations while satisfying different learning style preferences. Learning style theory and practice is related to personality style (temperament) and attempts to place individuals within a grid that itself is a matrix of categories such as introvert/extrovert, active/passive, splitters/lumpers, thinking/doing, and other variables.

While its critics may claim that such classification systems oversimplify human variation, or even suggest that such variation should be overlooked in favor of one teaching technique (typically didactic), the general trend in education is towards the recognition of different learning styles and the development of methods for reaching more students through their personal styles.

Brown and Atkins [1] theorize that knowledge- seeking and -understanding are two approaches to learning, and the learner is in a continuous process between these two key orientations. A logical extension of their theory suggests that, at the very least, an educational course should be designed to satisfy the knowledge-seeking part of the student as well as that same student's need to comprehend and assimilate that knowledge.

By accepting this, the instructor or course designer will take care to address these different though complementary student objectives. Going beyond two different aspects of learning within each student, and looking instead at the different ways of learning of any population of students, is the concept of learning styles. With learning styles we move from content-based back to learner-based.

The concept of learning styles is difficult to define. The term itself implies student-centricity and is related to personality styles. Its counterpart in educational practice, teaching styles, implies teacher-centricity or content-centricity. Not surprisingly, there is no one definition of the meaning or the application of either of these phrases.

DeBello [7] offers a definition developed by the National Association of Secondary School Principals (U.S.A), which considers learning styles as "cognitive, affective, and psychological behaviors and which are relatively stable indicators of how learners perceive, interact with, and respond to the learning

environment.... [He also offers his own generic definition as] the way people absorb and retain information". (p. 2).

Dunn [8] defines learning styles as the way each learner begins to concentrate, process and retain unfamiliar, difficult information. Davidson [6] writes, "learning styles are the unique ways whereby an individual gathers and processes information and are the means by which an individual prefers to learn." (p. 36).

Merriam and Cafferella [13] define learning styles as "consistencies in information processing that develop in concert with underlying personality trends" which "encompass the ways people see and make sense of their world and attend to different parts of their environment." (p. 175)

"People learn in different ways. These differences depend on many things: who we are, where we are, how we see ourselves, and what people ask of us.... We hover near different places on a continuum. And our hovering place is our most comfortable place". (p. 3-4)

Not all researchers and practitioners agree that teaching to learning styles, or 'left-brainness' or 'right-brainness' helps students. Skeptics of applying learning styles in the classroom base their doubts on the mechanism for placing a person within a learning style category, the dearth of conclusive studies, and observations with young learners.

At present the application of learning styles is the topic of several discussions in the International Forum of Educational Technology and Society (IFETS), a subgroup of IEEE Learning Technology Task Force.

There are two core problems related to learning styles, firstly the definition of the concept. We understand learning styles as the student preferences in how to perceive and process information. We think that these preferences cannot be changed or can be changed only over a long period of time and that an instrument is necessary to measure and classify them. And secondly there remains the question of whether these learning styles can be applied to the process of learning. We believe that the course adaptation to the student learning style not only improves the process of learning but also the level of satisfaction and comfort of the student.

2 Incorporating Learning Styles into the User Model

Adaptive web-based education systems need four components: a user model, educational materials, a model of the content organization and relationships among the educational materials, and a strategy to select the order and type of these materials to achieve the optimal way of learning for each student.

Our work is focused in the student modeling and the technologies that allow us to adapt the course content and sequencing to the student model. With regard to the classification of Brusilovsky about the taxonomy of adaptive hypermedia technologies [2] [3], we use in this work some of the adaptive navigation support technologies such as adaptive link generation or adaptive link sorting.

The student model can be based upon a number of characteristics of the learner. The students' learning goals or knowledge level can be the basis for collecting data in a user model. Most adaptive learning systems get the conscious student information from the students themselves. Nevertheless, students are not aware of their learning styles and we need a questionnaire to identify them. This information should be integrated among other student characteristics in the user model, a basic component of any adaptive web-based education system.

From the point of view of how the system classifies students we can distinguish two main types of user modeling techniques: overlay modeling and stereotype user modeling. By overlay modeling, the user's state of knowledge is described as a subset of the expert's knowledge of the domain, hence the term "overlay". Comparing it to the expert's knowledge derives student's lack of knowledge. A stereotype user modeling approach classifies users into stereotypes. Users belonging to a certain class are assumed to have the same characteristics. Stereotype classification can be done for each adaptation feature [11].

Table 1. Corresponding features.

SENSING/INTUITIVE	CONTENT (CONCRETE/ABSTRACT)
VISUAL/VERBAL	PRESENTATION
ACTIVE/REFLECTIVE	PARTICIPATION (ACTIVE/PASSIVE)
SEQUENTIAL/GLOBAL	PERSPECTIVE
INDUCTIVE/DEDUCTIVE	ORGANIZATION

Obviously, we are using the stereotype user modeling because there is no perfect learning style. Learning styles is a question of preferences and our system must be able to adapt the course contents to these different learning styles. We think that a user model should include learning styles as a key factor to decide the course content sequence and structure. From a general point of view, the proposed mechanism consists in incorporating the learning style data obtained by means of the Index of Learning Styles Questionnaire [12] to the static user profile. We have established a relationship between Felder learning styles [9] and the web-based education features that could be adapted. Sequential/global dimensions affect to the “perspective” of the student, the point from where the student is looking at the course. Sequential learners prefer a closer looking while global learners prefer a looking from outside. Presenting the course in the preferred way may solve the problem of being lost in the hyperspace for sequential learners and the problem of lack of freedom for global learners.

Sensing/intuitive feature is related to the content, more accurately the kind of content presented. Sensing learners prefer presentation of explanations after exemplifications and vice versa for intuitive learners. It causes the necessity of relatively independence of explanation versus exemplification to carry out this adaptation. Visual/verbal is a difficult dimension to adapt in web-based education because while in sequential/global and sensing/intuitive dimensions the system adapts the course sequence, in visual/verbal the adaptation could cause the elimination of some material. Even if you could express the same content in both ways, through words and through images (something difficult to state a priori) we do not find any reason to do not present both formats in the same concept explanation or exemplification. Maybe the inclusion or not of images could depend on a great degree of technical requirements. The active/reflective dimension is studied deeper by other lines of research. These lines are related to Computer-supported cooperative work (CSCW) and groupware applications that are being explored nowadays.

The inductive/deductive dimension is eliminated of ILS for pedagogical reasons. We think that inductive/deductive is in essence very similar to sensing/intuitive and we do not estimate that the adaptation could be different from this dimension.

At present, some work has been done in order to automatically incorporate the above-mentioned considerations into an adaptive web-based learning system, the Task-based Adaptive learner Guidance On the Web, TANGOW [4]. This system allows for a flexible course structure and content representation, and makes it possible to take different user models’ features into account.

The whole process is depicted in figure 1. All necessary processing is done on the server side. Firstly, the student browses the ILS Questionnaire with any HTML browser. Then, the course structure retrieval module is used to access to the database of Web-based courses through SQL queries extracting the information about the information of the course the student is interested in. This procedure provides us with the course structure that is stored, already adapted to other static user features. Next, the adaptation module obtains the information of the course from this stored structure and the information about the student from the ILS Questionnaire. Depending on the ILS Questionnaire score, the course is adapted to the student learning style. Our prototype looks over the course and changes the structure according to some of the preferred learning style dimensions.

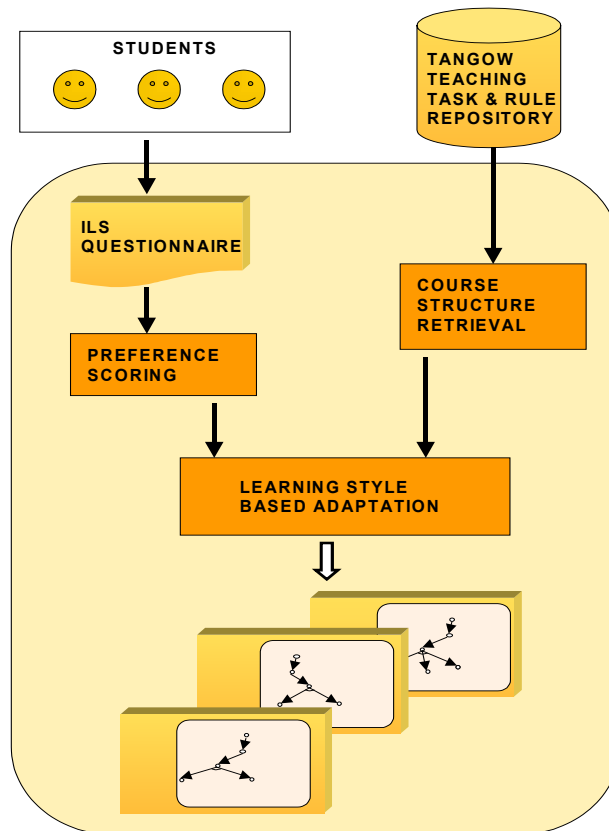


Figure 1. Structure of the prototype.

Finally, the feedback function returns the adapted structure of the course to the students. Also, the system informs the user about his/her preferred learning style and the structure and sequencing of the adapted course. This adaptation procedure can provide different students with different concept sequencing depending on the information obtained from the default course structure and the student preferred learning style. It means that our prototype dynamically generates a different course for students with different learning style.

3 Conclusions

We suggest the application of the results of the ILS questionnaire to automatically adapt some dimensions of the Felder-Silverman model to the course content and structure [14] [15] [16]. Although there are other systems that deal with learning styles, such as Gilbert and Han [10] or Carver et al [5], our system can also take into account the web-based features of content, presentation, participation, perspective and organization.

The incorporation of the static feature of learning styles to the user model has been proposed. In our approach, we are using the stereotype user modeling because there is no lack of knowledge. In learning styles there are just preferences for one or another dimension and all of them must be suited by the system.

Adaptive hypermedia systems can advantageously be used in education, especially in distance learning. The underlying idea of adaptive hypermedia based on learning styles is quite simple: adapt the presentation of course material so that it is more conducive to each student learning the course. This tailoring should allow for student learning in the shortest possible period of time. This approach has the

effect of removing the impact of the instructor's learning and teaching style and allowing the student to see the material through the clear lenses of his own perspective and learning style.

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