

# Adaptation in Intelligent Tutoring Systems: Development of Tutoring and Domain Models

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**Abstract.** This paper describes the aspects kept in mind for the development of the tutoring and domain models, of an Intelligent Tutoring System (ITS), where the instruction type that will give the tutoring system, the pedagogic strategies and the structure of the course are established. Also is described the software development process and their principal functions. This work is part of the research project that involves the adaptation process of the interfaces into Intelligent Tutoring Systems at the University of Sinu's TESEEO Research Group ([2]). The final objective of this work is to provide mechanisms for the design and development of system interfaces for tutoring/training, those are effective and at the same time modular, structured, configurable, flexible and adaptable.

**Keywords:** Adaptive Interfaces, Tutoring Model, Domain Model, Tutoring Intelligent Systems, Instructional Cognitive Theory.

## 1 Introduction

The accelerated rhythm of change presented in all the levels in our society, has placed in evidence the need to tighten the relation between teachers and students, in such a way that be fortified and that be done increasingly more real, contextualized and active. This has involved to that each one of the actors involved in the teaching-learning process performs new roles and acquire greater commitments.

Since the introduction of the information technologies in the teaching-learning process, the development of systems has been seeking to support all the process, since the so much perspective of the teacher one as of the student. In this search have been elaborated systems that, though they have served as additional component of the process, they do not pass to be multimedia tools that are limited to expose to student the concepts of determined subject in one static way and in many occasions little attractive. From there that, the evolution of the information systems applied in the education has been increasingly more innovative, since the point of view of the

design, navigability and usability so much for the administrator as for the user of the systems. The introduction of Internet in this environment has brought as consequence that the developers of these technologies implement Web applications that use simple interfaces and easy navigation.

Under these premises we have oriented our research toward the development of Web Adaptive Intelligent Interfaces, establishing user models that permit to the tutorial system be adapted to different students using adequate pedagogical strategies to each student style, seeking thus to fortify the existing relation between the technology and the learning process. For example the Honey and Munford [1] studies reveal that the learning depends on various personal factors that practically every individual possesses an own style and that this does not always remain invariable but can change with the time and to depend on the context of the educational tasks. Taking in account the experience of the studies before mentioned that promote the improvement of the quality of the education by means of the personalized learning, we examine the characteristics of some learning styles models in order to selecting the most appropriate one for the adaptation of the proposed system.

In our work the domain model of tutoring system is a fundamental piece, therefore is from the evaluation and feedback, that the system will be able to identify the degree of meaning that the student has respect to the course or thematic, and to leave from the results, to evaluate the tutoring strategy and its own performance, according to the student preferences and learning styles. The domain model is converted thus in the link among the user model (Description of the learning style and student preferences) and the tutoring model (Description of the processes and tools to utilize during the teaching).

Therefore to achieve the evaluation of the knowledge meaning, a contents design is required, that permit to tutoring system to know to priori a navigation map of the course and the fundamental concepts that the student should signify. To structure the course that will give the system, we have developed a simple web application, the content editor (EDC), which is a tool in which the content of the same one is described step by step, entering each nucleus and sub-nucleus, with the respective pre-requisite and co-requisite and from this description, that will carry out the educational one by means of the EDC, the system will extract the path rules through that they will describe the sequence that should continue the student.

We are waiting that our work contribute in the improvement of teaching-learning process of our students, be a tool of educational support, and that become a pillar of development of these technologies in the region like an alternative solution to the difficulties that should face the present student; mainly the homogeneous form as is transmitted the knowledge without attending to the individual differences.

## 2 Tutoring Model

When any system is personalised, is important have clear that a fundamental part is the user model, which in our case, they are supported in the Kolb learning cycle [2], Honey and Mumford learning styles[1] and in the Witkin cognitive theory [3,4],

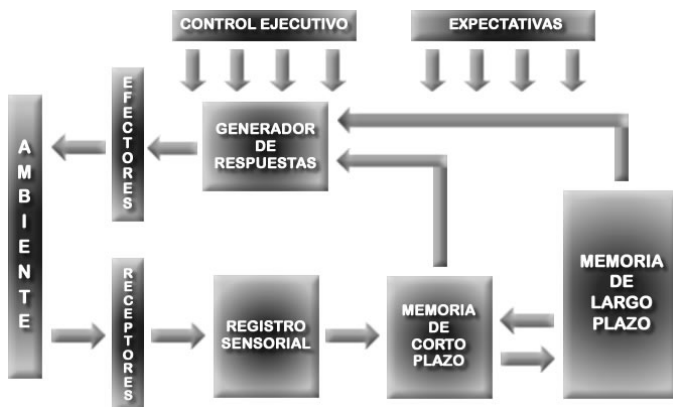
which is studied in [5]; but also one must keep in mind that, for a system as the we are proposing, another very important aspect is the tutoring model, where the pedagogical strategies are established and the type of instruction that will be used (depending on the learning style preferred by the student), also to this it concerns all the referring problems in the development of the curriculum or the program content and the teaching way, the same is involved with the selection and the sequence of the teaching material and the tools and components for instruction.

This model is based in the cognitive learning theories; these theories are very influential in the practice of the instructional design. The cognitive learning theory [6,7,8] generally corresponds to the rationalist philosophy and often seems compatible with the main principles in the constructivism. The difference of the cognitive theory compared with behaviour theory is that the cognitivists do a lot more emphasis in factors of the apprentice and little to the factors in the environment. That is the reason that we support our research in this trend, specifically in the Robert Gagné theory [9,10,11].

## 2.1 Robert Gagné Cognitivist Theory

This theory establishes that there are different types or levels of learning. The key aspect in this classification is that each level requires different type of instruction. Gagné [9,10] identifies 5 main categories of learning: Verbal information, Intellectual skills, Cognitiv strategies, and attitudes.

For each learning type are necessary different external and internal conditions. For example, so that the cognitive strategies are learned, there should be opportunity to practice the development of new solutions to the problems; to learn attitudes; the apprentice should be exposed to a credible model or with persuasive arguments. Also, Gagné describes five conditions or factors, that influence in the learning: Reception and registration of the information by means of the senses, Storage and recovery in the short and long time memory, Perception and expectations, Trial of the information and Executive control of cognition / executive strategies.



**Fig. 1.** Basic model of learning from Gagné

The Fig. 1 show like Gagné [13] understands the learning process. The model is extensively accepted for the process of design. The instructional designer sees his role as a supplier of environmental stimuli, carefully created to facilitate the long-range retention when the information enters the long-range memory, this is related to the existing information and worked with the pre-existing scheme, the instruction then measures the answer of the apprentice, which reflects the manipulation of the information that does the brain.

## 2.2 Tutor Roles

It is possible to affirm that the learning style is equal to teaching style. This has a clear consequence, if the instructor does not understand the relation between the teaching and learning styles, he teaches in an unconscious way according to his own style of learning. It turns out to be fundamental that the tutor, on the one hand identify its form to learn and by another know the styles of its students to adapt better its style of teaching al style of learning of those.

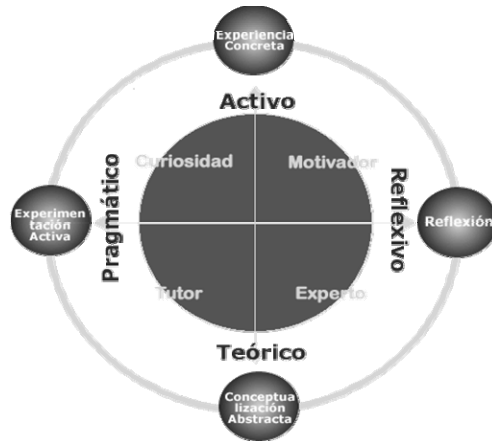
In our case, is important to clarify, that once identifying the levels of preference by each one of the styles of learning, the system will assume the roles according to each style, according to the priority of the same one.

We will utilize the definitions of relation among the Kolb and Money learning styles, and the roles for the tutor established in [14]. The four basic roles of the tutor, that the system will assume once identifying the style of learning of greater preference, are defined like:

- **Tutor.** This instructor type is a model to follow, teaches providing the necessary knowledge so that the students can think and to act. Applies the rule: Teaching through the personal example.
- **Motivator.** This instructor provides practical exercises, mixing real situations with virtual so that the students can create experiences and to reflect on them. The fundamental objective is to develop in the students the capacity for the independent action, the initiative and the responsibility.
- **Knowledge Expert.** The instructor should possess knowledge in an area of specific work, to provide all the information and experience required. Endeavours for maintaining the level of expert among the students by means of the unfold of knowledge detailed and challenging them to that reinforce their competences.
- **Curiosity.** The instructor that has behaviour as promoter of the curiosity, assigns challenges to student for the autonomous learning by exploration and discovery. The instructor aid to discover things to analyze the applications in complex and new situations.

We define in the Fig. 2, the basic roles of the tutor for each learning style:

Then is established that each style of learning of Honey-Alonso, needs two roles of the tutor for its efficient instruction, Combining the tools and materials of learning that utilizes each one and that better they adapt to their predominant style, without forgetting other activities and strategies that promote and maximize the other styles.



**Fig. 2.** Tutor Basic roles and their relation with Kolb learning cycles and learning styles of Honey-Alonso

### 3 Domain Model

The key to obtain improvement in the teaching-learning process is based in teaching the students how to learn in a significant way. In order to implementing this strategy, should be permitted to the student:

- To organize and/or to express new ideas.
- To understand and/or clarify concepts
- Deep in explanations.
- Increasing the retention of ideas and concepts.
- Processing, to organize and to prioritize the information.
- Integrating new elements to its base of know-how in a significant way.

And last but not least, to identify erroneous concepts. In our Intelligent Interface model this is a key aspect, from evaluation and feedback, the tutoring system could be to identify the learning grade that has the student and from results, to evaluate the tutoring strategy and their performance related to the adaptation level taking in account student preferences.

The domain model is the link between user model and tutoring model, therefore to achieve the evaluation of the learning of the knowledge, a contents design is required, that permit to tutoring system a priori know a course navigation map and the fundamental concepts that the student should to learn.

It is thus, like the domain model can be understood as the formal representation of the contents of the subject or course. Here the general structure is established, the description of the content of the subject that will do the educational one, which will be validated after to have defined the topics and sub-topics order in the area or course, in order that the tutoring system a priori has a navigation map.

In this model is involved the course organization and the actors and objects in the teaching-learning process: the teacher, who is the one that manages the course, the

course that is the course content related information, topic, shows the specific information of each one of the topics and sub-topics in the content; evaluation, That are exercises and information that the student should present to advance al next topic.

3.1 Contents Editor (EDC)

To structure the course that will give the system, we have developed a simple web application, which is a tool in which the content of the same one is described step by



Fig. 3. Course Creation

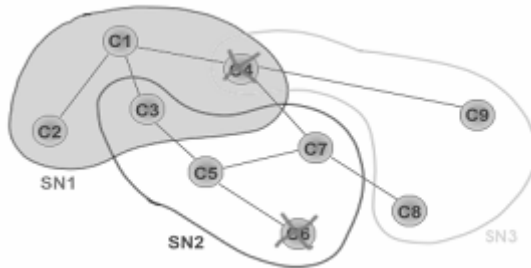


Fig. 4. Hierarchical structures of contents

step, incorporating each topic and sub-topic, with its respective pre-requisites and co-requisites (Fig. 3).

From this description, that will realize the tutor, the system will extract the travel rules through that will describe the sequence that should continue the student. The tutor establishes the content of the subject differentiating the following sections: units, topics, sub-topics and concepts. Initially al to create the course, the tutor will define the units that are in it. Continued it will indicate the topics and sub-topics pertaining to each unit and finally will enunciate the main concepts, . This it will be seen represented by the system as is illustrated in the Fig. 4.

Once it structured the course, the tutor should validate the restrictions for the concepts that understand each unit, establishing the type of relation among them. In agreement with the domain, will exist concepts that will do part of various sub-topics at time (Fig.5 ); is for this that depending on the results of an evaluation of the pre-concepts, the system will design the navigation with those contents that the student does not know or that still not know.



**Fig. 5.** Concepts distributed by topics

Then the evaluations will be able to do by topics and they will have as an objective to discover if the student has related the concepts; on another hand the games, exercises, discussions and other will have as end to discover if the concept is learned or not . This is another adaptation way that will implement our system, showing to each student the contents that in reality he needs to learn.

The previous thing, will be the final exit of all the adaptation process that will carry out the system; that is to say, after detected the predominant learning style, the system, according to it established in the tutoring model, chooses the roles of the tutor that should implement, as well as the tools and materials of adequate learning, and keeping in mind the structure of the definite course previously for the tutor, they will be presented to the student the contents of the subject according to their inclinations and preferences.

## 4 Conclusions

Keep in mind the goal of promoting learning, more active, effective and significative, our group is developing one intelligent and adaptive tutor system, based in personality

aspects and in the cognitive instructional theory. With the conjunction of these, a tool will be obtained that support al student during the acquisition of the knowledge, in a way personalized, being adapted to its individual form of learning.

The process described will be carry out, in the first place, through the identification of the style of predominant learning in each student, where the intention is that the system adapt to this, and present to him the contents of the subject of the most adequate form, keeping in mind inclinations and preferences marked by the learning style preferred, without forgetting those characteristics dictated by the other styles.

With this mechanism we are looking for that the student have a more active role in his education and that the tutoring system guide and re-direct its process of in a efficient way for the learning. We are trying to use Evolutionary Computation paradigm for the machine learning process that automated the user profile detection scheme [15].

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