THE ROLE OF LEARNING STYLES IN INTELLIGENT TUTORING SYSTEMS

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Abstract: The Bologna Process changes the educational paradigm, to be focus on the student and in the learning outcomes. The majority of e-learning platforms are used as mere repositories of content, based on the classroom paradigm and don't support the individualism of each student learning process. Through the integration of new pedagogical methodologies based on students learning styles, we present an approach to intelligent tutoring systems in order to improve the learning process. This article is focused on the importance of learning styles to create the student model in intelligent tutoring systems and what was the student's feedback about the adaptation of the system to each learning experience.

1 INTRODUCTION

E-learning is increasingly spread in various levels of education, whether in education support presence, either in the distribution of the distance courses.

The e-learning platforms today, known generically of virtual environments for learning, offer several features that allow the management of courses, communication and distribution of content.

The vast majority of the platforms are based on the paradigm of the classroom, where knowledge is transmitted the same way for all students. This paradigm uses the contents as the only means of transfer of knowledge.

The Bologna process that aims to create a European Higher Education Area by 2010, pretends to change this paradigm, in order that focus the educational process on the student and in the learning outcomes, reflecting the new demands of knowledge-based societies, which implies a more personalized education.

According to Dias (2004), building spaces for online learning is a challenge that goes beyond the simple transfer of content to the Web. This approach tends to transform the environments in online repositories of information and not in the desired spaces of interaction and experimentation.

To allow a greater adaptation of the learning environment based on the student's profile, it is proposed the adoption of theories of artificial intelligence in education, based on the experience of students so that the content and contexts of learning can be reused and adapted to new situations.

In the last three decades, the artificial intelligence has been adopted in various forms of education. The initial experience of adoption of artificial intelligence in education dating back to 1984. Several other approaches appeared in the adoption of artificial intelligence in education, and in 1988 one of the first architectures of intelligent tutoring systems was developed by Burn and Caps.

One of the most important issues in the adaptation of an intelligent tutoring system is the modulation of student behaviour in order to adapt the pedagogical model to the student model.

This adaptation to be more effective is necessary to identify the student profile, based on several parameters. One of the most important parameter is the student learning style. Each student has his own style of learning, which influences the collaboration during the learning process

In this context, the development of adaptive learning environments, based on the student profile, this type of systems can contribute to the change in

the educational processes, based on new pedagogical methodologies integrated with artificial intelligence techniques in order to provide learning environments adaptable to the needs of each student.

The main motivation of this work focuses on the development of intelligent tutoring systems, to improve the educational paradigm, considering the student learning style and the collaboration in the learning process.

2 LEARNING STYLES

The basic theory of learning styles is that different people learn in a different way. One way to see the learning styles is to connect them with the learning cycle advocated by Kolb (Kolb 1984), where learning is seen as a continuous process based on practical experience that incorporates a set of observations and reflections.

Later, this model was developed by Honey and Mumford (1986) creating a questionnaire of learning styles based on the model proposed by Kolb. It was identified by the authors four learning styles, related to the four stages of the learning cycle proposed by Kolb: activist, reflector, theorist and pragmatist.

Each learning style has the follow characteristics (Honey and Mumford, 1986):

• Activist - Students with an active style involve themselves fully and unreservedly in new experiences. Have an open mind, are optimistic, which makes them enthusiastic about something that is new. Tend to act first and consider the consequences later. They engage in many activities and when they lose the enthusiasm they change to another activity. The main philosophy is to try everything they can. They have great enthusiasm with the challenges of new experiences, but discourage with the implementation and consolidation of ideas. Tend to get involved in tasks with other people, but usually try all activities centred on them.

• Reflector - The reflector like to be more in the rear to observe and reflect on experiences from different perspectives. Collect data and prefer to think about that before making any conclusions. Its main philosophy is to be cautious. They are very balanced, preferring to consider all possible angles and implications before taking any action. They prefer to watch other people in action. The reflector people are by nature discreet.

• Theorist - People with a predominantly theoretical style incorporate comments into complex theories, but they are logical. They consider the problems on a vertical way, step by step and in a logical way. Assimilate facts based on consistent theories. The main philosophy is "if it is logical then it is good." They have an independent spirit and like to formulate principles, theories, models, assumptions and thoughts. The approach of the problems is mainly logic.

• Pragmatist - The pragmatists tend to experiment the ideas, theories and techniques for checking whether they work in practice. Having new ideas they seek for an opportunity to try it in practice. They are impatient in discussions with subjective or vague ideas. They are essentially practical and like realistic decisions to solve problems. The main philosophy is: "there is always a better way to do things" or "if it works then it's good."

The styles of learning have become increasingly important in education, given the change in the paradigm of education caused by the transition to the knowledge society. The lifelong learning paradigm leads to new learning context, which are increasingly more heterogeneous, where is important to take into account the learning styles of each student to provide an education more effective and focused on the student.

Figueiredo and Afonso (2005) consider the context and content as the key elements of the learning model. The learning model defines the learning activities as the situation in which individuals learn. The content is the information that is structured and consists of text, materials, multimedia resources and lecture. The context is a set of circumstances that are relevant to the student to build knowledge through its connection to the content.

In the model presented, the teacher has a bipartite role in the presentation of content and creating the learning context. The context can be a classroom or a virtual learning environment, in which the role of teacher is more focused on content in the case of a classroom, and the context in the case of a virtual learning environment.

The contents assume the role of transmission knowledge, where information is transformed into knowledge through a given learning activity.

The integration of intelligent systems in the learning support, allows an adaptation of content and contexts to the learning style of each student, providing adaptive tools to support collaboration (Lesgold et al. 1992, Goodman et al. 2003).

3 INTELLIGENT TUTORING SYSTEMS

The adoption of artificial intelligent in education has the goal to improve the learning process adapting the contents and the learning environment to the student profile. The student profile is based on his learning style, learning needs, goals and choices.

The first systems adopting artificial intelligent techniques were the Intelligent Tutoring Systems (ITS). Kearsley defined an intelligent tutoring system as an application of artificial intelligence techniques to teach students (Kearsley, 1987). Sleeman and Brown defined an intelligent tutoring system as a program that uses artificial intelligence techniques for representing knowledge and carrying on an interaction with a student. According to Sleeman and Brown, an intelligent tutoring system must have its own problem-solving expertise, its own diagnostic or student modeling capabilities, and its own explanatory capabilities (Sleeman & Brown, 1982).

One of the first architectures of a ITS system was presented by Burn and Caps in 1988. This architecture was based on four main components: curriculum module, student module, tutor (pedagogical module) and the interface module between the student and the system. This basic architecture was improved by several researchers, including Ong and Ramachandran in 2003, Thomas in 2003, Bass in 1998, Choquet et al. in 1998, Titter and Blessing in 1998 and Nkambou and Gauthier in 1996.

Modern intelligent tutoring system architectures (Figure 1) are very similar to the Burn and Caps proposed architecture. The four modules are represented frequently as the domain module, student model, pedagogical module and the interface module.

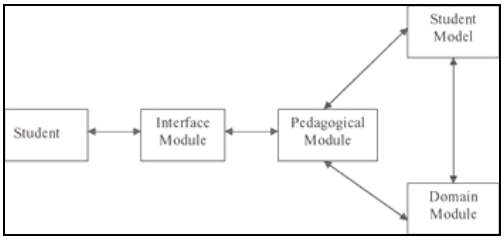


Figure 1: Components of an intelligent tutoring system (Ally, 2004).

The student has the main role in the intelligent tutoring system. All the features of the system have the mission to adapt the interface and the pedagogical material to the student profile and his preferences.

The domain module is a knowledge management system, storing all the concepts that the system pretends to transmit to the student.

Connected to the domain module are the student model and the pedagogical module. The student model represents the learner behavior, his profile, learning style, motivation level and his interests. This model is based on artificial intelligent skills that simulate the human behavior. All the student behavior is recorded in the system and used for "reasoning" and adapt the domain module to the leaner needs. The pedagogical module acts has a virtual instructor, presenting the contents in an appropriate sequence, based on the student skills and his learning style. This is an interactive process and this module has the mission to explain the concepts to the student given several points of view and supporting all the learning process.

With the capacity to communicate and interact with the student, the interface module has an extremely important mission. If one ITS had a powerful pedagogical, domain and student model, but the interface module is very poor, the ITS will not be effective because the interface is the front of all the system and has the ability to cap all the attention of the learner. To develop a good interface module is necessary to consider the usability issues of a user computer interface, because this module interacts with the user and the other components of the system. If the interface fails all the other modules fail too.

The type of intervention of the pedagogical module in the system is very important for the student creativity and motivation. Wenger considers that is more efficient to let the student search for the solution for one problem before make any intervention (Wenger, 1987).

In order to adapt the tutoring system to the learning needs, we propose the adoption of Learning styles to intelligent tutoring systems in order to provide a more effective adaptation, taking in consideration student motivation and the effectiveness of each learning tool according to the student learning style.

4 THE ROLE OF LEARNING STYLES IN ITS

The current generation of learning management systems is fundamentally based on the concept of

virtual classroom, allowing the distribution of contents and its discussion, but are still not very efficient in the collaboration.

The learning management systems, even those that are based on constructivist theory, where collaboration is essential, not suggest ways of adapting the learning process to specific needs of each student.

The next generation of e-learning platforms, it seems that this concept will changed, where the learning support it will be the most important component, leaving the teaching and production of contents as less prominent. Thus, the adoption of intelligent tutoring systems can contribute to the improvement of learning, adapting the presentation of content and offering support in its interpretation and discussion, which allows a personalized education and adapted to the learning style of each student.

The intelligent tutoring systems have been developed for the typical individual education (computer-student). With the advent of the Web in education, several authors studied the adoption of tutors in collaborative environments, giving them the capacity to work together, using collaborative tools (Lesgold et al. 1992, Goodman et al. 2003).

Khuwaja (1996) says that while intelligent tutoring systems are implemented with considerable success, they are not practical enough to be used in the real world. This may change with the introduction of new methodologies applied to multiple areas, in case of face-to-face education or at distance.

ITS systems are based on computer-based training (CBT) technologies and are learner centric. The main disadvantage appointed to these systems is the limitation of the student creativity, because the student needs some autonomy in their process of knowledge construction. In the other side if the system is very passive the motivation of the student can decrease quickly.

The heterogeneity of students in higher education will be increased as a result of the demands of society and knowledge economy, which demands a life-long learning approach.

The lifelong learning has been defined as one of the priorities of the Bologna Process. Thus, it will be increasing the number of students in different contexts of learning. To meet these new challenges is a necessary a greater customization of learning methodologies, to support each student learning style.

The identification of the student's learning style is an important requirement for the ITS systems to adapt the learning environment to the needs of each student.

To implement this approach we develop a generative intelligent tutoring system (GITS), based on the student learning style, to module his/her profile.

The student module is based on Honey-Alonso learning styles questionnaire (CHAEA), adapted and validated for the Portuguese language by Miranda (Miranda 2005).

To identify the learning style of each student it was integrated in GITS system the CHAEA questionnaire. The student when accesses the system is invited to complete the questionnaire.

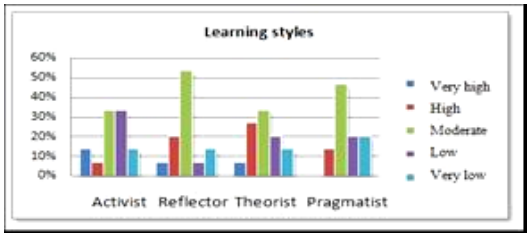
The questionnaire consists of eighty questions enabling the identification of preferences for each style: active, reflective, theoretical and pragmatic.

To evaluate the GITS system we made a case study in two different groups. One of Introduction to Computer Science, composed by 20 students, and other of Web Development, composed by 15 students. The number of styles identified is less than the number of users of the platform, because the answer to the questionnaire is voluntary and does restrict the use of the GITS system.

To identify the students' learning styles we consider only the experimental group, which used the GITS. The control group used a different platform without the ITS system.

The experimental group of Web Development had a smaller membership in response to the questionnaire that the group of Introduction to Computer Science.

The analysis of the results indentifies a moderate preference for each style: active, reflective, theoretical and pragmatic. Only 7% of students had a very high preference for reflective style and 13% by the theoretical. There isn't any student with a very high preference to the pragmatic style. The moderate level is the predominant.



Graphic 1: Learning styles of research group.

In the adaptation of learning context made by GITS to each student style, shows that most of the students had a moderate preference, which implies a very narrow adaptation.

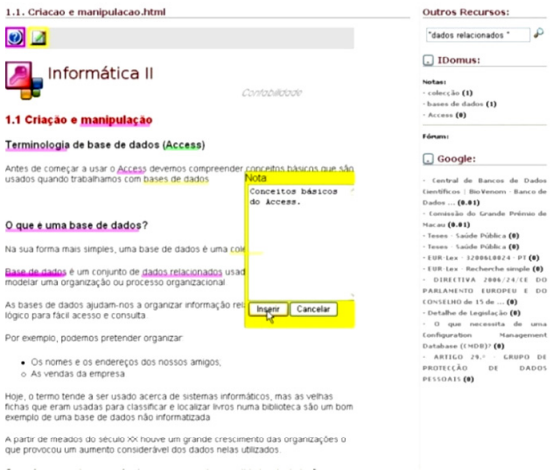


Figure 2: GITS interface to add notes to contents.

Only for students with a very high preference for the active style the GITS made an adaptation of the learning activities to explore the potential and students creativity. For students with a very high preference for the reflexive and theorist styles, the system did an adaptation on forums, to improve reflection, and on the Chat for the Active style to promote a direct discussion.

The GITS system modulate the user behaviour based on the student learning style, but with a main moderated preference for each style most of the students had a standard view of the system. Only the high and very high preferences change the appearance of tools, contents and activities.

4 CONCLUSIONS

The use of intelligent systems has several advantages in the support and personalization of e-learning. The intelligent tutoring systems are typically used in computer-based training (CBT) and don't support the collaboration and cooperation like groupware and cooperative work technologies. We propose the adoption of generative intelligent tutoring system to support Web-based Educational Systems.

The validation of the prototype was done through data collection of the GIST prototype. We do two case studies in two subjects, one in Introduction to Computer Science and other in Web Development.

Based on the results we can conclude that the adoption of collaborative and adaptive capabilities to intelligent tutoring systems, like forums, and the possibility to add notes to contents to share knowledge, is a good feature to improve the learning experience.

The organization of contents using learning activities was highlighted as very important by most of the students in the survey and the adoption of learning styles to model the user profile was considered important for the students.

The GIST system supports the student in their learning activities, collaborative work, portfolio management, agenda management, and shows several points of view of some subjects, suggesting Web resources to complement the student knowledge.

These capabilities it was considered by the students very important to improve the knowledge and the collaboration, which can be adopted in several learning management systems to provide a more effective support in the learning process, going in the direction of the needs of knowledge based societies.

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