Agents Based Adaptive Hypermedia System with the Competency Approach

Jose Sergio Magdaleno-Palencia[1], Mario Garcia-Valdez[2] , Manuel Castanon-Puga[3]
and Bogart Yail Marquez[4]

[1,2]Tijuana Technological Institute, Mexico
[3,4] Baja California Autonomous University, Mexico
{[1]sergio.magdaleno, [3]puga, [4]bmarquez}@uabc.edu.mx, [2]mario@tectijuana.edu.mx

Abstract. This work is motivated by the need to propose a model for the study of personalized hypermedia systems with a competency approach, which is one of United Nations Educational, Scientific and Cultural Organization (UNESCO) and General Administration of Higher Education Technology (DGEST) recommendations. We use computer agents, to construct a student model with emphasis on his learning style, multiple intelligences and the competency evaluation to adapt the course material according to the student's needs. The system will also use artificial intelligence techniques. The systems will be used at a university level; the primary goal is to help each student learn and thus reach a suitable competency level.

Keywords: Agents, Adaptive Hypermedia System, Competency model, Learning style, Multiple intelligences.

1   Introduction

Each human being perceives and processes information differently; hence the importance to create a system to adapt these individual characteristics, for instances a system that works as a personal tutor for each individual. Studies shows that when presented information to the people according to their learning style, they learn better [1].

The goal of this project is to create a system that takes a novel approach to using agents based in personalized educational hypermedia components using the students profiling and the competency model. The system will be applied with programming courses with the competency approach in a university of higher education in Mexico.

One of the UNESCO recommendations in education is to promote lifelong learning as well from the DGEST to seek comparability, compatibility and competitiveness of the plans and study programs in a national and international context [2]. To create the system is necessary to know about the following topics.

1.1 Multi-agent model.

An agent is "A computer program, or part of a program, that can be consider to act autonomously and that represents an individual, organization, nation-state, or other social actor.", [3]

An agent is situated in some environment, within which it can act independently and flexibly to meet its main objective. The agent will receive data from its environment and must choose an appropriate action. According to the authors Wooldridge and Jennings, agents have certain properties such as: autonomy, sociability, reactivity, pro-activity, intelligence, rationality, consistency, and adaptability,[4]. "A multi-agent system (MAS) can therefore be defined as a collection of, possibly heterogeneous, computational entities, having their own problem solving capabilities and which are able to interact among them in order to reach an overall goal", [4].

The MAS system will be used to learn about the learning process while the student uses the system. This process involves different types of agents; in a group of students each one has its own personality, learning style, background, motivation, culture, etc. Hence de MAS can be a powerful tool to model this kind of systems, because it can recreate and simulates this behavior.

1.2 Adaptive hypermedia system.

Adaptive hypermedia systems (AHS) have been used as software tools in the teaching of courses; they allow for adaptation according to the users learning style by making the necessaries adjustments in the way the course material is presented [5], that its why it is called a personalized hypermedia system. The classical architecture for an adaptive hypermedia system includes: the user, includes the learning style and multiple intelligences, as well the evaluation during the process; the adapter, the necessary rules to adapt the course material; and the domain model, that contains the material itself according the educational model.

Each one of them to know the student's profiling, the process to adapts the domain according the students needs and the domains itself.

1.3. User model

The user model includes for their profiling the learning style, multiple intelligences as well the evaluation of the course material during the process of learning the course material.

1.3.1 Learning style

Each student has their own learning style; each one processes and perceives information differently. According to work done by Neil Fleming at Lincoln University in 1987, through this work the word VARK was used to stands for Visual, Aural, Read/write, and Kinesthetic sensory modalities that are used for learning information [6]. These preferences are used by the learner according the ways that they want to take-in and give-out information.

Also Alonso, Gallego and Honey in their research indicate that students learn better when there are studying when they know their predominant learning style [1].

1.3.2 Multiple Intelligences

The theory of multiple intelligences was developed in 1983 by Dr. Howard Gardner; he suggested that the traditional notion of intelligence, based on IQ testing, is far too limited. Instead, Dr. Gardner proposes eight different intelligences to account for a broader range of human potential in children and adults. These intelligences are: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal and naturalist[7]. Intelligence depends on the context, the tasks at hand and the demands that life presents us, not only an IQ score.

1.4 Competency model

The educational model of competency is one of the UNESCO recommendations to promote lifelong learning and competency building, as a result of a globalized world of communications. This model integrates the types of known learning outcomes known, the theoretical domain, declarative or relating to knowledge, procedural skills or know-how relating to (executing or doing something, using techniques, methods, skills and strategies [8]) and the affective or attitudinal, knowing being, which are three of the four pillars of education promoted by UNESCO worldwide [9].

The competencies are distinguished by their types, the most common are conceived as: basic, generic and specific. The components are broken down into three levels such as: general competency, the unit of competency and elements of competency [20].

The system will use Bloom's Taxonomy to help adaptation to the student's learning style; it considers the cognitive domain, in respect to any area of knowledge. The types of learning's domains suggested by Bloom are: cognitive (knowledge

understanding, application, analysis, synthesis and evaluation), affective and psychomotor [11].

1.4.1 Competency evaluation.

In the traditional teaching evaluation is usually of knowledge through objective evidence or essay. In the competency based education assessment can be based on competency rules if any, but especially in the testing of evidence through demonstrations, product design, checklist, scales, simulations and portfolios [10].
The project will be using the competency approach, with competency standards and professional requirements derived from manufacturing and service sector; it forms the learner through a teaching methodology that emphasizes the know-how and uses an organization and infrastructure similar to the area where these skills will be used [10]. For the evaluation during the process of the student learning we will be using the competency evaluation according the work done by Guzman s [10].

2 Agents Based Adaptive Hypermedia System with the Competency Approach.

The proposed system architecture is shown in Figure 1. We proposed a model based on three agents:
User Agent. This agent maintains the model of the user, which includes his learning style, type of intelligence and background knowledge, this information is gathered from other agents or systems, in form of formal tests, or inferred by the User Agent, from the User's interactions. Bloom's Taxonomy will be used to help the Hypermedia Adaptation to the student's learning style. The taxonomy considers the cognitive domain, in respect to an area of knowledge. The types of learning's domains suggested by Bloom are: Cognitive (knowledge understanding, application, analysis, synthesis and evaluation), Affective and Psychomotor [10]. For the student's learning style, we will use the Fleming's questionnaire, and for the type of intelligence the multiple intelligence Gardner's questionnaire; also for the competency evaluation we will use the evaluations proposed according the work done by Guzman [10].
Adapter Agent. This Agent is responsible for the selection of the appropriate learning activities in accordance with the competency approach selected by the Competency Model Agent. This Agent also defines the possible sequence of activities and the navigational options available to students according to their profile and competency approach. This Agent is responsible for the Adaptation of the Navigational options and Content presented to students. The content delivery systems interact with this Agent to get the data that is going to be presented to Students. Here artificial intelligence techniques are used.

Competency Model Agent. This Agent is responsible for the Competency Approach, has didactic rules and personalized lesson plans tailored to different student's profiles. This Agent can also be replaced with a different Agent that follows a different approach according to the student's needs during the learning process.

Environment. The environment is another Agent that keeps track of the context in which the learning activities are taking place. This information is taken into consideration by other Agents to accommodate the learning activities to better suit the environment.
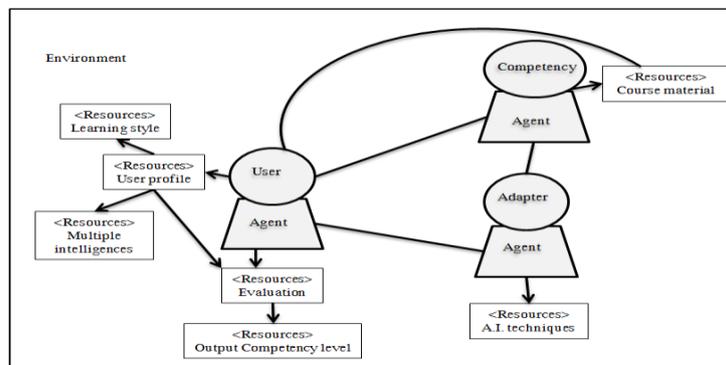

Figure 1. Proposed Model

The learning process will be adapted and monitored by Agents and Instructors until the user can reach the competency level required. The system evaluation will use the competency evaluation approach [10]. It is important to know that the adaptation process will also consider the domain, the profiling and the student's performance that will be measure by the competency evaluation. Each Agent will have a set of rules, initially specified by Instructors to personalize the material according to the user's profile and the results of the evaluation for each topic of the course. This process will be in a loop until the user can reach the competency level required.

3 Case study

One of the commitments' of the DGEST in Mexico, is to seek comparability, compatibility and competitiveness of the plans and study programs in a national and international context [2]. Hence the case study will be implemented at the University level, in this case in Tijuana Technological Institute, Mexico, wich primary goal is to help each student learn and thus reach a suitable competency level thus according the UNESCO and DGEST recommendation. The proposed model will use programming language courses material with the competency approach.

3.1 Applications of adaptive hypermedia in education.

Advances on information systems and technology shows that it is very important to focus on developing competency-based learning models [12]. Till this day the development of AHS, has been instrumental in helping students achieve meaningful learning; also by the new needs of life imposed by globalization, advances in modern psychology and changes in the aims of education [9], [13].

New e-courses tend to be oriented to support the activities according to the constructivism theory [14], hypermedia systems have became popular in the last years as tools for student' learning [15]. Some projects have been carried out for competency-based training standards, instructional technology education[16],[17], and competency-based systems for recommending study materials from the Web to learners (CBSR). It explores the benefits of a competency model for an improved pedagogical approach to e-learning [18] and also Adaptive Learning Objects Sequencing for Competence-Based Learning [19].

Some systems adapt A.I. techniques for the recommendations [21], but they do not use the competency model for the pedagogical material. Also some hybrid system architecture for learning objects [22] had been done.

With the implementation of this research, we pretend to know the following: Which are the main characteristics of adaptability that the educational resources should have with a competency approach?, which are the main characteristics of adaptability that the evaluation mechanism should have for the student's knowledge level based on the competency model?, which Artificial Intelligence techniques are for diagnosing and evaluating the student's knowledge in the competency approach?

3.2 Design and implementation

The implementation of the model follows a Model-View-Controller (MVC) architecture, and is implemented using the Django Web Development Framework, for the server side, using PosgreSQL as the Database Management System (DBMS). Also in the client side the technologies used are standard CSS3 (Cascade Style Sheets 3), XHTML 5.0 and JavaScript; Browsers supported are Firefox from Mozilla as well Internet Explorer from Microsoft. The Python language is used for other components. The Jade Framework is also used in prototypes.

4 Conclusions