Chapter 1
Developing a Multi-Agent system for a Blended Learning application

Dan-El Neil Vila Rosado, Margarita Esponda-Argüero, Raúl Rojas

Abstract Blended learning systems have become more popular than e-learning systems or even more than conventional educational methodologies. On Blended learning systems, the learners can view teaching materials asynchronously from different sources and collaborate with their peers and also they get the necessary face to face interaction with the instructor in the classroom. PowerChalk has arisen as the result from the analysis of several systems for E-Learning; it was designed to resolve an important limitation of current design methods: adaptability. In terms of adaptability, we have to consider that parallel to the evolution of e-learning methodologies, the intelligent agent paradigm has generated interest in many applications specially in order to support scaffolding activities and problem solving. It is for this reason that in this paper presents the develop of a Multi-Agent System (MAS) on the PowerChalk system, a blended learning application that provide a robust, reliable, usable and sustainable multimedia technology for collaborative learning.

1.1 Introduction

Actually, teaching is supported by multimedia technologies at different levels; videlicet, the technology used in some educational organizations could range from just a simple personal computer up to a complete intelligent environment. In a tech-

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nological sense, we can say that the gap between traditional and e-learning is narrowing but we need to take in account that e-learning does not replace obsolete existing pedagogical theories and approaches.

The technology-based learning is just an alternative to the traditional classroom model of a teaching-learning environment. The excuse for implementing Educational Technology, also called Learning Technology is based on reducing employee time away from the job of develop educational contents and shortening the amount of time students spend in their own learning; however, this technology has the drawback of the little consideration to delivering effective instruction in accordance with the medium, and also the problem to provide effective social transactions for learners and teachers. Unfortunately, in several educational technologies, the learning interaction is a one on one relationship between the student and the educational content.

Blended learning emerge like the convergence of on-line and face to face education. Josh Bersin gives a definition of blended learning as the combination of different training media (technologies, activities, and types of events) to create an optimum training program for a specific audience [2]. From this point of view, blended learning is a solution to integrate the different kinds of technological advances with the interaction offered in the traditional learning. Among the technologies to use in a blended learning session we can find blogs, wikis, on-line tools and on-line material, e-books, podcast and digital ink.

From the perspective of merchandising, several companies have entered to the development of learning technology (E-learning systems) which has generated scientific challenges and therefore a huge expansion of scientific groups focusing on E-learning systems. The different scientific groups have trying to develop systems with high quality, low cost and capable of revenue growth but above all solve the challenge of customer retention; however, research shows that up to 60% of any kind of implementations failed, despite improvements in technology, content development, increased knowledge and awareness [7, 16]. This situation does not mean that existing market products and applications are completely wrong, but shows that the developers have lead to the generation of new categories of systems with new capabilities and product configurations. Particularly, adaptability, the reuse of existing technologies, components and functionalities and the integration of different systems is an important issue that will lead the development of any Educational technology.

In general, a formative application should be interactive and provide feedback, have specific goals, motivate, communicate a continuous sensation of challenge, provide suitable tools, and finally avoid distractions and factors of nuisance interrupting the learning stream [11]. On the other hand a set of features specific for educational learning systems interfaces are: they have to provide a comprehensive idea of content organization and of systems functionalities, simple and efficient navigation, advanced personalization of contents and clear exit. Following these motivations, we developed PowerChalk as an interactive media tool that provides an adaptive, modern, flexible, technology-friendly and pedagogical approach suitable to any intelligent environment; specially those focused on blended learning [13].

The modular structure of PowerChalk let us amend quickly any problem in the system and evolve to new features or modules to improve any E-learning process [14]. As evidence of the adaptability of "PowerChalk" in this paper we propose a modular multilayered architecture for integrating agents and computational intelligence techniques in PowerChalk that could be used in a blended learning session for the purpose of enhancing learning and teaching.

The concept of multi-agent systems are broadly used in the development of large, complex systems by including attributes such as autonomy, cooperation, reactivity, adaptability and mobility [15]. Using intelligent and reactive agent in an e-learning architecture enables researchers to obtain a personalized e-learning system that adapts to the goals and characteristic of each learner [6]. With the modular multilayered architecture we want to extend the adaptability to the goals and characteristics of learners, teachers and developers.

This paper is structured as follows. We review the related work in section 1.2. Then, in section 1.3 we describe the PowerChalk architecture, and in section 1.4 we describe the multilayered architecture for integrating agents in PowerChalk. Finally, in section 1.5, the implications of our findings and further research are discussed.

1.2 Related work

Nowadays there are few electronic systems and projects that offer a combination of collaboration platforms, interactive chalkboards and displays that enhance any discussion session. Some representative examples of electronic systems and applications to give support to education and sharing information are:

- K-Sketch. Interface design for creating informal animations from sketches [5].
- E-Chalk. Electronic chalkboard developed by the Freie Universität Berlin [9].
- Cabri software. Interactive media software to create content faster to accompany any learning session with mathematical and physical objects or to provide activities as resources in 2 or 3 dimensions [12].

The systems above are specialized to a very specific task and have different limitations, among which we mention: cost, hardware or software limitations, inefficient software architecture, they can only work with certain types of data, lack proper software engineering, and present difficulty to evolve or update for developers or end-users. PowerChalk structure let us to get a sustainable application because resolve the difficulty to evolve or update as long as the capability to work with different kinds of data. These systems and many others do not use the agent technology.

On the other hand, several project implement learning systems based on multi-agents architectures. The use of intelligent agents makes it possible to achieve a powerful system adapted to the needs and characteristic of every learner and to provide adaptability and intelligence to the learning process through the introduction of agents. However, each of these systems use the multi-agent technology from a particular point of view, and in most cases the focus is on a specific agent type [8].

ABITS is composed by different kinds of agents (evaluation, affective and pedagogical agents) which extend a course management system to an automatic curricula generation [4]. The Intelligent Tutoring System (ITS) developed in [6] take in account the perspective of the students and the teachers. In this work, they have introduced a Student Model, a Domain model, a Pedagogical model and an Educational model. In this manner the ITS proposed gets all needed data, obtained fruit of the interaction of the students with the system, to adapt the rhythm of introducing the contents of the matter to the learning rhythm of each student and the Education module obtains measures that permit to get recommendations to enhance the course. MASCE is a multi-agent systems for collaborative e-learning [10] that consider two types of users; namely students and instructors. This system consist of three types of agents, the Student, Instructor and Assistant agents.

The work of [8] offers a good list of previous and related studies based on intelligent agents. They justified that e-learning systems suffer from a lack of integration, the lack of re-use support and the lack of adaptation and also claim that the majority of web-based educational systems are currently from the class of Learning Management Systems, wich provide a large variety of support services to both learners and teachers but lack adaptability. In this sense, they develop an agent-based adaptive architecture to overcome these problems. The proposed architecture is based on Intelligent Blackboard agents (that provide preferences for designing and delivering educational content) and a formal design model (object Petri Net) used to verify and validate the model before the implementation.

In general, interesting results have been achieved by systems where pedagogical agents are developed regarding the student motivation and companion. Also, tutor agents are usually related to student modelling and educational decision taking. However, there is no systems that consider the characteristics of a blended learning approach and the respective interaction of a complete e-learning process.

1.3 PowerChalk architecture

This blended learning application is composed of smaller, separated chunks of code that are well isolated. They can then be developed in separated teams with their own life cycle, and their own schedule. The results can then be assembled together by a separate entity. PowerChalk has a modularized architecture for distributed development based in Java-NetBeans technology.

Such a modular architecture has the followings advantages [3]:

- It simplifies the creation of new features.
- It makes it easy for users to add and remove features.
- It makes it easy to update existing features even to code level.
- Fast application development.

With these benefits PowerChalk becomes a modern, configurable approach to any blended-learning situation, lesson-planning or intelligent environment. The modular architecture of PowerChalk is shown in figure 1.1.

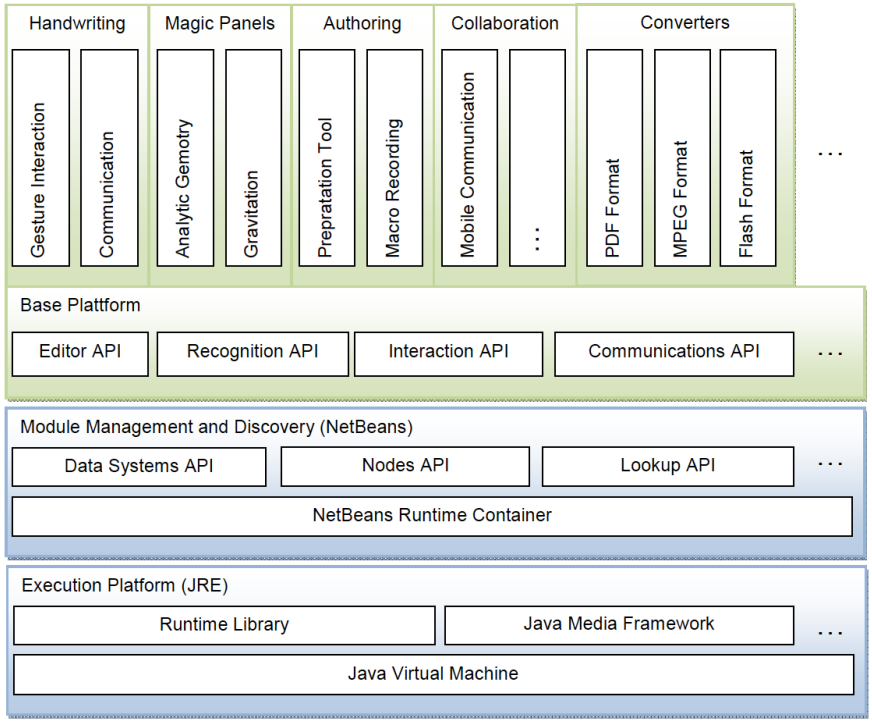


Fig. 1.1 Modular structure of PowerChalk

1.4 Agent based multilayered architecture

In this paper we start from the idea of having a tool for learning sessions. So we have to consider the development and structure of an E-learning process. On the other hand, different architectures have been developed to design Educational content. Some interesting architectures take in account just one-level of development and implement direct agents to the users based on student's personal profile [10, 7, 6]. Agent based multilayered architectures are developed in [8, 1]. The advantage of a multilayer architecture are: Makes a logical separation of tasks and services for the end-users (teachers and students), developers and agents; easy to define the respective tasks of the agents in the development process; any change to the elements on the layer can be made in one place and be available to the whole application; it is

possible to change the contents of any layer without having to make corresponding changes of the others and enables parallel development of the different layers of the application.

In this paper we focus in the development of a multilayer architecture based on agents for the different stages of any e-learning process.

1.4.1 E-learning process

The e-learning process can be divided into two major phases: content development and content delivery and maintenance (figure 1.2). A typical e-learning process has planning, design, development, evaluation delivery and maintenance stages [7]. On these schema the participating roles are: learner, teacher and administrator. The number of individuals involved in the stages of a learning session may change. Even some roles ad responsabilities may overlap.

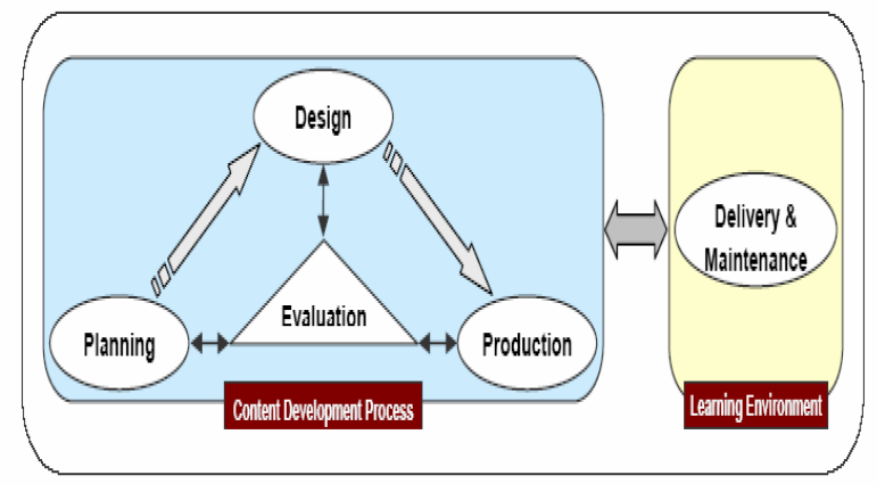


Fig. 1.2 The iterative process of E-learning

From this schema we can see that the e-learning process is iterative in nature and the individuals involved in the stages should be in contact with each other. In this paper, we propose a set of agents to every phase, namely, a set of agents to the content development process and another one to the learning environment.

The modular architecture of PowerChalk let us to identify the modules focussed on every stage of the e-learning process and develop several kind of agents. In the general case, agents will be acting on behalf of the stage or some specified user with different goals and motivations. We build agents in order to achieve task for the

different roles involved. The attributes of an agent in the PowerChalk system are: persistence, autonomy and reactivity.

1.4.2 Content development based on agents

We propose the following architecture 1.3. User agent is used for identification in order to get individual user profiles. The content agent delivered content need request to data layer and the user multiagent system (user MAS) communicate between a user (normally a teacher) and system, to create educational content. In the interface layer we can found agents whose activities work in the editor module of PowerChalk [13].

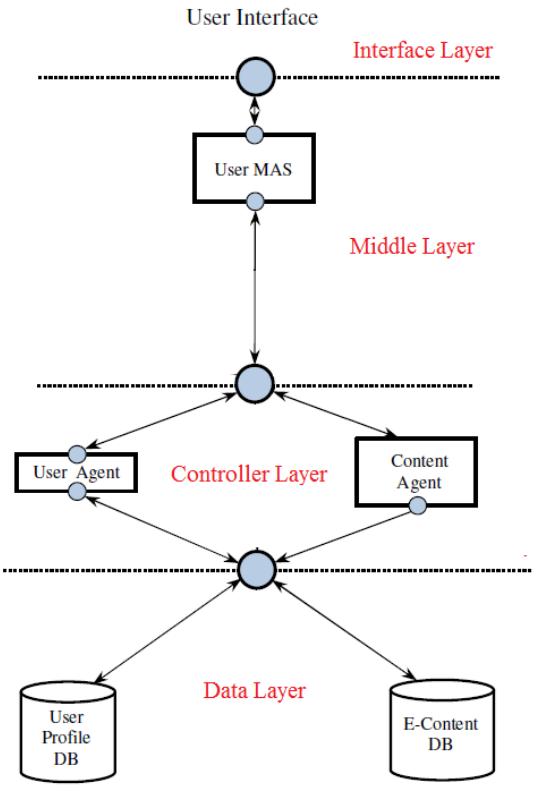


Fig. 1.3 Content development multilayered architecture based on agents.

1.4.3 Content delivery based on agents

In terms of the content delivery, we focused in the development of agents to interact with the different modules that work with the editor module of PowerChalk. So that the multilayered architecture is the same like the PowerChalk structure (See section 1.4).

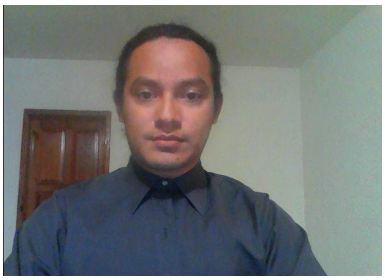
Examples of this agents are: development of agents for the improvement of the visualization of the strokes (Handwriting module), agents for the magic panels (improvement of rendered animations), imple mentation of agents that help tothe visualization of the information on the canvas editor in another formats (converters module), etc.

1.5 Conclusions and future work

The consensus is that PowerChalk it is a collaborative, robust, reliable, usable and sustainable interactive multimedia system for blended learning and also a friendly tool to review and share information on-line or off-line. Supply PowerChalk with a set of agents preserves the pedagogical benefits of the traditional chalkboard and provides the possibility to present educational content in a learning session in different ways. Combining the advantages of an interactive multimedia tool and the faculty to be easily updated and adapted, the modular architecture allows it to be an useful and efficient method to embed agents to improve planing, design and production of a learning session as well as enhance the delivery of educational content on this blended learning application. It must be pointed out that the modular structure of PowerChalk let us amend quickly any problem in the system.

A complete usability test it is in progress, in order to assess in a measurable way the advantages of modular programming in PowerChalk and the implementation of the different agents. Also, we are increasing the efficiency of every module and the functionalities of the agents. In this sense, a short-term objective is the development of agents to support an Intelligent Tutoring System for the learners. It has considered the development of agents with data-mining techniques to generate personalized Student and Pedagogic Models. The goal of this set of agents is that the alumni learn more and better, taking in account the specific rhythm and learning style of the students.

Otherwise, teachers and students have been proposing new PowerChalk modules to design and develop. Among the future modules we can find: Algortihms animations, virtual labs sketched, etc. In this manner the development of agents focused on the performance of these modules always will be taken in consideration.



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