An Electronic Ludic Learning Environment for Mathematics based on Learning Objects

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Abstract: This paper presents an electronic ludic learning environment based on certain learning objects, as an effort to motivate learners toward mathematics. The learning environment follows the architecture of an Internet portal having mechanisms to administer a variety of local and external educational content into a unified and fully customizable workspace. The environment provides services like membership, customization, catalog, interaction and interoperability to support the acquisition of mathematical knowledge and generation of mathematical thought.

Introduction

There are many efforts to explore alternative ways of teaching mathematics creating programs, curricula or didactical materials that incorporate new didactic tools, approaches, models or methods that engage learners towards a more pleasant mathematical learning (Szendrei, 1996).
With the introduction of new technologies into classrooms, there are promising evidence of an improvement of mathematical learning and student performance (Kenneth, 1996), associated to positive effects on attitude towards mathematics (Rosas et al., 2003). As Jonanssend and Carr (2000) put it, if technology is used as mindtool "can be used to support the deep reflective thinking that is necessary for meaningful learning". Nevertheless, the ludic component in the instruction of mathematics has acquired relevance to engage learners toward mathematics, through ludic learning environments (Sanchéz, 1998), or introducing mathematical games into the classroom, commercial (CIMT, 1997, Gross et al., 1998) or developed by researchers (Gorriz and Medina, 2000, Rosas et al., 2003).
As an effort to diminish learner apathy toward mathematics, we present our approach of an electronic ludic learning environment for mathematics based on certain learning objects, their properties and its presentation through a fully customizable workspace.

The Electronic Ludic Learning Environment

The electronic ludic learning environment (ELLE) that we have developed is a collaborative workspace for the generation of mathematical knowledge through ludic learning objects. It has been designed to give support to learner-learning object interaction, learner-learner interaction as well as the learner-workspace interaction. For this purpose, the system provides the following services,

*Membership***.** Provides an interface to access personal information about the user, such as their login and password, email address, active session and personal identification. User session information is used by the interaction tools and learning objects. This layer manages user groups, introducing of roles associated with mechanisms that control the access to content, according to access control lists.

*Customize***.** Through this feature users can customize their workspace according to their current interests. The customization can be done at different levels like the color scheme of their personal workspace, the layout of the leaning objects, and the addition and substraction of selected learning objects to their workspace among others.

*Interaction***.** The learning environment provides interaction tools asynchronous (instant messaging) and synchronous (email) that allow interaction between users within its workspace. This interaction is intended to help people to join forces in the knowledge building process. Because these tools are fully integrated into the environment, embedded applications within learning objects are able to use their interaction capabilities in conjunction with a membership layer to communicate learners or applications, to exchange data between them.

*Catalog***.** The catalog provides a single interface to browse and retrieve learning objects into the workspace.

*Interoperability***.** Because of the inherent reusability of learning objects, the environment has mechanisms to incorporate to the catalog external learning content and make them available local learning objects to other systems.

Framework

ELLE is an Internet portal constituted by portlets (portal elements), each one containing a single learning object. The system is based in the open source project Jetspeed from the Apache Software Foundation (http: //jakara.apache.org/jetspeed) which provides a Java based framework to build Internet portals that fulfill our requierements. We also integrate to the environment the Jabber instant messaging system, (http: //www.jabber.org), that provides learner-learner communication through instant messages and chat groups.

The environment builds the leaner portal home page from several sources; HTML static pages, dynamic server-side processing HTML pages, HTML client-side dynamic pages (with Javascript, Java applets or Macromedia Flash objects), XML to HTML transformed pages, syndication content through XML applications and native applications (another WEB based applications like a search engine), among others. Figure 1 shows a typical workspace with different learning objects and an interaction tool.

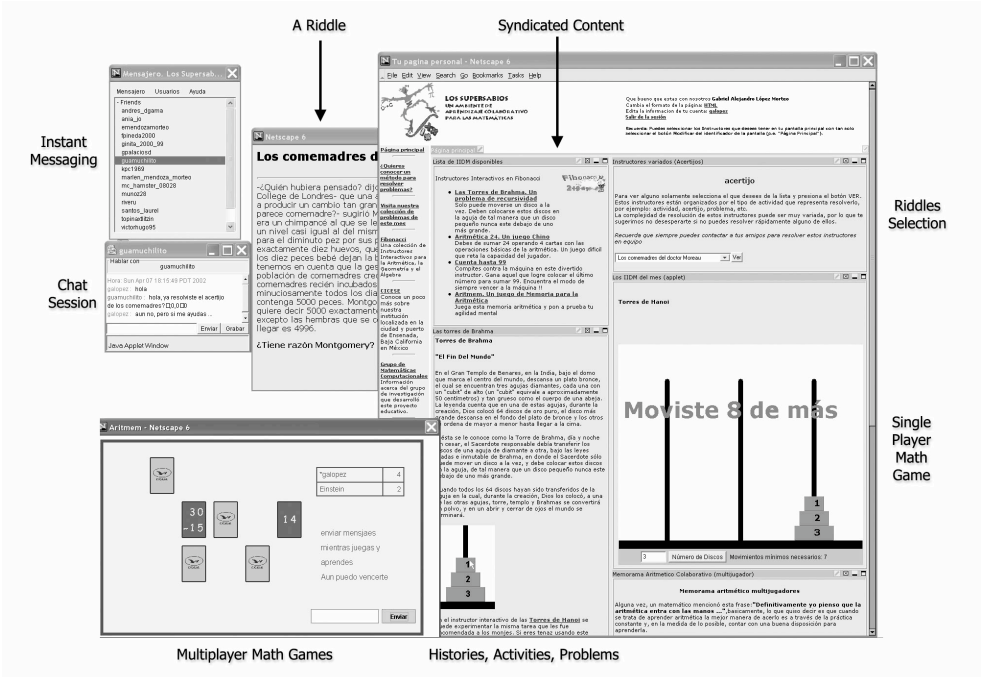

Figure 1: A screen-shot of the learning environment within a learner session.

When a user logs in for the first time, it is presented with a pre-configured home page that contains a collection of learning objects, as well as a pre-defined layout of the workspace, chosen by the system administrator. Therefore, in the case of a tutor-driven context, this feature permits him to provide a unified content to its learning community, at least until learners begin to customize their workspace. Also, the

teachers can expose to the learner with a layout of the workspace that teacher considers more adequate for their group and their educational objectives. The system provides auxiliary mechanisms to keep non-removable spaces; this can be achieved by fixed sections of non-permanent content into the public section of the environment, in conjunction with email lists, and broadcast of instant messages through the embedded instant messaging client.

Learning objects

The learning objects are the fundamental elements in the environment. Thesse are individual software components with mathemathical concepts presented in a ludic fashion. They can be viewed as mathematical recreations (math games, riddles, puzzlez, etc.), on a pedagogical model that defines the strucutre of its presentation and with certain level of iteractivity (e.g. Java Applets, animations, audio files, etc.) (see López Morteo and López Mariscal, 2000, López Morteo et al., 2001, López Morteo et al., 2002).
The administrator registers the different learning objects into the catalog through a single file, while the system automatically incorporates the learning objects into the environment. To register a new learning object, an administrator specifies the portlet type which holds that object in accordance to its file format, the URL of the learning object regardless of its location (local or remote), the portlet's name, a brief description that will appear in the catalog, and a series of optional parameters that can modify the behavior of the portlet when it is shown in the workspace.
The learning environment can import educational content from a variety of sources and formats, in such a way that the administrator has options to import and export educational material. The environment supports the inclusion of HTML pages, XML content, and Rich Site Summary files (RSS). ELLE is also able to manage and display information from a learning object through XML format and metadata, which is defined through specifications from the IMS Global Learning Consortium (IMG, 2001) and the IEEE Learning Technology Standards Committee (LTSC, 2002).
We have extended interoperability mechanisms to educative legacy applications through a methodology to transport certain object oriented single-user applications into multi-user collaborative applications to be integrated into our learning environment. The learner experience is improved by means of interaction with their partners through collaborative math games and projects. In our methodology, the learning environment architecture provides mechanisms to support the exchange of messages and events between distributed applications. This exchange is necessary to keep synchronization between interfaces, data and the state of the applications. We developed a collaborative version of an arithmetic memory game that illustrates these mechanisms and part of the process of the development can be seen in Ibarra Esquer et al. (2001).
We have tested the learning environment through three workshops for high school students in 2001 and 2002. Learners attended a face to face course and used the learning environment and their learning objects along the course. After the workshop the students answered a poll of assertions about their attitude towards mathematics, previous experience with computer games, perceptions about the learning environment and the learning objects. Also we made interviews and classroom observations. The results show evidence that students have a positive attitude towards learning mathematics in a ludic context with a problem-solving orientation. Also we observed that the use of the ELLE objects in conjunction with the interaction tools (instant messaging) captivate learners' attention and promote interactions between them.

Conclusions

The use of the computer based ludic learning environment as an auxiliary tool for learning mathematics (available at http: //azul.cicese.mx/supersabios). Has the effect to entice learners towards mathematics, captivating their attention and having the side effect of generating interactions originated by learners not by the teacher. The unified interface to access learning objects regardless their source format, simplifies interaction with the environment through a fully customizable workspace with a single layout and a color scheme for all the content. Thanks to the capability of embedding external material into the learning environment, teachers can incorporate it easily, keeping copyright information, page layout and presence (e.g. logo images) like in the original source, delegating to the environment tedious work such as changes in colors schemes or font size. The collaborative framework provided by the learning environment, gives learners the opportunity to interact with their partners to resolve mathematical problems together, as well

interaction tools that can be used in a social context to create personal relationships between learners, that could stream into the generation of a virtual community. Our learning environment represents an effort to diminish learner apathy toward mathematics, showing not only their useful aspect in daily life, but also showing that learning mathematics can be a fun experience that can have a positive influence in their life.

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