Development of a Learning Environment Based on Interactive Instructors of Mathematical Entertainers

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Abstract. We present the first steps that lead to the development of an Internet portal designed to support teaching of mathematical concepts by means of recreational situations. This is the concept we have named as a Learning Environment based on Interactive Instructors of Mathematical Entertainers (AIIDM). The main piece of this environment are the IIDMs, which are software components that show mathematical concepts in a novel, interesting, attractive and entertaining manner, and have as a main goal getting in a person the desire for the mathematical knowledge.

1 Introduction

The problems associated with the transmission of mathematical concepts are diverse. Since the end of World War II, important efforts have been made, to try to stimulate the acquisition of Mathematical knowledge and lure towards activities related with Math. Among these, the ones that support the use of mathematical recreations [2], [3], [4], [10], [11] are of particular interest to us..

Our previous and current research is based in the concept of IIDM. We defined it as a component of educative software specialized in mathematical concepts represented through the mathematical recreations and presented their first implementation in the system Fibonacci [6], [7], [12].

Here, we present our first efforts to integrate the IIDM into an environment that involves elements of collaborative learning. This is what we have called a Learning Environment based on Interactive Instructors of Mathematical Recreations (AIIDM).

2 The Interactive Instructors of Mathematical Recreations

An IIDM is a software component that supports teaching of a specific mathematical concept. Recreational mathematics give us the capacity to create interesting, surprising and challenging situations, to which we add the characteristics of the new technologies to get the ability to present the mathematical concepts in an entertaining, attractive and interactive way. The main purpose of the IIDM is contribute to the acquisition of mathematical knowledge in one or more individuals, by means of the interaction with it and among them.

The IIDM are formed by mathematical concepts referenced through one or more mathematical recreations. The interaction with the IIDM is achieved by adding different computational tools, which allow a user to interact with the system and other

users. There is a pedagogical model immersed in its construction and in the context it is presented, which sustains the IIDM [6], (Fig. 1)

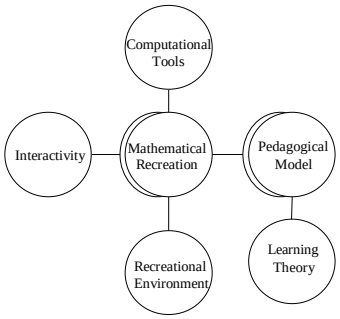


Fig. 1. Structure of an Interactive Instructor of Mathematical Entertainers. It has concepts that extend the reach of the IIDM, such as a recreational environment, interactivity and different computational tools.

We build IIDM of different types: games, stories, riddles and activities. In most cases, games and riddles will invite the users to construct knowledge gradually as they interact with the IIDM, or by cooperation and competition with other users; while stories and activities will show a specific concept or an interesting and peculiar situation, with a demonstration or exhibition of that concept, without leaving aside the recreational aspect it has. In some cases, certain IIDM could be helped by others in order to get to the desired goal.

3 Collaborative Learning through IIDM

In order to allow individuals to learn by means of collaborating through of the use of the IIDM, the integration of a communications schema is required. To achieve this, we selected an open source implementation of an Instant Messaging software named Jabber [5]. This software has a client-server architecture and allow us to perform real time instant messaging and presence notification with an XML (extensible Markup Language) based protocol.

A Jabber client uses sockets for communication with a Jabber server. The client establishes a connection to the server and all the message exchanging is done by means of XML structured messages. Some of the features of the server include the handling of the connections and messages, user authentication, storage of messages and is able to keep a list of contacts to every user registered on that server.

Some IIDM involve direct interaction between two or more users, such as games. In these cases, some parameters and actions need to be sent from one user to the rest of them in order to have a satisfactory experience. Having this necessity, we designed and developed an IIDM communication interface based on Jabber, which has the capability of detecting active users, send invitations for participating in games, and communication of the parameters and actions of the IIDM. All parameters and actions are represented in XML strings, and are sent as the body of a Jabber message. When a

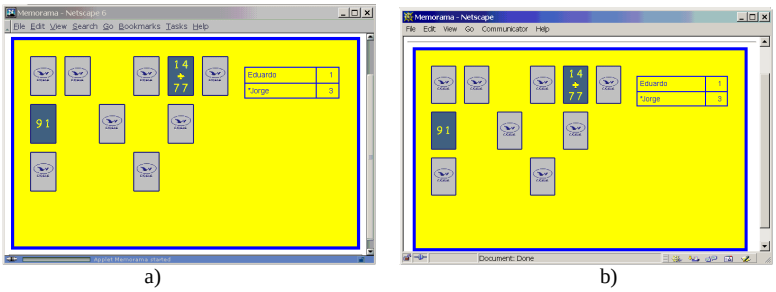
user receives a message, the string is recovered, parsed, and the interpreted elements are shown in the interface of the IIDM.

3.1 Implementation of IIDM over a Learning Environment

Here, we show our first experiences with IIDM, and present two examples of them. The first (Aritmem) shows how the communication interface was adapted in order to involve two users into a game, the other one (Golden Ratio), shows a concept by means of an interactive applet supported by HTML content, in a clear conjunction of technologies.

3.1.1 Aritmem

We have named *Aritmem* (Arithmetic Memory) to an IIDM based on the traditional memory game, in which the players try to find matching cards laying on a board with their contents hidden. The cards on the board contain arithmetic operations and their results. The psycho-pedagogical concept behind the game is the same as the very well known as *learning cards* (also named *flashcards*), that are pairs of cards with related concepts used to memorize those concepts. More than memorizing, the objective of this IIDM is bringing the user a different situation in which to apply, practice and reinforce arithmetic skills.



a) b)

Fig. 2. Interface for the Aritmem IIDM. An instance of a multiuser game is shown. a) User A interface, b) user B interface. In this case, user A is looking at the selections made by user B

We developed an application that allows the user to select the kind of operations he wants to play with, different playing levels, and the possibility of challenging either the computer or another user of the system (Fig. 2). The game is carried out in the usual way, until all cards on the board have been matched.
To have the ability to communicate two users within a game, we integrated the communication interface to the IIDM. While the game is been played, the messages include the cards that will be used for the game, the cards each user selects and the acknowledgment and synchronization messages.

3.1.2 Golden Ratio

The golden ratio is a number linked to different areas of Math. It's relation with different aspects of nature, art, economics, etc. [9] makes it a good IIDM. It has the following algebraic property:

$$f^2 = f + 1 \quad \textbf{(1)}$$

Building an IIDM to show the characteristics of such number, allow us to show its different properties, how and where is possible to find it, and its relation to other mathematical concepts such as the Fibonacci sequence, the Logarithmic spiral, etc.
We show how it can be approximated through the Fibonacci sequence, in which each term is equal to the sum of the previous two terms. An interesting property of this sequence is that, as it grows, if we divide a term over its previous one, the result approximates the Golden Ratio. We can take each term in the sequence and draw a square with a side length proportional to the value of its matching term, then put every square next to its previous one, always obtaining the shape of a rectangle. The division of the width over the height will result in a value that approximates the Golden Ratio (Fig. 3). This rectangle is known as a Golden Rectangle.

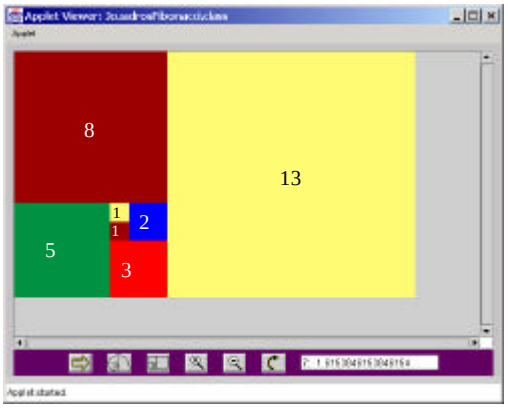


Fig. 3. Interface of the Golden Ratio IIDM. We appreciate a rectangle formed by several squares with their dimensions according to the values of the terms in the Fibonacci sequence. The rectangle approximates the proportions of a Golden Rectangle. It also shows the approximation to the Golden Ratio obtained with the dimensions of the rectangle.

We developed an application (Java Applet) that allow us to construct a Golden Rectangle step by step from the terms of the Fibonacci sequence and, at the same time, will show us the approximations to the value of the Golden Ratio (Fig. 3). The applet was embedded into a web page which content explain the different aspects shown in the applet. This way we have constructed an IIDM that explains an interesting mathematical concept in a different way as is usually done in a classroom, since in this case, the user controls the way he is acquiring the knowledge, and has the possibility of reproducing the learning experience as many times as he wishes.

4 Learning Environment Based on the Interactive Instructors of Mathematical Recreations

The IIDM should be placed within a highly technified context that allows a person to find his area of interest, and also that gives him the ability to interact with more

people in order to collaborate in learning acquisition. That is the idea that led us to the construction of an environment that involves new technologies and teaching methodologies into components of educative software, which are strongly linked to elements of collaborative learning. This is what we have called Learning Environment based on Interactive Instructors of Mathematical Recreations (AIIDM) [8], and have embedded IIDM such as the presented in the previous section.

An AIIDM is thought as a collaborative space focused on the transmission of mathematical knowledge. A use scenario is created by means of the integration of a number of IIDM set into an attractive surrounding that propitiates their usage.

The best interface that matched our necessity is the known as Internet portal [8]. We took the definition of Internet portal as a WWW system with an interface formed by small independent applications that share the information of a user profile through a common infrastructure [1]. Another characteristic that these systems give is to allow the user to customize the content of the interface according to their needs or likings.

As a platform for the implementation of the portal, we choose the project Jetspeed, which is a subproject of the Java Apache Project [1] and has an open source license that gives us total access to the source code, and can be modified according to our needs.

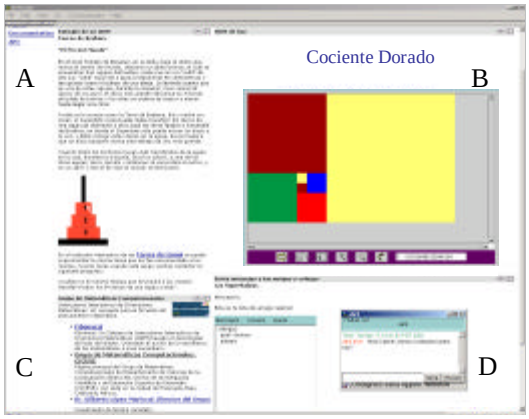


Fig. 4. Interface of the AIIDM. Each section shows a portlet with an IIDM or an independent application. A) IIDM that shows the story "The Towers of Hanoi". B) IIDM built to show the concept of the Golden Ratio. C) Example of categorized content. D) Instant Messaging system.

Jetspeed provides us with a Java based portal construction infrastructure. Inside of the portal, the information is organized in extensions called *portlets*, which are small applications embedded in the portal and that obtain access to the information of the users by means of the interaction with the environment. A portlet can be constructed from three different views: an interactive application, an HTML page that can or not be linked to an application, or categorized content which is not linked to an application and has information that is periodically actualized.

This structure fits the concept of the IIDM, in a portlet we can insert an HTML page that shows some kind of story, an interactive applet of a game or activity, categories organized information, or a collaborative tool that supports the interaction between the users of the system, such as Jabber (See Fig. 4).

This way we shape the AIIDM, integrating our applications, informative pages, instant messaging system, etc. into a common interface defined by the portal, and that can be easily customized to the needs and likings of every user.

5 Conclusions

We present an effort focused on the integration of IIDM into a collaborative learning environment that helps the mathematical concepts transmission process. This is the first step toward a methodology for creating IIDM that make use of the multiple technological capabilities that help us support teaching of mathematical concepts.
We elaborated a communication scheme in order to aid collaboration between IIDM, and therefore between users, and integrated it into an IIDM. The interface selected for the environment was the Internet portal, and the IIDM were embedded into it.
Mathematics learning can result in a very enjoyable experience if its concepts are shown in an attractive way. The new technologies provide a big support for this idea, which may lead to get people interested on searching for knowledge inside this huge science.

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