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An Exercises Editor for an E-Learning Environment

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Abstract: - One of the most important tenets of e-learning is that it bridges work and learning. A great e-learning experience brings learning into the work environment. This is a key point, the capacity to construct a work environment when the student can develop proper tasks to complete the learning process. This paper describes a work environment based on the development of two tools, an *exercises editor* and an *exercises viewer*. Both tools are able to manage color images where, because of the implementation of basic steganographic techniques, it is possible to add information, exercises, questions, and so on. The exercises editor allows to decide which information must be visible or remain hidden to the user, when the image is loaded in the exercises viewer. Therefore, it is possible to hide the solutions of the proposed tasks; this is very useful to complete a self-evaluation learning process. These tools constitute a learning architecture with the final objective that learners can apply and practice new concepts or skills.

Key-Words: - E-Learning, Educational software, teacher-student interaction, students skills.

1 Introduction

Education has always played a fundamental role in society. The incredible development of the Information and Communication Technologies (ICT) is modifying the whole features around our general environment.

It can be affirmed that while web and e-mail distance education has large potential, at present the majority of educational institutions of our country are developing traditional learning. In traditional courses, students attend classes; faculty members deliver lectures and provide educational materials. To take full advantage of new technologies, we need to fundamentally rethink our approaches to learning and education and our ideas of how new technologies can support them.

Although this scene, we can say that web technologies are widely used in education. See [3] and [4] for some approaches and software for web distance education, and [7] and [8] for some papers about the influence of the e-mail in the learning process.

Among others, the main disadvantage of the communication through e-mails is that there is an interruption in the learning process that might last for long and even destroy the whole learning experience [2]. But we are not completely agreed with this idea. Obviously, advantage of 'real-time' communication is that students are able to ask questions and get answers in real time, but we find an important drawback, that is, the lack of 'time-dependence' between the two parts.

In this paper, we present a new e-learning environment based on the implementation of an exercises editor to construct different tasks than can be proposed to the students in a personalized environment. With this environment we are introducing new technology for learning but we are also introducing a new way to think about learning.

In the next sections, a detailed description of the system and some examples will be shown.

2 A general overview

The general objective of this work is to create two basic tools called exercises editor and exercises viewer, which make possible a communication teacher-student or student-teacher where teachers can support, motivate and evaluate students in their learning process, and where students can learn new contents or practice skills in a self-evaluating process.

Therefore, the key point in this process is the implementation of the exercises editor and exercises viewer. The essential characteristic of both tools is that they are based in the using of color images. The reason for this is that, with the help of basic steganographic techniques, we are able to hide information inside the images. The possibility to embed information in the images gives us a chance to hide the solution of the exercises we can construct or propose in the editor. Consequently, the system incorporates the self-evaluation characteristic. So, what makes this environment different from others is

the introduction of data hiding in a distance learning system.

To work in this environment, the student only needs to install in the computer the exercises viewer to perform the learning process. On the other hand, the exercises editor constitutes a powerful tool for teachers to manage the process. As we will describe later with more details, an editor like this should allows the teacher to open any image and, inside it, to distribute some controls or frames where the questions, exercises or explanations may be added. But, what is more relevant, the exercises editor user is able to choose if the information included with the image must be hidden or not. So, the same control text or frame is useful to introduce a question or to write the solution of any question; there exists a screen in the program where the option to hide the text has been implemented. If we wish to hide the text, we only have to mark this option. If the information is hidden, it remains hidden in the viewer until the user press the proper control, as it will be shown later.

One of the general characteristics of this system is that allows the teacher to support the main aspects of its role: to transmit knowledge, by creating didactic material, and the capacity to verify the learning process of the students.

It is remarkable that both tools are not platform dependent, as they have been implemented for different operating systems (Windows, Mac, Linux).

3 Hiding information in images

Steganography is the art and science of hiding information by embedding messages within other, seemingly harmless messages. Steganography means, “covered writing” in Greek. As the goal of steganography is to hide the presence of a message, it can be seen as the complement of cryptography, whose goal is to hide the content of a message.

A well-accepted application of data hiding is for watermarking, which requires embedding a small piece of data in a manner that is robust to a variety of attacks pretending to destroy the watermark while preserving the usability of the host. In contrast, our objective is to obtain techniques to keep information in some images.

Data can be hidden in a greyscale or color image, because slight changes to the colors of pixels are usually imperceptible to the eye. The simplest and most used method to hide information in images is the well known Least Significant Bit (LSB), in which the hidden message is converted to a stream of bits which replace the LSBs of pixel values in the cover image. Then, given a color image with three bytes per pixel, each of the three components (red, green and blue) is specified by one byte. So, it has 256 possibilities. Data to be hidden are a stream of bits, each of which is hidden by storing it as the least significant bit of the next byte of the image, replacing the original bit. As the least significant bit of any byte of the image is a 0 or a 1, and the bit to be hidden is a 0 or a 1, it is expected that, on average, the bits being hidden modify only half the least significant bits. Consequently, it is reasonable to think that 1 or 2 least significant bits per pixel will change.

But we can use more bits in each byte to embed information. If we use two or more bits per byte, the size of the string of bits that can be hidden is really very important. For example, taking an image of 800 x 600 and using only two bits per byte, we can keep 6 bits per pixel, what represents that we are able to hide a file with *351,56* Kbytes. However, using more bits per byte to hide bits of information has an important drawback. When the number of bits used is increased, the original image is much more deeply modified. We have to be sure that the human eye cannot detect the modifications in the pixels. In other case, the presence of embedded information can be easily detected. In practice, one, two, or even three bits per byte can be used without revealing the presence of some noise in the image.

It is interesting to be very carefully when choosing the cover images because slight changes in the color of isolated pixels may be noticeable. Therefore, it is better to use images with a large number of small details with many different colors.

For a general introduction of basic techniques in steganography and data hiding, see [5].

4 Description of the exercises editor and exercises viewer

As it was briefly exposed in Section 1, the core of this environment is the exercises editor and the exercises viewer.

In broad terms, the exercises editor can be seen as a work environment where the teacher can construct personalized exercises or questions for the learners. The exercises viewer can be seen as a working environment for the learner where it is possible to receive some tasks with the aim to reinforce skills, or simply control the learning process. Both tools must be analyzed in detail in this section.

4.1 The exercises editor

The exercises editor constitutes the base of the environment; it has been implemented in java in

order to be used in different operating systems. This tool has been thought as an image editor and allows constructing and designing any exercise that may be requested in an online communication student-teacher or teacher-student. Moreover, it provides teachers the capability to select which information is going to be visible for students when they open the image, and which information must remain hidden until the student decides to recover it.

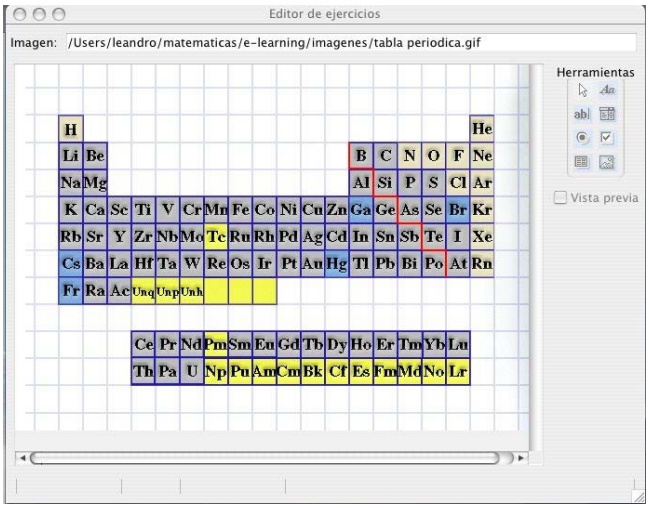

Fig.1 The exercises editor.

Fig. 1 shows the general aspect of the exercises editor. In this example, an image with the periodical element table has been loaded in order to work some questions about these elements. On top of the image it appears the location of the image. On the upper right side, the control panel can be seen.

The steps to create an exercise in the editor are summarized as:

- Load an image in the editor.
- Use the options in the display to create items of text, questions, pop-up menus, etc.
- Choose, for each item, if the information must be visible or hidden in the viewer.
- Save the image when the exercise has been completed.

The editor is able to load the most usual graphics formats, as GIF, JPEG, PNG, BMP, and others. However, not all these formats are suitable to hide information due to the method they use to compress the data representing the image. Once the loaded image has been modified and the information has been added, the format chosen to save the image in the editor is the PNG (Portable Networks Graphic). The reason for this is based on the main characteristics of this format. First, it works with several types of images, greyscale or color images, and even 24 bits per pixel. Besides, what is more important for our objective, is a format without loosing, that is, the RGB components of the image are not modified in the compression process (in JPEG format, these components are modified during the process, so there is loosing). Therefore, this format is perfect to apply the LSB technique.

The power of the editor is based on the implementation of different controls in a graphic display to make as simple as possible the process to construct exercises. Fig. 2 shows the different controls that the graphic display offers. In this image, the numbered keys can be described as:

1. **Selection**. This control has been designed with the objective to select the different elements included inside the image. One any control text or frame has been selected (using this selection control); it is possible to move, to resize and to edit the selected item.
2. **Labels**. With this control it is possible to create text lines to pose questions. The text included in this control cannot be modified by the student when the image is loaded in the visor.
3. **Short text box**. These are boxes (one line) where the students can write short answers or the teachers can pose short tasks.
4. **Pop-Up frames**. They are unfolding items, where the user can select one of the existing items.
5. **Options buttons**. In this control it is possible to define several options and the user must choose only one of them.
6. **Verification buttons**. Verification buttons where it is possible to choose one or more options.
7. **Text box**. A long text box can be created using this control (not only limited to one line). In this case, the student can write long answers or the teacher can write long exercises or long answers (they can be hidden or be visible).
8. **Images**. This control is suitable to add new images to the loaded one. The images must be of small size (they can also be hidden).

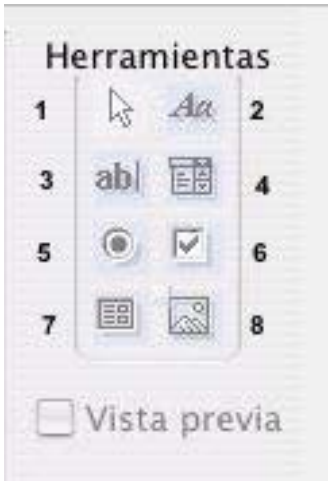

Fig. 2 Graphic display in the exercises editor.

Perhaps, the most innovative characteristic of this tool is, as it has been already mentioned, the possibility to hide answers or information in the images. For this proposal, an algorithm named STEG_RGB_LSB has been inserted in the editor. To perform the task to hide information, the controls Label, Short Text Box, and Text Box permit us

- To introduce text,
- To decide if the written text will remain visible or hidden when the user opens the image in the exercises viewer.
- To decide if the text content can be modified or not by the user in the exercises viewer.

These options are summarized in the Fig. 3.

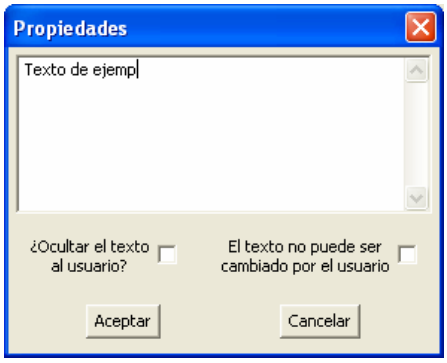

Fig.3 Different options for text boxes.

Therefore, the algorithm STEG_RGB_LSB has been inserted in the editor. As the name suggest, it is based on the LSB steganographic technique and uses this method to hide data in the RGB components of the image. This algorithm allows the trainer to choose the number of bits that must be used to keep the information, that is, it is not limited to use one bit per byte in the pixels. Therefore, if it is necessary to hide a lot of information in an image, it is possible to use 4 or 5 bits per pixel in order to increase the capacity of the hidden data.

4.2 The exercises viewer

The exercises viewer constitutes the perfect complement for the exercises editor. If the editor plays the role of generating exercises and questions, some tool is needed to view and perform the proposed tasks. This tool is the exercises viewer, a working environment where to load any image generated by the exercises editor.

Different tasks can be accomplished in the viewer, according to the necessities of the user. The student should be able to develop the questions, problems, skills that have been included in the image. Perhaps some of the questions have been prepared to be answered in the frames created for that purpose. On the other hand, some other questions have been proposed to be solved or answered in separated sheets. Once the student has finished the tasks included in the image, there is an option in the program for visualizing the hidden information. This hidden information will be, in most cases, correct answers or suggestions for the tasks proposed. So, the self-evaluation in the learning process can be carried out.

In Fig. 4 it is shown an example screen in the exercises viewer, with an activity proposed about a work of art in a church. Observe that some controls are used to answer the questions proposed. In the control placed at the bottom, the solution must be chosen from some statements. Note that the solutions to the exercises do not appear visible to the learner, until the right option is pressed.

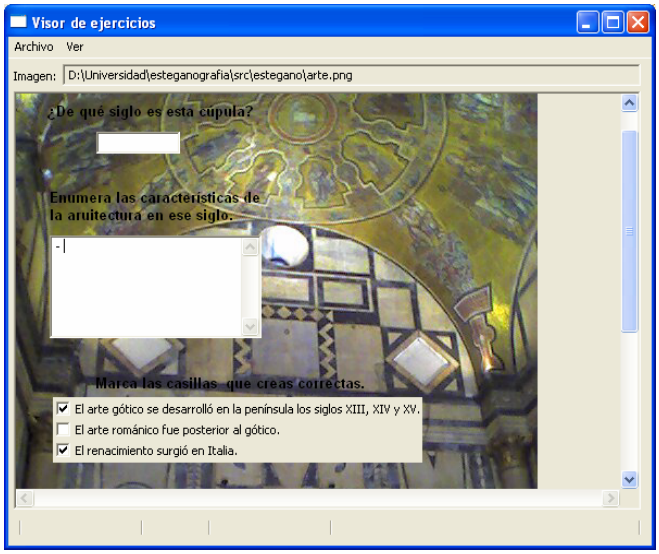

Fig 4 Some questions in the exercises viewer.

It must be remarked that in the exercises viewer there exits the possibility to see the hidden information; thus, when the option 'see solutions' is pressed it is possible to see the hidden controls. Such a way, the self-evaluation process can be concluded. There is no restriction about the moment in which the hidden information can be visualized.

5 Examples

We must be aware there are times when well-designed tutorials are not efficient and motivating. A working environment like the proposed in this paper may be of great help in those cases when the learning process requires more direct inmersion in a problem or situation.

The term problem solving has been used throughout this paper in a very broad sense.

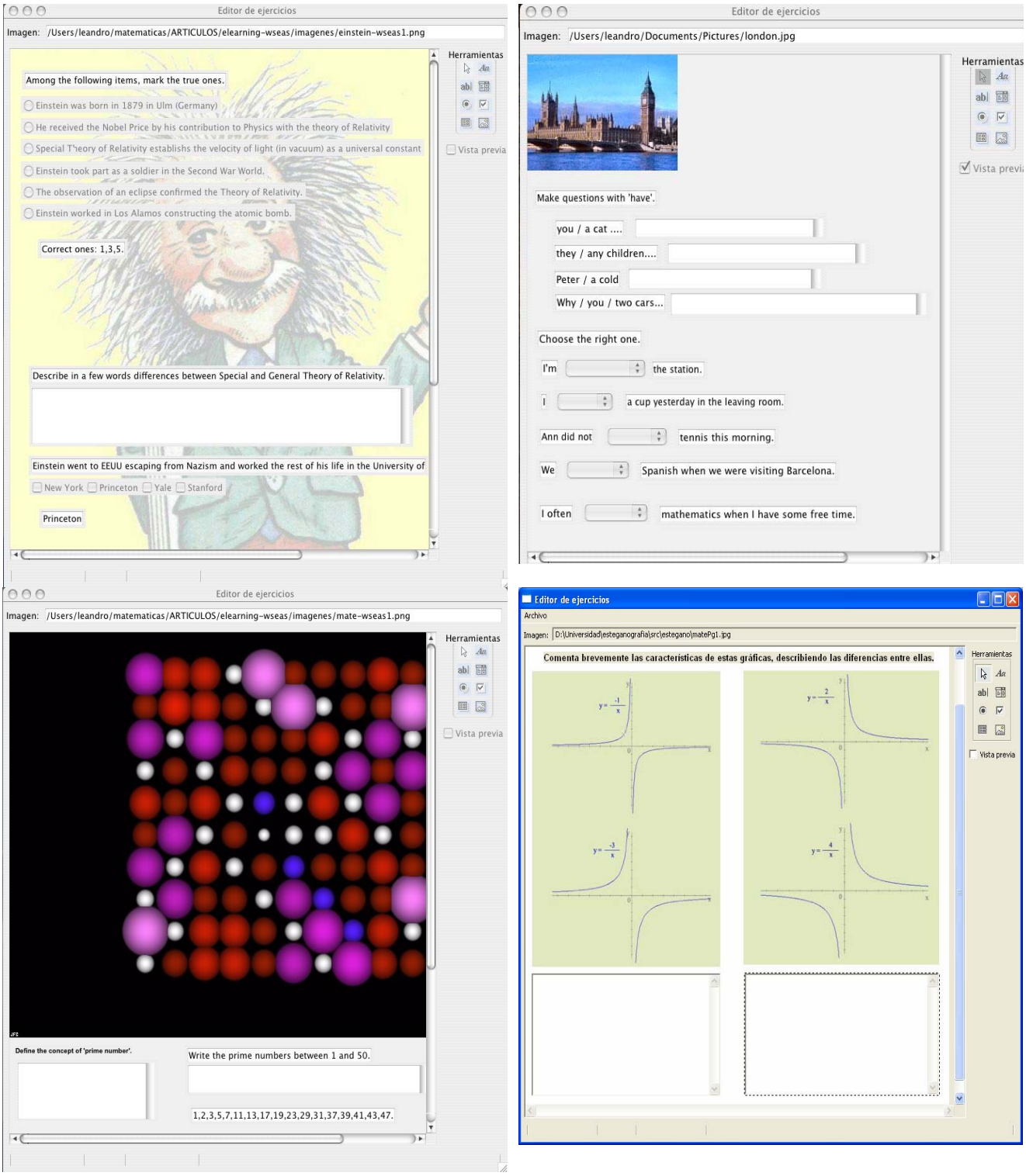

Fig. 5 Examples of exercises created with the exercises editor.

Thus, it includes activities such as accomplishing a task, making a decision, answering questions, and solving a problem. Therefore, it is also remarkable that this learning environment may be applicable to different subjects. The only restriction that must be carried out is that some images are needed to insert the tasks that the learners must perform.

We can see some examples in Fig. 5. All the examples have been created with the exercises editor and the images have been used to hide the solutions to the questions proposed.

The solutions are visible in the exercises editor, but remain hidden in the exercises viewer. For these cases, only one bit were used to hide the information,

although it is possible to use more bits, since the volume of the information to be embedded is small. Some experiments with color images show that it is possible to use two, or even three bits per byte and the human eye is not capable to notice the modifications introduced in the original image.

6 Conclusion and future work

Little consideration in the literature has been given to specific needs of the students. One of the main features of the system proposed in this paper is the personalization of the learning process; that is, a system where learners with different learning goals and different learning aptitudes are treated differently.

This learning environment is based in the construction of an exercises editor and an exercises viewer. The exercises editor permits the teachers propose tasks to the students. Moreover, the introduction of steganographic techniques in the editor allows hiding information in the images loaded in the editor. This hidden information can be visualized by the learner in the exercises viewer. Such a way, anyone can check if the tasks proposed have been correctly answered.

The future work is related with the possibility to create a learning environment where both students and teachers were in touch one each other. The objective should be to create an efficient communication environment teacher-student or student-teacher where the specific necessities can be transmitted. Therefore, the personalization of the learning process is improved, sine it is possible to create exercises or propose tasks according to the individual characteristics of the students.

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