Virtual characters as study guides. Evolution towards a virtual collaborative learning environment

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Summary. An analysis of the characteristics of the use of virtual characters in hypermedia study materials is carried out. The results of using characters in study materials for the introductory course to Computer Science majors are presented.
Instructor and student characters act as companion buddies during the study, providing indications, guidance, and eliciting questions.
The research lines required for transferring these characters to a virtual environment that is "intelligent" and collaborative are described.

Key words: multimedia, hypermedia, virtual characters, collaborative virtual environments

1 Introduction

Our teaching experience indicates that, when starting any university major, and particularly in the case of Computer Science, students have to face new situations that they need to overcome in order to be able to succeed in the university environment. These situations are strongly related with cultural, social, and emotional aspects of new students, as well as aspects related to the incorporation of information technology in a different academic environment.
Taking this into account, a proposal aimed at incorporating and using ICTs in the learning process is analyzed.
A working methodology favoring student motivation during the initial stage of their majors is established, promoting innovative educational proposals to assist them during the learning process. In this paper, the results of a magister thesis in Information Technologies Applied to Education are presented [10]. Within this context, educational contents and materials of the introductory course have been reviewed, and a new proposal emphasizing the introduction of information technology resources to be used during the learning process in order to promote and facilitate the incorporation of the new concepts and contents that students will learn during this introductory has been produced [6] [12].

In a general context, the proposed contents are considered to be suitable to successfully level all students; however, it is clear that students will have to make a considerable effort to incorporate these contents due to their insufficient previous training and the brief duration of the course.
For this reason, an additional hypermedia web resource is incorporated to the proposal so that students can chose when and where to study the topics included in the introductory course. Thus, by combining a high interactivity level with the contents, the possibility of analyzing various situations based on eliciting questions, having more time to assimilate the concepts, and the option of completing systematic evaluations, students will be immersed in a favorable environment to stimulate satisfactory learning situations.
This new educational space that combines technological aspects and multimedia features will allow the incorporation not only of new knowledge, but also of skills, aptitudes and attitudes that will play a role in the development of the students' critical and reflective thinking [7].

2 Theoretical framework

Cognitive learning theories emphasize the acquisition of knowledge and internal mental structures. These theories are mainly aimed at the conceptualization of the learning processes of students, and they analyze how the information is received, organized, stored and located. Through these theories, knowledge acquisition is described as a mental activity that involves internal codification and structuring on the part of students. In this context, students are seen as a very active participant in the learning process.
Additionally, the “situational learning” [11] considers social interaction as an essential component of the learning process. In this context, knowledge is derived from the activity, the environment, and the culture to which students belong. A significant concept in situational learning is that of "authentically activated", that is, the activity is defined by a community of practice and not by an academic analysis of contents. The purpose here is not that of recovering intact knowledge structures, but rather, that of providing students the means for them to be able to create novel understandings that are situationally specific by "assembling" previous knowledge, obtained from different sources relevant to the problem at hand. Constructivists highlight the flexible use of previous knowledge more than the ability to remember pre-produced ways of thinking. There seems to be agreement among the various perspectives of constructivism [8]. These agreements are based on:
a) The learning process is (or it should be) an active meaning construction process rather than an information acquisition one.
b) The instruction process is a support or mediation process for this meaning construction process that goes beyond the communication or transmission of information. There is also agreement in considering that, as proposed by Jerome Bruner, knowledge is not in disciplinar contents, but in the constructive (or co-constructive) activity of the person on the content area, the same as in any given socio-educational context.

Rogoff and Hernández, among others, have established significant distinctions among the main constructivist psycho-educational paradigms that become instructional approaches. They mention, among others, a model called “instructional model of experts and beginners”, where the actions of the educational agent are emphasized: experts are in charge of modeling and promoting certain knowledge on beginners. In this sense, the experts in the model would help favoring and bringing beginners closer to knowledge by means of the mechanisms normally used for their tasks.

3 Creation of virtual characters

The incorporation of virtual characters to study materials is developed by means of a “multimedia script” process. The initial idea of the script is answering these questions: "what is the purpose?" and "who is it aimed at?". Ideas then become texts, images, and sounds. To this end, it is advisable to have a work routine to structure contents [9]. This work routine for creating scripts will have the following phases: contents, narration, icons, sounds, and technical aspects.

Script contents are given by the textual material that will be used in the various sequences and the way in which this material is inter-related through a conceptual hierarchy that will go from general to specific.

The narrated script establishes the way in which information will be presented. It is equivalent to what is known as literary script, indicating point of view and style.

The iconic script shows the images that are available: graphs, photographs, figures, charts, video or animation images, and at which time of the narration these will be used.

The sound script is developed synchronically with the narrative script. Sound records must be sequential, and this sequence will be indicated by means of an order number.

The technical script is produced by computer science professionals as they become acquainted with the idea of the educator. It consists in defining the bases for development, methodology, programs to use, presentation formats, screen design, effects to be used in each section, etc.

At present, various resources that allow designing through a prototype technique are used. It can be of disposable or evolutive nature. In the case of disposable designs, a slide or screen presentation product is normally used to simulate and present the contents script. This product is then passed on to the programmer, who uses it to extract the information and build the final product in another format and with another software application. In the case of evolutive designs, all work is done with a software application that allows generating the final study material.

Bou Bouzá [2] takes movie script elaboration principles and applies them to multimedia scripts. Movie scripts, the same as television scripts, have three elements: discourse, performance and message.

In multimedia applications, the discourse element of movie scripts is equivalent to the information to transmit, that is, what we want to tell. The performance element is present as performance components. The message or background can be found behind the plot or in the conclusion drawn from the story we are being told, or the information provided.

In the design of educational applications, Bou Bouzá establishes two types of possible scenes: those related to the educational strategy, called "educational loop", and those used as strategy companions or support, called "narrative loop". The term "loop" refers to the repetition of a succession of similar elements. The narrative loop is used in this context to accompany the educational process, for instance, by describing concepts or asking questions that guide students in their learning process.
It is desirable that applications make users apply their own experience to what they are learning through educational loops; in this way, the narrative function acts as a reinforcement of the educational function. For example, a series of practical exercises would be part of the educational loop, and it would be accompanied by narrative loops to introduce concepts or present the corresponding final conclusions.

4 Developing characters

The creation of virtual characters is tackled taking Bou Bouzá's script generation concepts as a starting point, and adding Rib Davis' characterization suggestions. The experts/beginners model is used for the construction of a cognitive model.
Rib Davis, the same as Bou Bouzá, works on movie scripts and presents the characteristics required for building characters, which is useful for the development of multimedia characters.
Scripts are filled with characters. The character creation process can be seen as "a compilation of individual fragments taken from here and there", not randomly chosen, but selected with the intention of creating with them characters that are both credible and appropriate for a specific script [15].
Characters are defined from a set of "personal features", in addition to a scenario, a history and one or more objectives. According to Rib, the ingredients needed to build a character are those that result from an individual and that make each person different from the rest. Even though Rib describes how to create characters for theater, cinema and literature, the elements used for creating these can be adapted to the creation of virtual characters within a multimedia script.
In order to create a character, three basic aspects have to be considered:
a. How is the character when it is born (due to genetics and its environment)?
This is called "Birth features" and they include: gender, race, social class, family background, and name.
b. How does the character change and evolve through learning and experience?
This aspect considers features related to education, aptitudes, family, sexuality, background history.
c. How is the character now?
This aspect includes age, appearance, friends and foes, vision of the world, beliefs, personality, use of language, commonly used expressions.
Virtual characters are built taking into account that they are going to accompany students through the multimedia play, pretending to be helpers or as guidance for the learning process. The expert/beginner model refers to the desired cognitive characteristics for each character.
In the case of experts, unlike beginners, it can be said that [3][4]:

1. They are aware of the most significant characteristics and patterns of information.
2. They have acquired a great deal of knowledge, and this knowledge is organized and available in such a way that it shows a deep understanding of their object of study.
3. The expert knowledge is not reduced to a set of facts or propositions, but it reflects application contexts, that is, it is "conditional" or it is subject to a set of circumstances.
4. They can retrieve, with little effort, the most relevant aspects of their knowledge.
5. They have a thorough knowledge of the discipline or area of knowledge; however, this is no guarantee that they are able to teach others.
6. They have various flexibility levels in their approach to new situations.

Experts are able to faster automate the operations involved in information processing, which allows them focusing on higher-level processes such as analysis and synthesis. Thus, they know the context, they operate, and they know how to successfully "move" in it [17].

5 Experience carried out. Characters for the EPA module

The contribution of this paper consists in the creation of three virtual characters for a module of the introductory course to Computer Science majors at the UNLP.

The introductory course is given on a classroom basis and has a duration of 6 weeks including diagnostic tests. The module selected is that of "Expression of Problems and Algorithms" (EPA). In this module, students tackle problem resolution and algorithm development topics using a basic programming language called Visual DaVinci, which contains a set of instructions focused on teaching control structures and modularization in algorithm expression [5].

In EPA, students must put into practice their cognitive skills to solve problems. They usually face obstacles during the learning process, based on which different teaching strategies are sought.

A study of the mistakes made in diagnostic tests in 2006 and 2007 was carried out, and the most common difficulties for problem resolution were identified. In theoretical and practical classes, as well as in surveys carried out by the faculty in previous years, it was noted that students had difficulty in reaching the abstraction level necessary to solve problems that have to be solved with computers.

Based on the data obtained, students indicate that they have difficulties when solving one specific problem presented in the diagnostic test. Sixty percent of students indicate that they do not know how to correctly break down the problem into sub-problems and, if they are able to do it, they are not able to correctly communicate the modules. The most common problems are related to problem interpretation and contents related to modularization and parameter conversion concepts.

These issues that present difficulties for most students are selected for this experience, so as to favor learning strategies with hypermedia material including exercises accompanied by tutorial features.

To design the material, the cognitive skills required to solve problems are analyzed. In order to clearly present the necessary steps, a multimedia script is developed introducing the use of characters for the different conflictive situations, so as to

facilitate the task and provide guidance aimed at reducing the gap between the beginner and expert knowledge.

The incorporation of characters is aimed at generating a strategy that helps students make the transition from high school to university by improving the understanding of the topics to learn. To this end, the characters are conceived from various study areas that provide a structure of knowledge areas; students are familiar with this type of organization because high-school subjects are grouped in study areas.

The story presented by the three characters guides the learning process, and the discourse used is based on this guidance and usual doubts students have when learning the first steps of algorithm generation. In this case, three characters are used: two tutors and one student.

"Tutor" characters help the student and provide guidance from their respective areas of knowledge. The "student" character is a possible student model for this material. For "expert tutors", various knowledge areas were analyzed through the cognitive characteristics of renowned experts in each possible area [14]. Thus, two characters were selected, and their characteristics analyzed and adapted to each of the personality stereotypes.

The selected study areas are Computer Science and Philosophy. These two areas allowed creating characters based on their "expert" characteristics. The personalities selected for the tutors were Socrates and Ada Byron King, since they both have interesting expertise levels to help beginner students in the resolution of problems with a computer.

In the case of the third character, a student with learning difficulties was selected.

The character "Ada" is named after the original personality, but, instead of reflecting its original time of existence, it is a contemporary female with no reference to social class. The real educational characteristics are also kept and it is presented with a successful and creative intelligence. Ada knows that she can apply her cognitive strategies to the resolution of problems that are not only of a scientific nature. She is fun and addresses students in a nice manner.

"Soca", the second character, is a pseudonym for Socrates. This is a male character and his features are those corresponding to his time; however, his appearance is more related to Native American features. He uses his communication skills and resorts to questions to provide cognitive clues to guide students.

Edu, the student character, is short for Eduardo. This is a male character. He represents a student that is new to the university environment, originally from out of town, who decides to move to this city and study at the National University of La Plata. He is likeable and is at a loss with the new topics he must learn. He asks for help, both to his tutors and the real students that are using the study material.

Figure 1. Characters of the EPA module: Ada, Soca and Edu

6 Results obtained

The material was used during the two weeks that preceded the diagnostic tests of the introductory course to Computer Science majors. A total of 24 students participated.
The material was designed following the evolutive prototype method.
A classroom workshop was prepared to share the experience of using the material, and to review its structure based on the use of the students.
The students used the material at home, and there was a classroom workshop for those students who used the study material. To assess the material, a survey covering several items was conducted.
One of these items was related to the essential features that identify each character and their relevant participation in the material. It included statements that should be graded in the following scale: I strongly agree, I agree, I agree a little, I do not agree. In the case of virtual tutors, their strengths as study guides are ascertained. In the case of the student character, the statements were aimed at determining how closely real students identified with this virtual model.
In the case of Soca, the statement was: "With the help of Soca I was able to ask myself more questions before I started writing the solution to the problem in Visual DaVinci." In this case, one of the highest agreement rates was recorded: 70% "I agree", and 25% "I strongly agree". Both categories add up to 95%. Soca is fundamental for the methodology on which the material is based – asking questions and helping students be able to ask themselves questions to analyze the solution before writing it down.
As regards Ada, the statement was: "With the help of Ada I was able to easily understand the main aspects that could be solved and the data required"; here, there was a 75% rate of agreements, one disagreement, and 25% of the students could not answer this question. If these results are combined with the age variable, interesting facts can be noted. The oldest student (47 years old) is the person who disagrees. The students who did not answer are all between 17 and 20 years old, and belong to the same group that could not answer other questions of the survey.
The least agreement rate corresponded to Edu. The statement was: "I identified myself with the character Edu". This question had the lowest percentage of agreements – 45% (30% strongly agree and 15% agree). The youngest students

answered in the 45% group, whereas older students either agreed or disagreed. The 47-year-old student strongly disagreed. The total number of disagreements added to 40%, which is to be expected due to the average age of the group of students who took the survey and the features of Edu.
One of the first conclusions mentioned, the use of characters was appealing to all participating students.
The use of various study areas forces students to review the material and adapt it to the new discipline in order to be able to present it. The use of characters makes the presentation of the various topics more appealing and facilitates the introduction of the study areas.
The recreation of expert tutors from different disciplines took into consideration the analysis of the cognitive processes required to facilitate an approach between beginners and experts. This allowed generating the features of the characters Ada and Soca.
Students identified the character Edu as their equal or peer. It requires a greater interaction degree to allow molding the character to various preferences.
Among the modifications that can be introduced, it would be interesting that students could create their own student avatars o "being able to build themselves", as students frequently mentioned. This creation refers not only to the physical appearance and gender of Edu, but also to its personality and knowledge level. In the case of "personality", different profiles presenting Edu as disoriented as regards the topics, a know-it-all, hasty in his or her answers or with difficulties to reason can be generated.

7 Work proposal: Evolution of the characters

The idea is providing all characters with a certain "intelligence" so that they become "virtual intelligent pedagogic agents." A pedagogic agent can be defined as an intelligent agent who observes the learning process of the students and makes decisions regarding how to better help each particular student. This agent can act as: tutor, apprentice, or assistant. It can help small groups of students who are collaboratively working in their learning process [1][18].
Students would move within a collaborative virtual learning environment which would be focused on what is being communicated and the assistance provided to the students so that they can learn together. This must be tackled with a suitable methodology that should include training activities for teamwork that promote the development of cognitive strategies for the group task specialized in a study or expertise area [16].
The work carried out with the characters and their level of expertise allows establishing possible reasoning strategies for pedagogic agents. The type of virtual activities to develop needs to be reformulated so as to favor the distributed learning process and integrate virtual pedagogic agents in one environment.

8 Conclusions and future lines of work

The creation of the script for each character is a creative process that allows incorporating various multimedia discourse elements, ranging from voiceover, the introduction of the characters, their story and personality, to the presentation of procedures, cognitive clues and pieces of advice for the learning process. For the incorporation of each discourse, the task being introduced was considered, as well as the required cognitive processes, and a development of the software prototype that incorporated the hypermedia technology that was suitable for the topic.

Tutor characters are accepted as study guides. In principle, both profiles seem to be necessary for the resolution of problems with a computer – one of the profiles to teach how to reflect on the problems, and the other profile to guide students on the details of the concept they must learn.

In this context, students valued the interactivity that can be achieved with the object of study, which is evident from the numerous comments and answers to the survey question asking them to mention some characteristic that they found useful to understand how to solve problems with a computer – several students explicitly mentioned the advantages offered by the "interactive top-down" method. They also mentioned that being able to browse through the links of the diagram allows them to clearly see how the program works. Through the links, they can have a general view, as well as a view of the parts and the detail currently selected.

The development of interactive images to structure the reasoning process required for the development of an algorithm is also important – 60% of the surveyed students stated that being able to access the "interactive top-down" design helped them understand "how to build the solution to a problem and, from there, obtain the code or program."

This work has been designed considering aspects of the teaching-learning process. The proposal of assisting students with collaboration-based virtual learning environments implies achieving a suitable specification of requirements for the pedagogic agents, as well as researching tools and methods for the design and development of intelligent virtual environments.

From a pedagogic standpoint, instruction structures must be conceived and designed to allow collaborative work in the learning domain taking pedagogic agents into account.

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