THE SIMULATION AS AN INNOVATIVE TOOL IN MEDICAL EDUCATION

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Abstract:

As students of the Italian University Institute of Rosario and based on our experience with the use of automatized systems for learning purposes, in addition to our practice in the development of two learning softwares as undergraduate assistants to the chair of Medical Cybernetics and Bioinformatics, we believe that simulation is a useful method in Medical Sciences, either when used for educational or testing purposes. It accelerates the student learning process and removes many of the inconveniences the patient and the organization of health services undergo during the learning process. We can thus conclude that the simulator is an innovative tool that effectively supports medical education.

Key words: Learning, Computer-assisted teaching, Educational software, Memory trainer, Simulation.

1. Introduction

At the Italian University Institute of Rosario (IUNIR), our learning environment, simulation and skill training have been educational options for many years, and they are currently part of the formal content of undergraduate courses. These are some of the areas in which simulations are used:

- Biostatistics
- Basic and Experimental Surgery
- Histology
- Hospital Practice
- Surgical Clinic

Based on our rich experience in the use of the simulators mentioned above, we intended, as a general objective, to prepare a package of electronic simulations. The first is a memory trainer called "TUBERCULOSIS: A SPREADING EVIL" and was devised for the teaching of a contagious disease - endemic in our country- such as Tuberculosis, through a theoretical framework in which all aspects of the disease are developed, thus integrating content from other courses such as Microbiology and Virology, Pathological Anatomy, Semiology, Cybernetics and Medical Bioinformatics. This, in turn, allows the evaluation of theoretical knowledge acquired in the section dedicated to hands-on practice.
Likewise, Histologic Simulations for the DIGESTIVE TRACT are designed to train the student's visual skills, so that the learner is able to recognize histological structures by observing them.

The specific objectives are: 1) to design and make two electronic simulations on Tuberculosis and Histology; 2) to implement them in the educational setting of the IUNIR as an innovative, cost-effective teaching and evaluation method; 3) to upload the simulations to the network of simulations so as to achieve a widespread distribution of projects and reach as many people interested in the subject as possible; 4) to contribute to doctor’s qualifications, thus providing the community with medical professionals with a higher scientific level and better skills in clinical decision-making regarding these entities.[1]

The simulation summarizes all the theory related to a process, in which real situations are replaced by artificially created ones. The student is expected to learn from these artificial situations certain actions, skills and habits which he must then apply in real life with the same efficiency.

These models offer a “problem-solving” opportunity in an atmosphere of motivation and interest from the student.

From the ethical point of view, the use of simulation as an educational tool should be supported by the fact that it:

1. Provides students with better training.
2. Allows a more objective evaluation from professors.
3. Leads to and finds errors in medical practice.
4. Respects and preserves patients’ autonomy.
5. Respects and preserves health professionals’ autonomy.

1.1 Simulation - Training and skills

Only when knowledge, action and being are integrated into a single channel, will a real balance of knowledge be achieved. This will define the individual as competent, skillful and expert, always denoting that the ability to solve situations is given by the integration of skills supported by knowledge and performance.

2. Comparison to Previous Work

By comparing our work to a previous histologic simulation, we can remark the following differences:

- It does not evaluate student theoretical knowledge, but his ability to recognize different histological structures by observing.
- It focuses on the digestive tract.
- It answers the student need for more practice on the microscope.
- It includes photographs of the university's own preparations.
- At the end of the session, the student is given the references for all those structures that were supposed to be identified.

With respect to the simulator "TUBERCULOSIS: A SPREADING EVIL", no previous work took a specific pathology and developed it through computer simulations,
enabling its learning and evaluation. That is to say, the work we have introduced into our field is innovative and of proven effectiveness. This application is used as support material for the teaching of this disease, interactively displaying the concepts needed for learning the subject.

The main advantages of our simulations over previous ones are:

- It has a **low developing cost** due to the simplicity of the technology used, being this quality extremely valuable due to the minimal budget assigned to investigation works.
- Thanks to being on the net, they have **widespread diffusion**: an increased number of students have access to them.
- They are expected to be translated into other languages (English and Italian).
- The software created by the students of the institute is subject to **constant updating** and feedback of information as knowledge progresses in the area of health and scientific knowledge.
- The design of the web pages used, minimizes the specific knowledge in informatics required, both for the designers of the simulator and for the people who are going to use it as an educational-learning method.

## 3. Application

### 3.1 Characteristics of the simulations as an educational tool

The simulation has many uses in education:

1. **Informative function**: Its activities offer content that provides students with structured information of reality.
2. **Instructive function**: Educational tutorials guide and regulate student learning because, explicitly or implicitly, they promote certain behavior from users to facilitate the achievement of specific educational objectives. They direct the activities of students based on their response and progress. In this way, the computer acts as a facilitator in building student awareness.
3. **Motivating function**: Students are usually attracted and interested in educational software, because programs often include elements to capture users’ attention, maintain their interest and, if required, target the most important aspects of the activities.
4. **Evaluation function**: The interactivity that these materials promote allows immediate feedback for the responses and actions of students and makes the simulations particularly suitable for the evaluation of the work being done on them.
5. **Investigative function**: Simulators and database programs offer students interesting context for research and specific information search.
6. **Expressive Function**: Since computers are machines capable of processing the symbols through which people represent their knowledge and communicate, its potential as an expressive instrument is huge. Students use the educational software to express themselves and communicate with the computer and with other classmates through the program activities and, specially, when using programming languages, text processors, graphic editors. Furthermore, computers do not allow ambiguity in its "dialogues"
with students, so learners are forced to care more for the accuracy of their messages.

7. **Metalinguistic function**: Using operating systems (WINDOWS) and programming languages (BASIC, LOGO) students can learn the language of computing.

8. **Playful function**: Working with computers to devise educational activities is a task that often has playful and festive connotations for students.

9. **Innovative function**: Simulators turn pedagogical approaches into innovative methods, since they use a technology recently incorporated into the educational centers and, in general, allow various uses (videos, images, sounds, colors). This versatility opens wide possibilities of didactic experimentation and educational innovation in the classroom.

The simulation has four main uses in education:

- In the learning-teaching process: The simulation software is presented as a computing proposal conducted for improving the teaching-learning process in the training of health personnel of the various Medical Schools in the country. It improves learning, the student moves into new items only when the preceding ones are mastered.
- In the evaluation.
- In the acquisition of practical skills.
- In the identification of learning needs.

Its use depends on some requirements:

- The preparation of orientative guidelines for students and methodological guidelines for teachers including clear objectives.
- An initial practical demonstration from the professors with a theoretical introduction.
- Student self-training.

4. **Method Rationale**

Methodology used for the execution of the simulators: “Histology of the Digestive Tract” and “Tuberculosis: a spreading evil”.[2]

4.1. **Bibliographic review on the topic**

A review of the printed and electronic materials that deal with the subject was carried out, focusing on the textbooks listed in the course programs for Pathological Anatomy, Microbiology and Semiology as basic, complementary and reference literature for the teaching of tuberculosis in undergraduate Medical School; as well as in the books of Histology- particularly those chapters addressing the digestive tract- and under the guidance of the Institute’s Professor of Histology.

The simulations we create, consist of an educational software that will operate as a tool for course program support to achieve the integration of theoretical and practical aspects of the subjects involved.
In order to delimit the contents that each simulation would reflect when used and define the pedagogic strategy to follow, the goals, knowledge and skills regarding Tuberculosis and Histology, which are established in the course programs of the subjects named above, were identified.

4.2 Rationale for the selection of the simulation as a more suitable educational software and the electronic platform to be used

The simulation [3] promotes learning by deduction, by observing the response in real time. The simulator requires that students have appropriate prior knowledge on the subject, so that it can meet its objective- to assess the appropriate acquisition of knowledge and decision-making.

4.3 Virtual Environment and Tools Used

The tool used to make the simulations was a simple Web page editor such as the program FrontPage 2003, which in addition to its simple handling and ease of working with images, sounds and videos, can be used in a Web platform in the field of Medical Sciences and can be accessed via the Internet.

It provides an interactive and simple Medical Learning Educative Environment thanks to the multimedia resources and its ease of use, offering the user a convenient setting to learning.

Considering that we are pre-grade students and we do not rely on a large budget we decided to work with FrontPage as it poses the following advantages:

- It is included in the program package of Microsoft Office.
- It is used to create web sites rapidly.
- It gives the opportunity to create and change the Web site as well as any particular Web page, allowing its edition and maintenance.
- Its use is simple and it is possible to publish Web pages without knowing HTLM language.
- It is a fast, economic and reliable system, highly suitable for beginners. It is easy and intuitive to learn and use in the creation of web-based didactic material. It combines the simplicity of creating educative assistants with the inclusion of certain dynamism through the scripting, and at the same time, a global administration of the whole project using hyperlinks, web surfing and directories.

The simulator “Tuberculosis: a spreading evil” provides exercises and a theoretical framework as well, in which all aspects of the disease are widely developed; therefore it will be visited not only by medical students but also by anyone else interested in knowing about the disease.

The simulators will work with client-server philosophy and consist of two modules, one of edition for use by the programmer and another of execution, for the student-machine interaction.
4.4 Design of simulations

The design of the simulations was conceived so that they allow learning consolidation and practice in decision making, enabling, in turn, the exploitation of all the benefits and facilities provided by the computerization of the medical sciences. A preliminary design of the overall structure of each simulation was drawn on paper and in Microsoft Word. Subsequently, each of the simulations was produced using Microsoft Front Page, taking into account the contents to include, based on the requirements of the course programs for Pathological Anatomy, Microbiology and Virology, Semiology and Cybernetics, and the way in which the items would be exposed for decision-making and feedback through the different objects (images, animations, text and videos). The Histology simulator made use of the IUNIR histology lab own images to create the simulations.

4.5 Evaluation

Once the first version of every simulation was completed, it was assessed according to experts' criteria: professors in charge of the subjects involved in the Project, as well as a Systems Programmer, concluded that the simulations created were functionally, conceptually and pedagogically reliable.

Finally, the simulations were tested on several machines in the computer lab of our institution without any conflicts being detected.

![Simulation of Microbiology](image)

**Figure 1**: Simulation of Microbiology in which the student must choose the correct option.

The simulation involves situating a student into a context that mimics some aspect of reality and setting problematic or reproductive situations similar to those he would face in real life. At the beginning of the session, the student must identify himself. Each new practice is then saved in the system, allowing a permanent monitoring of the student.
As the simulator corrects the student's exercises, it sums up the score for each exercise completed successfully. At the end of the program, the student is given a final rating, which is automatically converted by the application into the current evaluation system of Excellent, Good, Fair and Poor.

It also presents an on-screen mapping of everything done, pointing out in what options mistakes were made, compared to the proper management of each step, as final **positive feedback** for the student.

![Simulation of "Histology of the Digestive Tract".](image)

**Figure 2:** Simulation of “Histology of the Digestive Tract”.

The simulation of histology, in particular, aims to train the student’s visual skills by making him work out the given situations based on the structures found on each image (former glass slide) and not only on his theoretical knowledge. This design makes this program a useful self-evaluation tool, and a didactic way of acquiring new practical skills while enabling the identification of emerging learning needs.

5. **Advantages of simulation over other teaching tools**

- It allows the easy examination of words, images, sounds, animations and videos, interspersing pauses to thoroughly study, analyze, reflect and interpret the information used, thus looking for the desired balance between sensory stimulation and the ability to abstract thinking. [4] Accordingly, the multimedia technology becomes a versatile tool that transforms students from passive recipients of information into **active participants**; it **personalizes education** by letting each student progress at their own capacity and availability of time.
- It is **interactive**; it provides an immediate answer to the actions of students and allows a dialogue and exchange of information between the computer and students.
- It is **easy to use**. The knowledge required to use most of these programs is similar to the knowledge of electronics required to use a video, that is to say, minimal, although each program has different operating rules which must be known. The educational software is made up of computer programs created with the specific purpose of being used as a teaching tool, that is to say, to facilitate the processes of teaching, learning and assessment.
- **Ethics in health**: It eliminates many of the inconveniences that patients and the organization of health services undergo during the learning process.
5.1 It allows the student:

- To learn and show what has been learnt
- To obtain real features during the practice
- To carry out self-evaluation
- To reduce the time required for learning and applying that knowledge
- It is a relatively flexible and efficient process
- It can be used to analyze and summarize a complex real situation
- In some cases, the simulation is the only tool available
- The error is used for learning purposes: it can be maintained and repeated as many times as needed during the simulation to make the student aware of the consequences of the error and learn to recognize and treat it properly.
- Students can use a learning method that adapts to their pace of learning and availability of time
- It provides potential access to ongoing education and maintenance of the skills acquired.[5]

6. Conclusion

The simulation is a really useful teaching-learning method in the clinical-epidemiological cycle of Medical Sciences courses. The kind of practice it provides is similar to the practice the student would carry out in real life.

The simulation offers advantages to students and teachers as well. It also has limitations, because it is able to mimic real situations but not to reproduce them exactly. The simulation does not intend to eliminate any step of the teaching process. [6]

The quality achieved in the educational software created, together with the inherently motivating nature of the simulation, the rigor in the design of the exercises, the pedagogical quality of the teaching activities and the harmonious integration of all these factors into the educational-teaching process, will contribute positively to the achievement of important objectives in the training of our medical professionals.

Simulation coupled with critical thinking and problem solving learning, has helped refine and understand the profound meaning of the competencies.

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