EduSol
Vol.18, Num.63
ISSN: 1729-8091
http://edusol.cug.co.cu

El software en el proceso de enseñanza aprendizaje de la Física
Software in the teaching-learning process of Physics

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Recibido: 23 de junio de 2017
Aceptado: 5 de octubre de 2017

Resumen: La observación a diferentes actividades docentes relacionadas con la enseñanza de la Física ha permitido constatar que no siempre el profesor dispone de conocimientos suficientes para utilizar el software como un medio didáctico para ese fin. Atendiendo a ello se analizan algunos principios didácticos y metodológicos que el profesor tiene que considerar para manejar este producto informático en su clase.

Palabras clave: Tecnologías de la Información y las Comunicaciones; Didáctica; Software educativo; Enseñanza de la Física

Abstract: The observation of different teaching activities related to the teaching of physics has shown that not always the teacher has sufficient knowledge to use the software as a didactic means for that purpose. Attending to this, some didactic and methodological principles that the teacher has to consider to handle this computer product in class are analyzed.

Keywords: Information and Communication Technologies; Didactic; Educational software; Teaching of Physics

Introduction

Technology is a systematic way of designing, carrying out, evaluating all learning and teaching processes in terms of specific objectives based on the research of learning and human communication, using a combination of human and material resources to achieve a more effective learning. (Pons, 1994)

It reflects on the application of the technique to the solution of educational problems, justified in the current science in each historical moment. It emphasizes the control of the teaching and learning system as a central aspect, and guarantee quality, at the same time it understands that the most important options are related to the type of technique that is convenient and how to incorporate it adequately (Sarramona, 1998). Technology aims to

erase that distance between unfounded efficiency and scientific knowledge, by serving as a bridge between technology and science. (Marti, 1992)

These approaches lead us to reflect on the importance of the use of technology in all areas of social development, which includes, therefore, education, which cannot, under any circumstances, be divorced from the advances of its time.

The last years of the twentieth century and those that have passed the twenty-first century have shown in the world an explosion of interest in the use of Information and Communication Technologies (ICT), in the teaching-learning process of the exact sciences.

At first, the ICT were linked only to the use of computers as technical support, but now other wide range of technologies has invaded the markets: smartphones, electronic tablets, to name but two examples, which allows expanding the possibilities of software employment.

ICT, when used appropriately in the teaching-learning process, can provide meaningful assistance (Pennington and Stevens, 1992), even without the immediate presence of the teacher or another person. For example, an advanced multimedia program can offer learning strategies, cultural information, and guarantee the development of skills (...) according to the needs and interests of the students. (Oxford, 1993)

Development

The computer in education

The use and varied ways of using the computer in education has sought from the beginning to satisfy certain needs of the didactic process, so it has been used as a teaching resource, as a teaching means, as an instrument of learning, and as an administrative support.

The use of the computer as a teaching means has popularized the use of computer programs, created with the specific purpose of using them as a teaching means to facilitate the teaching -learning processes. They are educational software, educational programs or educational plans.

According to this definition, more based on a criterion of purpose than functionality, all the programs of general use in the business world that are also used in educational centers with

didactic or instrumental functions such as: word processors are excluded from educational software, database managers, spreadsheets, graphic editors. These programs, although they can develop a didactic function, they have not been elaborated specifically for this purpose.

Area (2005) defines educational software as the set of computer resources designed with the intention of being applied in the teaching-learning process.

In Introduction to Computing, educational software is: "a computer application that, supported by a well-defined pedagogical strategy, supports the teaching-learning process, constituting an effective instrument for the educational development of the man of the next century" (Gener, 2000, p.54). This elucidation is very successful, since it covers beyond the instructive aspect of the teaching-learning process when considering its relationship with the individual's education.

Essential characteristics of educational software or programs

Educational programs or software can deal with different subjects (mathematics, languages, geography, drawing) in very different ways (from questionnaires providing structured information to students, by simulating phenomena) and offer a more appealing work environment, which is less sensitive to the circumstances of the students, and more or less rich in interaction possibilities But all share five essential characteristics: they are materials made with a didactic purpose, they use the computer as a support for students to carry out the activities they propose, they are interactive, they individualize the work of the students, they are easy to use.

Depending on these characteristics of the educational software, a grouping and a classification of them has been established, taking as a classifying element the function they perform within the teaching process.

Considering its structure, multimedia teaching materials can be classified into tutorial programs, exercise programs, simulators, databases, constructors, tool programs, with different conceptions of learning that allow, in some cases (open programs, author languages), the modification of its contents and the creation of new learning activities by teachers and students.

Gros (1997) proposes a classification based on four of these categories:

• Tutorial: teach certain contents.

• Practice and exercise: exercising a specific task once the contents are known. It helps to acquire dexterity.

• Simulation: provides learning environments similar to real situations.

• Hypertext and hypermedia: non-linear learning environment.

Gros distinguishes between hypermedia and multimedia, although the only difference would be linearity or non-linearity.

Another more generic classification is offered by Colom, Sureda and Salinas (1988), referring to computer-based learning, used as an instrument to help acquire certain knowledge. Computer Assisted Teaching (EAO) programs would be included here. The computer as an intellectual tool, facilitator of the development of cognitive processes, applied in the resolution of problems. The authors refer specifically to programming languages.

Martínez and Sauleda (1995) agree with Gros partially, although these authors include in the category "Instructional use" both tutorial programs and exercise and practice, and in the category "Demonstrative or conjectural use" the simulation programs (adding the ones they they call "realistic games" and "role games").

The educational software, according to what we have been able to appreciate, constitutes a valuable teaching means for the general education and training of the student. According to their characteristics and their type they allow their insertion into the process in direct support of the teaching-learning process, so they constitute an effective instrument for the educational development of man.

In order to ensure that the use of software in education plays an important role, it is necessary to take into account its quality, which must be measured in terms of the knowledge that they are capable of representing and transmitting. Therefore, it is necessary to make an assessment so that it is efficient taking into account the general objective, the educational, the technical, the aesthetic and the operational.

The great truth is that, in the same way that the multilateral and complex teaching-learning process requires a diversity of class types, methods and means to achieve the objectives, each type of software is oriented towards fulfilling functions. specific didactics and, as often happens, we find scientific truth, not by finding a single and universal link, but by means of formulas that reveal harmonious combinations of different existing paradigms.

Both teachers and students are increasingly interested in the use of ICT in the teaching - learning process, since the more visual the learning is done, the greater the volume of contents that will be processed and incorporated in the form of knowledge. In this way, a better retention and an increase of the self-esteem and the student's safety in relation to the solidity of their knowledge are also achieved.

The educational software can also be characterized according to a certain teaching strategy, so the use of certain software entails implementation strategies, implicit or explicit: exercise and practice, simulation, tutorial; individual use, competition, small group.

The creation of teaching-learning environments supported by computers requires the development of a specific software, which characteristics may depend on the learning needs to be met, the objectives to be achieved, the contents under study, the individual learning styles, the pedagogical strategical assumption and the conventions of local culture, among other factors. Consequently, the need arises to develop computer-based systems for educational purposes, commonly called courseware.

As can be seen, the software leads to certain learning objectives, sometimes explicit and sometimes implicit. This ambiguity in terms of its use and purposes is something habitual in our educational reality. The design of educational programs, when responding to a strict and careful planning from the didactic point of view, may not be matched in the implementation, giving a casual use and responding to specific needs. However, the inverse situation may also occur: a specific type of software not specifically designed, with diffuse goals and without defined recipients, can be used with a clear intention to achieve certain objectives in the class group. Both approaches are common.

When reference is made to the design and development of this software with a certain educational intentionality, more or less explicit, there is always a manifest or latent

conception about how the teaching-learning processes are produced. Therefore, the theoretical assumptions about the teaching-learning processes that underlie the development of educational software and how they condition it will be analyzed. When these considerations are not explicit, in many cases, the starting budgets may have a different origin, but in any case they respond to how the creators understand the teaching-learning process.

According to Gros (1997) these theoretical assumptions affect the contents in terms of their selection, organization, adaptation to users; to the strategies of teaching them and to their form of presentation, that is, to the design of the screens, and to the most effective way in which the user can communicate with the program. What is frequent is that, regardless of the intended purpose, the educator's conception of how to use a material will prevail.

It should be taken into consideration that some software is designed to be used within a regular teaching activity, oriented and directed by the teacher, while others are designed to be used by the student in their independent activity, after receiving prior guidance for its use, or simply in self-learning processes.

Considering the frequent use that is given to the computer within the teaching-learning process, it is important that some advantages and disadvantages of its use are taken into account.

Advantages: they facilitate personalized learning, they are multimedia and interactive tools, they reduce their prices constantly, and increase access at a distance.

Disadvantages: the development of computer networks is expensive, technology changes rapidly; there is still resistance on the part of adults to use this type of medium.

Based in the Vygotskian postulates, it is important to highlight the role of the adult in the learning process, offering scaffolding that will support the subject in their learning. To understand the concept of scaffolding, it is necessary to refer to another key point in Vygotsky's theory: the Zone of Near Development (ZPD).

According to Vygotsky (1979):

> It is nothing other than the distance between the actual level of development, determined by the ability to independently solve a problem, and the level of potential development, determined through the resolution of a problem under the guidance of an adult or in collaboration with another more capable partner. (p.133)

In this sense, some of the authors of neovygotskian tendency emphasize the important role played by the teacher in the use of educational software.

For each situation, the software application involves different processes and problems. Thus, the procedures and results of any activity based on the computer will emerge through the talk and joint activity between teachers and students. That is, the same software used with different combinations of teachers and students on dissimilar occasions, will generate different activities. These activities will be carried out on different time scales, will generate different problems for students and teachers, and will almost certainly have different learning outcomes.

Apart from the software itself, the fundamental influence on the structure and results of a computer-based activity will be linked to the figure of the teacher.

This technology can help to develop the teaching-learning process of Physics with efficiency and quality, always bearing in mind that the computer cannot replace the teacher, but contributes to play its role as facilitator, administrator and trainer when imparting knowledge necessary basic of this subject.

In the teaching of physics one of the most urgent tasks at present is the creation of methods and systems that help to solve the problem of finding optimal forms and regimes of work in learning in the shortest possible time, that is, solving the problem of effectiveness and intensification in learning. Therefore, it is necessary to intensify the teaching process, raise the coefficient of productivity and effectiveness both in classes and outside them.

The possibilities offered by ICT can contribute significantly to the creation of methods that help introduce new means to influence the intensification and optimization of the teaching-learning process of Physics. In the same way, the diversity and complexity of current knowledge requires that university curricula are constantly evolving into superior forms of

teaching where special attention to the cognitive activity of students is given, and their ability to independently extend their knowledge with the application of TIC.

But thinking about technological innovation is not enough to guarantee the success of the incorporation of the computer to education, it is necessary to carry out systematic approximations to the reality of the demands of potential users, which allows a quality education to be achieved where all individual graduates of any level are competent for self-learning, the exercise of critical and creative thinking, solidarity, and know how to take advantage of scientific and technological advances. (Benavides, 1990)

Within the teaching-learning process of Physics, it is important to highlight the determining role played by the solution of theoretical and experimental tasks, addressed by researchers such as Polya (1887-1985), Schoenfeld, (2003) and others, who consider that this is the basic cell, the fundamental nucleus within the process. A type of software that can be used to contribute to this process is the simulator software, since simulations have become an excellent tool to improve the comprehension and learning of complex subjects in some subjects, especially mathematics, physics, statistics and natural sciences. The simulations achieved with this type of computer product reduce to a minimum the training time required, which allows a greater concentration on the subject to be learned.

Many software simulators of physical phenomena are available on the internet that can be used for educational purposes, in most cases without cost.

Among the most used simulators in the teaching-learning process of Physics is Interactive Physics (IP). This free software application has been published in English and Spanish. Produced in 2005, it is the award-winning educational program of Design Simulation Technologies. It facilitates observing, discovering, and exploring the physical world through simulations; besides, it allows access to a wide selection of controls, parameters, objects, environments, and components; facilitates the use of objects, springs, joints, ropes, and shock absorbers; simulates contact, collisions, and friction; allows to modify parameters such as gravity and air resistance; measure magnitudes such as speed, acceleration, and energy of objects; and simulate the interaction between electrically charged particles, particles within a magnetic field, molecules subjected to different conditions, and

innumerable possibilities that will be analyzed in other contexts. In addition, he asserts that students master concepts of physics in a safe environment, free of expensive laboratory supplies and the time involved in preparing the laboratory.

It is almost impossible to master all the applications of this type that are now available in the network of networks. In this aspect, it is necessary to take into account two fundamental elements:

In first place: the teacher, in his role of facilitator of learning, must take ownership of the working philosophy of this type of computer product, that is, he must know in depth the management of the software.

Second: the teacher must have knowledge of the fundamental principles for the use of computers in the educational process. In this aspect, it is essential to emphasize, from the didactic point of view, what the use of computing in the educational teaching process presupposes.

When introducing computing in teaching, changes must occur in the main categories of the teaching system: objectives - contents - methods - forms of organization and evaluation of learning since, in this case, computing as a teaching means is dialectically integrated into it. In this system the relations are mutual since the fundamental didactic categories, in turn, act on the use of the computation modifying the forms and scopes of the same one. In other words, we must conceive the introduction of computing from didactic positions.

When the professor introduces the computer in his subject, he must take into account that the objectives can be reached with higher quality; that new knowledge can be addressed and that more active, reflective, evaluative and participatory methods and procedures can be used; which implies a different organization of the process; and that new forms of evaluation can be taken advantage of that lead to a more integral learning and to the verification of the development of more general and useful skills to live in a computerized world.

From the point of view of the personal components of the process (the student, the teacher and the group), the analysis must start with the teacher's diagnosis of the potential, needs

and needs of the students to be able to adapt the teaching task assisted by computers to this reality, and achieve their development through teaching activities where the search, construction or reconstruction of knowledge is present.

From all the above it is inferred that introducing computing in teaching does not mean in fact a modernizing contribution, it is necessary to change the very conception of the class to face the challenge of achieving a greater contribution of these techniques to knowledge, to the development of skills and the formation of values in schoolchildren.

On the other hand, it is also necessary to question how to prepare the teaching activity so that all the benefits of these technologies can be used.

Some basic methodological ways that guide the use of this technology are:

• Design computing as an element that facilitates the fulfillment of the actions that the student and the teacher must execute for the successful development of the planned teaching activity.

• Establish new ways to solve problems where the student can focus their attention on the conceptual elements rather than the operational elements and work in the search for different ways of solving and discussing the results obtained.

• Focus on the treatment of certain contents of physics where the quantitative is privileged from the inductive sequence: trace, measure, calculate, compare, propose and demonstrate, exploiting the possibilities offered by the computer for it.

• Print a computational approach to the study of algorithms and algorithmic procedures present in most science subjects, using the various forms of representation in order to better understand and use them.

• Support the development of a computer conception in students, familiarizing them with the need to collect, store, transform, transmit, access and interpret information in its multiple manifestations (texts, numerical data, sounds, and images); so that you can make inferences, deduce conclusions and offer recommendations enriching your training as citizens of a computerized world.

• Design the teaching activity in such a way that the student has to execute certain tasks, for it must foresee the use of thematic guides that can be sequence of problems that the student will have to solve making use of the program, the helps that he can provide to his classmates and the teacher, as well as the use of worksheets that keep the student making notes, diagrams, synoptic tables, etc. The use of these resources prevent the student from adopting a passive attitude towards the study material.

Conclusions

The software can be a valuable teaching means within the teaching-learning process of Physics, supported by a well-conceived learning strategy.

The use of software within the teaching-learning process cannot be conceived if we do not take into account the fundamental didactic principles for the use of computers in the educational process.

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