

## Analysing Computer Scientific Simulations from a Didactical Point of View

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### Abstract

*In the literature it is difficult to find accurate analysis of computer scientific simulations from the pedagogical and/or the scientific points of view. In software evaluation literature, computer simulations are frequently treated as generic items, explaining its advantages, or analyzing some features only from a "cosmetic" view. Nevertheless, simulations are used in the teaching/learning processes, so teachers need to have a critical understanding of them. A well-founded knowledge of the learning processes would be expectable from simulation designers or a close collaboration with science educators, since it has repercussions in the resultant application. Many different problems can be easily found when analyzing simulations and here we analyze briefly some of them from the view of the didactical conceptions that they ooze.*

### Introduction

The potentialities of informatics tools for Physics have been considered from many researchers. Applications focused to the improvement of labwork (through MBL or similar), specific applications as animations, computer simulations, java applets, modelling, etc. look like good tools for Physics classes [1], [2]. Teachers conceive these informatics tools to be integrated in teaching sequences, and thus it is worthwhile to analyse in detail what can we get from each of them and which are their underlying didactical conceptions. In these pages, we only refer to the computer simulations<sup>4</sup>. We establish a clear difference between animations and simulations [3], assigning to the former only dynamism of images and attributing a possibility of interacting and modifying parameters in simulations.

### Analyzing simulations

Given the large variety of applications corresponding to the simulation of certain physical phenomenon, teachers feel impelled to select the ones that fit better their needs [4]. A selective process entails to establish,

explicitly or not, criteria to choose or to refuse. We envisage here only some of the didactical features affecting in a relevant way the pupils' learning. Typically, in a computer simulation, we find a dynamic image that can change from the interactions computer-user, expressed by means of icons or by a text, as well some text proposing an exercise or a problem to solve. Analyzing these elements we can take an indication of the suitability of each particular simulation.

### Some features of computer simulations

We can take into account the following features:

#### 1) The questioning text in the simulations

There are simulations without any text where only some instructions are given. It is just necessary to run the application and to watch the screen.

If no text is present, there is no exercise to do, neither any problem to solve. We think it is worth to give more importance of questioning, as a way that can lead to find an answer, to solve a question, to satisfy a curiosity and thus guiding to interest in learning. Nowadays, less than never, we can imagine pupils waiting mildly any order (coming from a computer or from a teacher) to obey it quickly, if they are no interested on the action proposed. It is seen essential to promote challenges to stimulate their curiosity [5].

#### 2) Interpreting the role of the visualization

Many simulations looks like to be conceived having in mind that observation of interactive images of any physics system working is enough to understand how it works and, specially, it is the key element for understanding the scientific model that explains it. Everything happens as if images don't need to be understood; "Images speak for themselves" is said often although it is rejected already from many different researchers [6]. With this view in mind, automatically the images could convey the scientific model that allows interpreting the phenomenon involved and, immediately after, it would be impressed in our brain. Learning would be understood as filling a white blackboard; even it is never explicitly formulated as such.

#### 3) The epistemological view of science

The above conception of observing – understanding is also misleading from another point of view. There is confusion between the phenomenon, virtually expressed in the screen, with the scientific model that allows interpreting it. [7], [8]. We feel relevant to establish clearly the

<sup>4 4</sup> From now on, "computer simulation" will be referred to in the text as "simulation".

difference between the description of the phenomenon (expressed verbally, by images, symbols, or whatever) and the theoretical model that can explain it, that can predict its evolution. We believe important to communicate the nature of science to schools pupils as well to university students. To understand properly how science is built becomes also necessary for stimulating students to become Scientifics.

#### 4) Taking benefits of the tool advantages

An evident advantage of the simulations is its possibility that students analyse a specific system or a particular phenomenon in different circumstances. Simulations make feasible to play with virtual situations many of them impossible to achieve in a school laboratory.

To propose to students to make an in depth examination of the conditions that affect the running of a system, that is to identify the dependent and independent variables, to analyse "what would happen if..." some of the parameters or variables would change, etc. are recognised good tools for stimulating investigative skills in our students [9] and for promoting creativity [10]. However, we still found simulations where students have merely to follow some instructions without taking benefit of the potentialities of the tool.

#### 5) Reinforcing the qualitative analysis of the phenomena

Many efforts have been done until now to stress the relevance of analysing the physics phenomena from a qualitative perspective. Nevertheless, there is a long and reluctant tradition of teaching [11] considering that students have learnt Physics when they have acquired enough expertise for solving numerical problems where the essential is to apply some algebraic formulae and to obtain fixed results. That's why, we can find easily simulations where the fundamental and unique goal is to make some calculations and to obtain certain numerical value. It is a pity to waste the opportunity to use the tool more valuably.

#### 6) Taking care of the alternative conceptions

A detailed analysis of simulations also evidence that their designers often don't take into account the research results on science education on different points as for example on alternative conceptions. For example, it is easy to find simulations of electrical circuits where the sequential reasoning [12] is visualized and so, reinforced. As well, it is easy to find simulations on kinematics where any consideration about students' problems [13] with systems of reference seems not be taken into account.

## Discussion

The above paragraphs are coming from a research study in its first steps. However, we feel already able to say that the design of simulations should be matter of reflection from researchers in the field of science

education since they integrate knowledge from experts in two different fields: Science education and Informatics. The collaboration among them is necessary to obtain suitable informatics tools for science classes or to propose classroom activities that can fit easily with present students interests or with curriculum needs. We don't feel essential that science educators are able to design activities for simulation software but it would be worth that they help teachers to establish criteria that match well and non be contradictory with parallel discourses

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