Virtual experimentation in electromagnetism, mechanics and optics: web-based learning

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Abstract. This paper present novel virtual laboratories of electromagnetism, mechanics and optics to be used in the teaching of physics for the students as well as to the teacher in the classroom. The model used is friendly with the users and also is responsible for displaying data and its manipulation. The Vista/model, implements the behavior of the view to respond to user actions and expose model data in a way that is easy to use bindings, it is the mechanisms by which we can link the elements of the user interface objects containing the information to be displayed in the view. During the process of application of virtual laboratories the students shown a increasing ability to learn this specifics physics topics using a Web-based learning environment and a guide of work with the virtual laboratories framed in the meaningful learning pedagogical model.

1. Introduction

The recent learning theories focusing on reform in science education is emphasizing the importance of rethinking the role and practice of experimentation in science teaching and learning. Important Authors in the educational research found that there is a significant difference between what a learner can do with and without an external help. This is a reason that is an imperative need the use of Virtual Experimentation (VE), it is according with the contemporary advantage of the communications especially through the web sites [1–4]. We expect to students abilities in physics will be improved and their learning and problem solving in Web-based learning environments. The computerized learning environments should balance giving and with holding information and instructional supports in order to maximize the learning outcome of students. Despite of that the Web-based learning environments give students a tool in their learning processes, if the students not exert enough cognitive efforts, if they receive information too early, resulting in failure to acquire a schema from the given learning tasks. Moreover, it has been found that learners often abuse instructional supports available in the computerized learning environment without actually engaging in learning. Additional researches shown the impact of apps online on students performance and attitudes in physics classes at a high school, and found that this kind of repetitive simulation without adequate pedagogies to deliver course content not offer the expected results in the students knowledge [5–10]. In this paper, we will present virtual simulations of physics laboratories which are in total 20 simulations in mechanics, electromagnetism and optics totally developed in the University of Magdalena. Only a few of them are present in this paper to show the way in which they are used for
the students in the high-school and University of Magdalena, in the Engineer Faculty. These simulations of virtual laboratories are within the framework of meaningful learning through the use of a guide to work with the software. We know that meaningful learning is characterized by interaction between new knowledge and prior knowledge and the development of critical thought that lead to problematize the topic in study. For this process, the teacher acts as a facilitator and mediator between the student common knowledge and scientific knowledge, guiding reflection about the phenomenon studied, becoming a researcher of her own practice. We believe that the use of virtual laboratories should not be limited to observation of the physical phenomenon by using a virtual tool, but it must take the student to obtain a meaningful understanding of the physical phenomenon. Visit our web site to interact with the simulations (http://simulacionfisica.unimagdalena.edu.co/).

2. General architecture of experiences
MVVM (Model View View Model) without access to data (MVC) with Silverlight. It is the model responsible for all application data and business logic related view or views. Also responsible for displaying data to the user and allowing manipulation of application data. Vista model, implements the behavior of the view to respond to user actions and expose model data in a way that is easy to use bindings (mechanisms by which we can link the elements of the user interface objects containing the information to be displayed) in view.

2.1. Languages used on experiences
C#: Language used for Vista/Model. XAML: Language used to view (User Interfaces).

2.2. Background information for analysis of experiences
WPF application development with silverlight website development with ASP.Net and C#. Management of side events (delegates). Development of N-tier applications. XAP Deployment compiled on web sites.

2.3. Software requirements to manage the development of experiences
Silverlight SDK 4 and 5 Microsoft Visual Studio 2010

3. Virtual experimentation
We implement the new GUI design simulations for teaching physics that includes a pedagogical part Figure 1 The main objective is to develop generic and specific skills in the area of basic sciences (physics) by interacting with new technologies, achieving greater interest both teachers and students in this area and helping to improve learning environments used in the ownership, understanding and deepening knowledge deductively of the physical sciences. The research plan improvements in the level of interpretive, argumentative and purposeful students in the area of physical skills, through the development of laboratories using software, allowing students interested in a special way through this area, because Virtual labs are structured with interactivity, data processing area, friendly interface (display areas of the physical phenomenon, input and output data and aids). These learning tools become elements of great motivation for understanding natural phenomena and the development of skills. This research is relevant in institutions of secondary and higher education, as encourages the development of generic and specific skills in the areas of knowledge such as the theoretical and physical development to evaluate and propose equations to program in each experience, generation laboratory guidelines, developing simulations, application methodology practices and evaluation process before and after the implementation of simulations in the development of laboratories. Additionally in this research, we could count with the participation of the faculty of basic sciences of the schools of
secondary and higher education in our city for the implementation of the virtual laboratories and the first experience of the student with the software.

![Figure 1](image.png)

**Figure 1.** Snapshots of some virtual laboratories: (a) parabolic movement, (b) collision in one dimension, (c) discharge of a capacitor and (d) lenses.

4. Future works in virtual laboratories

The evolution of smartphones and tablets and use massively, offers a great opportunity to expand the use of virtual laboratories by students. Therefore, virtual laboratories will be implemented in a multi-platform that allows access from any Android, iOS or Windows device. We will update the graphical interface, creating a new 2D or 3D format depending on the type of experience Figure 2. However, neither the above logic equations simulator is not changed, the graphics engine also used the simulator will allow us to export any device by which one can be programmed once. Additionally, we propose that this new solution experiences are modifiable, ie, establish two or three scenarios for simulation giving the user a choice that is to your liking.

4.1. Technologies

For this new proposal we will use technology named Blender which is a free program that is used to create 3D modeling and animation, and also Unity is used which is an application used
for game development and this can encourage logic programs modeled using the programming language C#.

![Simulation experiment of parabolic motion using Unity 3D. Initial test runs on mobile devices.](image)

**Figure 2.** Simulation experiment of parabolic motion using Unity 3D. Initial test runs on mobile devices.

5. Conclusions
We present virtual laboratories in specifics physics topics to improve the abilities of students in the basic sciences. The model vista model is used to respond to user actions and link the elements of the user interface objects containing the information to be displayed. We expect that the virtual laboratories improve the level of interpretive, argumentative and purposeful students in the area of physical skills. This research is relevant in institutions of secondary and higher education, as encourages the development of the physics. Finally, this research initiate the implementation of the virtual laboratories in IOS, Android and Windows to expand the use of virtual laboratories by students with news the graphical interface, creating a new 2D or 3D format, modifiable to establish two or three scenarios by simulation.

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