



## New pedagogical tools: virtual laboratory Nuevas herramientas pedagógicas: laboratorio virtual

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**Abstract:** In this paper, we describe the design and development of an informatics tool for the chemistry laboratory, specifically the distillation process. This pedagogical tool has been designed because it allows students to simulate a standard process and the interactions included and manipulate them in a manner that resembles that of a real lab. Here, they find many elements of distillation labs, and they could allow the assembly of the process. It's an interesting tool for teaching chemistry.

**Keywords:** Virtual laboratory, distillation, virtual reality, simulation software.

**Resumen:** En éste artículo se describe el diseño y desarrollo de una herramienta informática para el laboratorio de química, específicamente para el proceso de destilación. Esta herramienta pedagógica ha sido diseñada para permitir a los estudiantes simular un proceso estándar; las interacciones incluidas y su manipulación se asemejan a un verdadero laboratorio. Aquí los estudiantes encontrarán muchos elementos del laboratorio de destilación: podría inclusive permitir hasta incorporarse y ensamblar el proceso. Es una eficiente e interesante herramienta para la enseñanza de química en ingeniería.

**Palabras clave:** Laboratorio virtual, destilación, realidad virtual, software de simulación.

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## 1. Introduction

The influence of technological change can be felt in all aspects of society, including education, because as emerging new scientific and technological developments, they have great success in the design and development of new teaching tools supporting the teaching and learning processes of students. Such is the case of virtual reality, where students can perform in virtual world laboratories that require no equipment or physical materials, thereby minimizing the cost of laboratories, increasing access for students in conducting laboratory practices and providing security in developing practices. Furthermore, in a virtual world, students have the opportunity to learn in a more motivating, effective environment with access to library resources that strengthen the development of classes.

The development of this type of educational tool based on virtual reality requires the design and development of three basic components: an interaction device (suit, gloves, helmet or other components ensuring the user's movements), a motion capture device (electronic device that receives signals (movement) of the user and transmits them to the computer) and a software application (virtual world) containing a scene in three dimensions with the real-simulated world, which are manipulated with the signals received from the motion capture device. Additionally, the software component should include the pedagogical and didactic model that facilitates the process of educating the student.

However, the design and development of the above components is susceptible to continuous improvement, as new technologies emerge and ideas for technology integration that facilitate better outcomes are explored to create new alternatives and innovations that

strengthen the teaching and learning processes.

Additionally, in the context of teaching chemistry and specifically in the process of simple and fractional distillation, high school students and universities face drawbacks that hinder the approach and resolution of problems due to the process and teaching tools. Another factor complicating the situation are the books that continue to develop their classes, since the approaches in many of these are structured in a closed, rigid, and linear fashion to the point that the students are trained to solve exercises of the same type without being able to adapt to apply their knowledge to different situations.

In view of the above, this paper proposes the design and development of a basic virtual laboratory for distillation that would support the teaching of distillation, and which will consist of three main elements:

- Interaction device, comprising an arm that performs the movements that will be detected by the motion capture device.
- A motion capture device, made up of devices that detect and capture the movements of the arm sent to an electronic interface, responsible for receiving and sending data to the computer.
- A software application (virtual world), consisting of the basic elements of a laboratory distillation in stage three dimensions, which are manipulated according to data supplied by the motion capture device. The application is developed by integrating software for building virtual environments in three dimensions, signal acquisition programs, special procedures, and programs that enable intelli-

gent agents that provide an interactive environment for users. Additionally, the application will have an educational component-based troubleshooting.

The project will provide an opportunity to gain the knowledge necessary for the development of new virtual laboratories, the creation of virtual worlds, designs, and development of motion capture devices based on mobile sensors and cameras, as well as the implementation of telepresence applications which can be used generically to build solutions in industrial education, healthcare, entertainment, etc.

## 2. General Concepts

### 2.1 Simple Distillation

Distillation is the preferred process for separating and purifying substances, allowing the collection of the compound of interest without losing other components that are part of the mixture [1]. It is one of the oldest and most effective methods in the chemistry laboratory, and is used whenever it is intended to separate a liquid from its non-volatile impurities, and was for many centuries the only physical method of varying the concentration of mixtures of pure liquids or to isolate certain liquids.

The initially distillation was developed as an art, but with the passage of time it became a universal scientific technique which requires deeper research on the properties, causes, and effects achieved by strengthening the knowledge of chemical thermodynamics and laboratory instrumentation; Today it continues to progress culturally, theoretically, and experimentally as set forth in the story of segment distillation [2,3].

### 2.2 Virtual Education

Virtual education is undoubtedly one of the areas where the greatest changes occur in making use of technological developments. A virtual education model takes advantage of a standard model, as the implementation of communication technologies generate value-added services to support multiple processes and activities present in the environments of education, especially by providing specialized support services: first, administrative matters such as registration of courses, tuition, among others, i.e. using programs called Applied to Education; second, academic and virtual courses, papers, interactive simulation laboratories, among others, with educational programs designed to directly and known as "educational software" purposes.

This term has been studied in recent years, and has been defined by various authors, including Spanish-language definitions "all kinds of computer programs created with the specific purpose of being used as a teaching tool, i.e. to facilitate the teaching and learning "[4]," those programs with one formative, instructional purpose "[5] and" programs that allow compliance or support educational functions " [6]. Then, you can interpret the educational software as a computer program that is used as a teaching resource which has been conceived and developed under clear learning objectives of environments conducive to teaching and learning.

The teaching-learning process is based on the principles of collaborative pedagogy applied to virtual education because students must take responsibility for frequent and active participation through various educational materials present in the network, such as exercises, articles, labs, among others. The main feature of this type of education is the distance be-

tween teacher and student, who, sometimes do not interact face to face, i.e. not necessarily having a fixed schedule while monitoring and following the activities undertaken.

### 2.3 The virtual University

The virtual university is an educational institution that offers high-quality knowledge and is distributed in time and place [7]. Therefore, you need to have network points, computers, and teachers interested in new ways of teaching, because teaching in a virtual classroom is transforming traditional pedagogy into an electronic teaching in which the teacher becomes a facilitator of the processes of student learning and a support of collaborative pedagogy, therefore, teachers must be trained in new teaching and development of new teaching tools and techniques. One of the greatest tools is the virtual laboratory as an alternative for those labs that can be costly, dangerous, or cause environmental damage.

### 2.4 Virtual Laboratories

Virtual labs are representations made through software objects displayed on a screen that mimic the physical characteristics of real objects; are highly attractive to young audiences, and are presented as games where students are allowed to participate to explore and interact with existing elements in virtual space [8]. These labs emphasize practical experimentation techniques and applications for continuous monitoring of student activities.

Teaching procedures through a virtual lab on a personal computer is a highly powerful concept, students are no longer limited to space or time and educational institutions which do not have economic or physical means to support a real laboratory may use this resource. Thus, it appears that some of the primary

reasons for using these cyber spaces are reduction in investment of expensive machines, the expansion of access to expensive and restricted laboratory equipment in laboratories by groups of students can observe a direct and cooperative work, but we need to strengthen self-employment and the limited access to free time in laboratories that allow enhancing knowledge on a specific topic, thereby reducing the cost of consumables while learning some important topic, [4,9,10].

### 3. Proposed system

Production class teaching tools described above require the design and development of three basic components: an interaction device, a device for transmitting information, and application software [11,12].

- The interaction device captures the user's movements can be a glove, a suit or other device; to perform its function, it has a number of sensors which detect the movements, these signals are filtered and conditioned for subsequent transmission.
- The transmission device receives signals from device interaction, organizing them into frames to send to the computer.
- The application software is a 3D virtual world where you have the elements to be handled by the interaction device that recovers the transmitted data to decrypt and adapt to be interpreted by the virtual world.

Additionally, the tool must have an educational component based on problem solving, it must provide the student with the process of teaching and learning [6, 13].

### 3.1 Interaction Device

Motion capture, also known as motion capture or its abbreviation MOCAP, is the process of capturing, storing, analyzing and studying data from any movement, usually human, to play different moments of the movement [14]. There are several ways to capture depending on use, economic resource, signal transmission, this time we decided to capture and image analysis.

The device presented is a mark on his hand, which he will follow up with a video camera. It has been designed to follow the color blue, it because the tone allows good contrast and is easy to distinguish from other colors, you should move on a dark surface to assist in contrast.

The catch is made by film and video image analysis taken using Python as Script language (programming language object oriented, offers integration with other languages and tools.) To the stage of analysis and data from images, allowing use a variety of techniques applied to digital images in order to improve quality or facilitate the search for information [15-19].

Because the camera is capturing the information transmission step is thrown into the capture step.

### 3.2 Application Software

Given the variety of programs used for modeling, texturing and animation in 3D, conducted an investigation to determine the most appropriate design software virtual laboratory distillation, obtaining the one most suited to the needs is Blender, a 3D modeling program supported by various tools and platform (running on Windows XP, Vista 32 and 64 bit, Linux 32 and 64 bits, MacOS, Solaris, etc.) which was created by the company Not a Number (NaN). It is aimed at artists and design professionals and multimedia, and can be used to create 3D visualizations or static high quality videos. It also incorporates a 3D engine in real time which allows the creation of interactive three-dimensional content that can be played independently. Blender is developed as free software with source code available under the GNU GPL, and its download and use is free. As advantages presented by creating polygons, curves, NURBS, text, and other tools used in professional programs; animation control includes support for tables, motion curves, morphology, and inverse kinematics; allowing you to create particle systems, warps and get 3D views by rotoscoping; rendering fields has lots of lighting modes, routes animated motion animation curves, and much more; it handles Targa files, JPG, Iris, SGI movies, also supports reading files "Inventor". Disadvantages include have little resource modeling tools, and a lack of library preset materials [20]. In Figure 1, the figures incorporate molded observations in the laboratory.

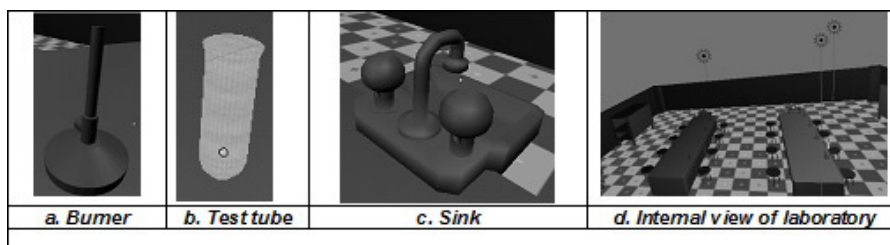


Figure 1. Laboratory Components development using Blender. Own source

#### 4 Results

Simulation software that allows 2D observation of a simple distillation lab where you can perform lab equipment assembly and to describe the elements of the practice through a menu has developed. Additionally, the handling of this software is through the movement of the hand that has a brand and an image capture brand.

Figure 2 shows software screenshots in snapshot mode, in Figure b recognition of laboratory equipment in the laboratory, and c to access and assemble materials.

In Figure 3 the images once you enter the simulation option is the character who has to do the movements within the laboratory is a type Mario Bros. doll, then to perform the movement of the hand branded moves the doll and moves into the designated space laboratory. In part b. the over-

all distribution of laboratory samples, two tables, a multi-element own chemistry laboratory and another table, where it was initially unoccupied refitting of the lab. To select a component, Mario should move the item to take and once he is near the trap and drag to the other table, to get there as loose and places; as it advances in the construction of practice the percentage of process is shown. If a wrong material is selected, it will be placed on the practice table but the percentage of completion of the practice will stop until valid moves are made.

Laboratory tests were conducted and proposed, finding that users show interest in the cozy setting that occurs, likewise acceptance by the user can be explained verbally and clearly and with coherent content. Regarding the operation manual, it becomes clear writing a revision to make it easier to understand, introducing all the options given in the game.

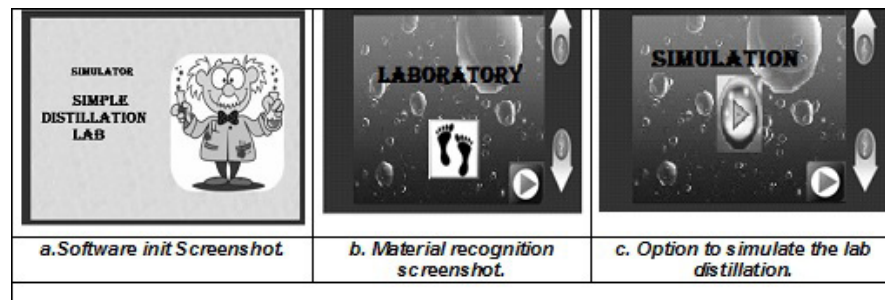


Figura 2. Options to work within the virtual laboratory distillation Application. Source: Own.

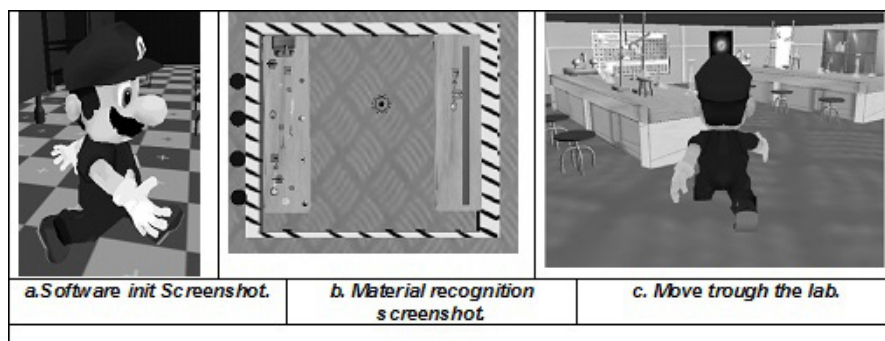


Figura 3. Laboratory environment. Source: own.

## 5 Conclusions

The need for teaching to support the teaching and learning processes using different tools becomes evident, but their development requires an interdisciplinary group which includes experts in different fields of science, in the case of laboratory it requires staff with expertise in pedagogy, programming, electronics, and chemistry.

Progress in this type of aid is necessary, since technology is evolving and enriching our lives, all aspects of society should be progressing with the technological pace.

The educational process in society has changed its essential form due to technological developments present, and thanks to them, knowledge has been acquired and spread in different ways, not only through written books and master classes, but as internet media, digital libraries, virtual learning environments, educational simulators, educational games, and virtual laboratories, among others. Students should know and manipulate the pedagogical tools offered to better understand the concepts in different knowledge areas.

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