ENSEÑANZA DE LAS CIENCIAS
Revista de investigación y experiencias didácticas

EVOLUTION OF VIRTUAL LEARNING ENVIRONMENTS IN CHEMISTRY EDUCATION

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Resumen

Visual information plays a central role in chemistry. The evolution of computational technologies in the last decade brought new opportunities to develop virtual learning chemistry environments to education that might change the ways of presenting and visualizing the chemistry knowledge. In this paper we present ten virtual learning environments related to chemistry teaching, and we compare them in terms of functionalities of visualization, virtual manipulation and possibility of creating new chemical structures.

Objectives

Our main objective is to present the evolution of virtual learning environments used in chemistry education in a period of ten years. We selected ten published virtual learning environments and compare them in terms of implemented functionalities of visualization and virtual manipulation of chemical structures. We also describe the technology resources available in each year.

Theoretical Framework

Visual information plays a central role in chemistry. The evolution of computational technologies in the last decade brought new opportunities to develop virtual learning environments to science education that might change the ways of presenting and visualizing the chemistry knowledge. We focus our attention to understand the aspects of these environments and its evolution from the insertion of hypertext browsers in 1994 to 2005, a period of over 10 years. Our intention is to provoke a debate about the relationship among technology development, virtual learning environment production and science education contribution. (Note: data about computers availability refers to Brazil).

Argument

In 1994 “technological convergence” meant text and graphics in the same screen. By this time personal computers had a processing speed of less than 100 MHz and Mosaic® was the main hypertext browser. In this context Russel and Kozma (1994) developed 4M:CHEM, where it was possible to visualize simultaneously movies and static images with macroscopic, submicroscopic and symbolic aspects of an experiment in four different windows. It was not possible to interact with molecular objects in this virtual environment and students could not create their own representations. The system should be installed in the computer and the graphical user interface was created specifically for the environment.

In 1996 it was possible to use computers to integrate audio and video in classrooms, and Netscape® was the main browser. This year Tasker and coworkers (Tasker et al., 1996) created VISCHEM, which showed in the same screen macroscopic, submicroscopic and symbolic representations (video and static images) of chemical knowledge. The virtual environment was accessed through a CD-ROM and the graphical user interface was also developed for this environment.

Distance learning curses in 1997 were delivered as K-7 tapes, and small WAV or MOV movies were downloaded through 28.8 kbps modems. In this context Tan and Tan (1997) developed CHEMMAT, a multimedia learning environment accessed through hypertext browsers. This environment was adapted to be accessed from a CD-ROM and contained video clips, static images and animations. The environment had no virtual molecular objects and all three levels of chemical knowledge could be visualized.

In 1998 Internet Explorer® and Netscape® disputed preference of internet users, and Google® was just starting its search engine. This year Beckwith and Nelson (1998) published the virtual environment CHEMVIZ which was accessed through hypertext browsers and needed Java® Virtual Machine to proper visualization and manipulation of molecular objects. The environment also demanded installation of packages like Gamess and Molden, and so it was necessary advanced knowledge of computational chemistry to create chemical structures.

Financial potential of internet business became evident in 2000 when Time Warner® and AOL® announced fusion of their activities, and Napster® started attracting attention from regulatory agencies. Internet Explorer® won the first battle of browsers and SVGA (800 x 600) screen resolution and 1GHz microprocessors was at popular cost. In this context Kozma and coworkers (2000) developed SMV:CHEM which was installed from a CD-ROM and accessed from its own windows system. The chemical representations could be seen in video clips, animations, static pictures and Cartesian graphs and the users could not interact with them.

In 2001 Microsoft released Windows XP®, which would be the standard desktop operational system for the next seven years. Also this year Wu, Krajcik and Soloway (2001) used a simplified version of professional tools named eChem to help students build and visualize multiple three-dimensional models. The graphical interface was build specifically for this system, and students could build, visualize and manipulate molecular objects of their own, despite symbolic dimension of chemical knowledge were absent.

Wikipedia had just been released in 2002 and had 30.000 entries, 90% in English, and reaches 2009 with 12 million articles, less than 25% in English. In this year ChemDiscovery was published (Agapova et al., 2002) which can be accessed from usual hypertext browsers. In this virtual environment it is possible to manipulate and visualize molecular objects, but the system is still accessed from a CD-ROM media.

In 2003 the unsolicited e-mail messages known as spam were responsible for 50% of the total amount of sent e-mails. CHEMnet (Nick et al., 2003) was developed to be accessed from internet with usual hypertext browsers. It was not necessary to use any CD-ROM for installation, and plug-ins could be downloaded from internet. The environment contained more than 2300 hypertext pages, 140 video clips, and 60 animations and interactive simulations, where students could visualize and manipulate molecular objects.

In 2004, 1024 x 768 graphics card were cheap enough to be popular, and digital convergence meant mobile phones, digital cameras, television and internet together. Personal computers with 64 bit and dual core microprocessors, Orkut® site and Firefox® browser were released. In this year Molecular Workbench (Pallant and Tinker, 2004) was published as a virtual environment accessible from internet, but using a Java® graphical user interface, installed from internet. In this system it is possible to visualize and manipulate molecular objects, but students cannot create their own representations.

Giordan and Gois (2005) published Construtor, a virtual environment where it is possible for students to create three-dimensional molecular objects from only a condensed structural formula (e.g. CH3CH2CH3). The molecular objects obtained by students are a result of a molecular dynamics simulation in the server side, and each molecular object is build on demand. This system is available from internet and students can access it with a usual hypertext browser with Java plug-in.

Conclusions

Virtual learning environments are becoming easier to access from tutorial installed in computers to CD-ROM accessible courses and, finally those accessible through internet. There is a tendency of internet access with usual browsers (Internet Explorer, Firefox, Chrome etc.), once it eases operational system compatibility and upgrade. It also is possible today to access resources like creation and manipulation of tree-dimensional molecular objects obtained remotely (Construtor) from molecular dynamics simulation tools, as internet access are becoming faster.

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CITACIÓN

GOIS, J. y GIORDAN, M. (2009). Evolution of virtual learning environments in chemistry education. *Enseñanza de las Ciencias*, Número Extra VIII Congreso Internacional sobre Investigación en Didáctica de las Ciencias, Barcelona, pp. 2857-2860
http://ensciencias.uab.es/congreso09/numeroextra/art-2857-2860.pdf