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MCH MULTIMEDIA: THE FUTURE OF SECONDARY AND POST_SECONDARY SCIENCE EDUCATION

MCH MULTIMEDIA Y FUTURO DE LA EDUCACIÓN SCUNDARIA Y POST-SECUNDARIA EN CIENCIAS

Steve Zylbergold

MCH Multimedia, 372 Ste.Catherine St. West , Suite 210, Montreal, Quebec

H3B 1A2 Canada, http://www.mchmultimedia.com/

ABSTRACT

MCH Multimedia develops and publishes interactive electronic-based educational tutorials for, but not limited to, university level science education (physics, chemistry, organic chemistry). As recognition of multimedia's potential for learning and instruction has increased, so has the demand for quality materials. MCH Multimedia's ultimate goal has been to accomodate the needs, concerns and limitations of professors and students in regard to the use of educational software. The tutorials are appropriate to accompany professors class lectures, or for individual self-paced student review, and can be delivered in a number of electronic formats such as CD-ROM, online portals and web downloads. The company works with other clients and organizations to develop and design customized educational and instructional materials. By working closely with subject matter experts and conducting qualitative research studies with members of the educational community, MCH has been able to achieve a high level of success and approval from within the academic community.

Keywords : Multimedia, Computers and Education, Physics, Chemistry

Resumen

El MCH multimedia diseña interactivas tutorial en la base del computador para los niveles de educación secundaria y universitaria. Debido al potencial de multimedia para objetivos instruccionales y aprendizaje, existe una gran demanda de materiales de calidad. El objetivo de MCH multimedia, es seguir las necesidades de los profesores y estudiantes en la utilización de software educativo. El software educativo es buena herramienta para los profesores en las clases y también para el aprendizaje de los estudiantes. Además este medio educativo puede ser distribuido en diferentes formatos electrónicos tales

como CDROM, portales en línea y para descarga de Internet. El otro objetivo de MCH multimedia es el trabajo con organizaciones educativas para el desarrollo de nuevos materiales para la enseñanza, lo que permite el auge del software de alta calidad y reconocida por la sociedad académica.

Palabras Clave : Multimedia, Computadores en Educación, Física, Química.

Introduction

Anybody who has walked into a school in the last five years knows that education is being revolutionized by the emergence of new technologies, specifically electronic media. The days of the hard-copy textbook for the large courses from high school to University are numbered. Electronic textbooks can and do more than hard-copy books. They move, they talk, they give feedback and they engage the user. The majority of the material that is being developed today, however, is of poor quality with too much text and too much clicking.

When McGill University Chemistry professor Dr. Bryan C. Sanctuary could not find an appropriate multimedia-based learning tool for his students, he decided to take matters into his own hands. Dr. Sanctuary's plan was to take the limitless information potential of electronic multimedia and apply it to advanced science education. The idea was to create a resource for his students that contained the comprehensive information found in a traditional textbook, but went beyond the confines of the conventional textbook in terms of interactivity. At the same time this would also help solve the problem his students had trying to read his handwriting on the blackboard. (Sanctuary, 2001.).

In 1995 Dr. Sanctuary founded his own small production company, MCH Multimedia. He assembled a team of top-notch software programmers, subject matter experts and educational researchers from across the globe to develop a useful tutorial program. Dr. Mangala Sunder Krishnan (Indian Institute of Technology, Madras, India), Dr. Tom Halstead (York University, UK) and Dr. Neil Woolsey (University of North Dakota, USA) came on board to lend their expertise in the fields of general chemistry and organic chemistry. Dr. Sanctuary also enlisted the help of several young up-and-coming software developers with science backgrounds to ensure that the comprehensive information was balanced with an understanding of which topics gave students the most difficulty. It was apparent to him that having younger programmers who could relate to the needs and concerns of students would help make the tutorials more effective.

concepts, but also motivated learners by allowing them to actively engage in the Dr. Sanctuary wanted a tool that not only brought ideas to life and helped clarify difficult presented material. The development team incorporated moving 3-D graphics, animations, detailed periodic tables, plotting and calculation excercises, review sections and quizzes that provide feedback and allow for self-assessment of individual learning progress.

Since the birth of MCH Multimedia, the company has developed advanced versions of their chemistry and physics tutorials as well as tutorials for organic chemistry and introductory chemistry. In 2002 the company was commissioned by the American textbook company Houghton Mifflin to produce “Physical Chemistry fourth edition”, an electronic companion to the textbook of the same name written by Laidler (University of Ottawa), Meiser (Ball State University) and Sanctuary (McGill) . Just months after it’s release, “Physical Chemistry fourth edition” won the EDDIE award from California’s ComputEd Gazette, a government non-profit organization that evaluates educational software for U.S. academic boards.

Recently MCH has broadened their professional scope to include the development of instructional technology for businesses and government organizations, as well as educational technology for other academic disciplines. To ensure that the quality of the content is never sacrificed, Dr. Sanctuary seeks out subject matter experts from each particular field to oversee all development projects. They simply apply the same development principles that they have since the beginning-to understand and cater to the learning goals, needs and preferences of each specific audience.

It has taken quite a long time for the mainstream academic community to warm up to the idea of using electronic media for educational purposes. (Garland, 1993; Clark, 1993)

Now that a greater number of people are interested in the benefits of multimedia-based instruction, the market has become flooded with electronic learning and teaching tools, a great deal of which are severely lacking in educational content. With so many multimedia-based learning tools on the market these days it is quite hard for school administrators, professors and students to know which ones will be effective.

“Because there is such an overabundance of products out there, it is necessary to have trusted organizations like ComputEd for evaluating the merits of educational software” explains Dr. Sanctuary.

“Before I started MCH I must have purchased dozens of multimedia products for chemistry and physics. Each one was either lacking in content, or presented nothing more than a book on a computer screen.”

“I presently teach introductory chemistry to large classes. This year the enrollment is 740! Although this is the biggest I have taught, for the past 20 years my introductory classes have numbered over 400. Many of the problems that I encountered in the past have been alleviated by the use and the development of multimedia teaching methods.”

Like Dr. Sanctuary, many science educators have come to see that the many benefits of using multimedia for teaching purposes. For instance many students think visually, and to finally be able to represent difficult concepts using state of the art imaging techniques, difficult concepts become easier to understand. The current generation of university students is more comfortable in an electronic environment than any previous generation. The next crop of university students will be of the generation who grew up with computers, and the use of multimedia applications will be second nature. (Irani-Tracy, 2000.)

"In 1993 I began to realize that computer animations helped students visualize many of the more difficult scientific concepts and started to develop them for use in the classroom. Students responded favorably to these and asked for copies. Giving out material to students immediately means that more care must be taken with the development. This was too big a job for me alone so in 1995 I started my company, MCH Multimedia Inc. to handle the development and the demand."

"This led to developing and learning different ways to present multimedia to the students. Moving to multimedia presentation is not intuitive and pitfalls exist," says Sanctuary "However we feel that we have solved many of these." (Sanctuary, 2001).

If educators want to reach their students successfully, they must adapt their teaching methods to incorporate the medium in which their students are most comfortable. One difficulty with this premise is that the current generation of professors is for the most part not as comfortable within this medium. Because of this many professors have been reluctant to incorporate multimedia into their curriculum. There is a feeling that trying to learn how to use the technology will be overly time-consuming. In other words it simply is not worth it. (Muilenburg, Berge, 2001).

"This is something that represents a challenge" says Chief Technology Officer Adam Halstead.

"How do we develop a teaching tool with potentially limitless benefits that is not intimidating to the instructors who can benefit most from using multimedia."

The designers at MCH recognize that these teachers do not want the technology to overburden them. (Clark, 1993). Hence their tutorials are designed with this in mind. One mandate of the company is that their software programs should be easy to learn, straightforward and intuitive. MCH Multimedia's development team aims to create electronic tutorials that can be used by anybody, regardless of their level of expertise with computers. Throughout the development process the programmers test trial versions of the software with real professors. This ensures that the programs meet the needs of their audience. As a result each of the programs boast an interface that is straightforward and unintimidating to the average user.

Dr. Sanctuary, realised that a very different approach must be taken towards creating multimedia tools. Many of the electronic tutorials on the market have too many words. People do not read as well at the computer screen and computers do much more than present text.

A major error made by some developers is to hire computer programmers to create the multimedia material, without the constant input of academics throughout the process.

When Dr.Sanctuary put the team together he made sure that the programmers themselves had backgrounds in the sciences. The mistake of hiring a computer programmer to program material that they are not familiar with can be put into perspective by considering the folly of commissioning an English professor to write a book on chemistry because his English is good.

However, failure to use a good computer graphic artist should not be underestimated. These individuals are trained to know how to organize material on the page and to keep the eye focused. They have command of the design ideas and the correct use of colors and fonts.

The idea of interactivity in educational technology is quite appealing to the academic community. It has become widely accepted that if students engage in the subject matter, there will be a tendency towards greater retention of the material. However "interactive" has become a term that is being used rather loosely. To many the word "Interactive" has come to mean "click". For this reason, the word has lost its meaning and other more precise definitions are needed.

Proactive Interactivity

"Proactive" in its simplest level is a term used to distinguish it from "click" There are several different levels of interactivity that have emerged for the use of multimedia material for teaching. Some of these are found in

Types of interactivity

Object interactivity	Refers to an interactive multi-media program in which objects (buttons, people, things, or other metaphors) are activated by using

(proactive inquiry)	a mouse or other pointing devices. Clicking usually generates a form of audio-visual response. The functionality of such objects depends on previous objects encountered, previous encounters with the current object, or previous instructional performance.
Linear interactivity (reactive pacing)	Refers to functionality which allows the user to move forwards or backwards through a predetermined linear sequence of the content. It is often called 'electronic page-turning'. Overuse of linear interactions in learning environments may reflect inappropriate use of technology.
Hierarchical interactivity (reactive navigation)	Provides the user with a predefined set of options from which the user can select a specific path or structure of accessing the content. The most common example of this interaction is the main menu where the user returns to select another option.
Support interactivity (reactive inquiry)	Involves providing the user with a range of help options and messages, some of which can be very simple and others quite complex.
Update interactivity	Relates to components of the program that initiate a dialogue between the user and the computer-generated content. The program generates questions or problems to which the user must respond.
Construct interactivity	This is an extension of update interactivity and requires the creation of an environment in which the user is required to manipulate component objects to achieve specific goals.
Reflective interactivity (proactive elaboration)	Refers to text responses. If *n* text responses are available to the user there is always the possibility that the user will require the *n+1* answer and the program will judge the enquiry as "incorrect".
Reflective interactivity	Responds by providing answers recorded by other users and allows the current user to compare and reflect on their response.
Hyperlinked interactivity (proactive navigation)	Provides access to a wealth of information that the user is allowed to navigate at will. There are multiple paths creating a "maze" that the user needs to negotiate in order to resolve a problem.
Non-immersive contextual interactivity (mutual elaboration)	Combines all previous levels of interactivity and extends them into a complete virtual training context. Users are transported into a microworld that reflects their existing working environment and the tasks they undertake mirror those of their working environment.
Immersive virtual interactivity (mutual elaboration)	Projects the user into a complete computer-generated world which responds to individual movements and actions.

As far as multimedia development is concerned the idea of proactive interactivity seems to have been first introduced by Schweir, Misanchuk (1993).

Proactive interactivity means the computer responds to the user and essentially means "feedback" in response to the user. Proactive interactivity has been kept in the development of MCH science tutorials. Any teacher can view educational material by either registering on the website (http://mchmultimedia.com) or emailing support@mchmultimedia.com.

Dr. Sanctuary's desire was that the tutorials feature a high level of true interactivity. In addition to the many digital movies to animate difficult concepts there are flexible plotting exercises, questions which give feedback, simulations of equipment to show how various experiments are done, drag and drop interactions to build, for example, the electronic structure of matter (Aufbau principle) or to create molecular structures.

In addition to engaging the student in proactive interactions, the features available on a computer allow all the features of textbooks, and more, to be presented. These are easily accessible. From pull down menus and button bars which are always present, the following resources are available:

- printing the screen
- calculator
- periodic table
- note pad and glossary
- mathematical tables
- scientific constants
- reference material
- help: technical support, on-line help, updates

Buttons help in navigation:

- restart whole tutorial
- restart this module,
- table of contents (shows where the user has been)
- link to note pad
- word search
- quiz
- turn voice on/off.

Navigation is crucial to the easy use of multimedia. This re-emphasises the importance of user-friendliness. At all times the user must know where they are by the use of pointers, and titles which display the topics, subtopics and even sub-subtopics. Hyperlinks give a "flat" view of the material rather than moving deeper into menu driven topics. That is, everything is available "on-screen" as much as possible.

The user can move from topic to topic with ease and it is easy for the student to

know where he/she is, has been and wants to go

MCH also makes their interactive tutorials available in a variety of electronic formats.

Although delivery by CD-ROM is still a current option, with the increased speed of the Internet, delivery of material either by electronic download or by the use of a portal will soon overtake CD-ROMs. Moreover, since many institutions are turning to fire walls to keep out viruses, the material should be capable of being networked on Local Area networks (LAN's) within a fire wall.

CD-ROM are currently more popular because they are easier to use and do not require plugins as Internet delivery often does. CD-ROMs are, however, relatively expensive, although much less expensive than hard-copy text books. All multimedia that has taken years to develop must be copy protected. This is now not difficult to do although does add an extra burden when users change computers and must re-register.

Using a PORTAL via the Internet has the definite advantage that all the files are in one location and any upgrades are invisible to the end user. Moreover, Portals can are secure, password protection of content is easy but a good bandwidths is needed. As mentioned above, although Portal delivery is the easiest to maintain, end users are shy about getting and installing plug-ins.

Perhaps the most rewarding aspect of creating electronic tutorials for MCH is knowing that they have the potential to reach a wider audience than in a traditional classroom setting. Each program can function on it's own as a learning resource, and they have already been adopted by some universities as a distance learning course.

"With our tutorials, we can help educate people whose life circumstances do not permit them to learn in a classroom", explains CTO Adam Halstead.

"Individuals who have families to take care of during regular school hours, have physical disabilities which make it difficult to attend classes, or simply live too far from campus can have access to science education."

MCH PRODUCT DESCRIPTIONS

HOW IT CAN BE USED BY PROFESSORS

As a Science professor it is your duty to successfully impart important and complex scientific concepts to students. Use the power of interactive multimedia to motivate your students and provide them with a clearer understanding of ideas that were once more difficult to explain.

- Promote the idea of more frequent individual study among your students and encourage them to explore various concepts and topics at their own pace.

- The many 3-D animations facilitate the explanation of complex ideas and provides students with helpful visual representations.

- Non-linear structure of the tutorial allows you the option of easily skipping to desired sections.

- Give your students access to multimedia learning tools that can help your online course environments go beyond simply posting comments and communicating with others.

- Accompany in-class lectures with a display of both graphics and text by using a conventional overhead projector. This can be easier and more effective than writing notes on a blackboard.

- MCH tutorials contain many good ideas for possible exam questions

HOW IT CAN BE USED BY STUDENTS

As a student, your main goals are to develop a comprehensive understanding of the central ideas in your chemistry and physics classes, and of course to get good grades. Our programs can be used as a great study and review tool for midterm and final exams.

- The review sections are excellent for brushing up on previously learned concepts
- The holistic overview of the subject matter helps put new ideas into a meaningful context.
- The interactive excercises allow you to truly engage and immerse yourself in the information. You can actively construct your own body of knowledge.
- The visual representations can provide you with an additional way of understanding some of the most challenging academic content you will encounter in your academic career.
- Quizzes and feedback provide you with an opportunity to assess your learning progress.

Physical Chemistry Table of Contents	Introductory chemistry table of contents	General Physics Table of Contents
1. Nature of physical chemistry & kinetic theory of gases	Quick Tour	Quick Tour
2. First law of thermodynamics	Introduction to Chemistry	General principles
3. Second and third laws of thermodynamics	Observe, measure and calculate	Math review
4. Chemical equilirium	Matter, atoms and ions	Vectors
5. Phases and solutions	Naming chemical compounds	Kinematics
6. Phase equilibria	General Stoichiometry	Projectile motion
7. Solutions of electrolytes	Chemical reactions	Frames of reference
8. Electrochemical cells	Ideal gases	Forces
9. Chemical kinetics I. The basic ideas	Gas kinetics	Newton's laws
10. Chemical kinetics II. Composite mechanisms	Solids	Momentum and collisions
11. Quantum mechanics and atomic structure	Solutions	Work and energy
12. The chemical bond	Equilibrium	Rotational motion
13. Foundations of chemical spectroscopy	Acids and bases	Gravitation
14. Some modern applications of spectroscopy	Electrochemistry	Thermodynamics – 1
15. Statistical mechanics	Energy and Entropy	Thermodynamics - 2
16. The solid state	Chemical kinetics	Waves in physics
17. The liquid state		Sound in physics
18. Surface chemistry and colloids		
19. Transport		

properties	Electromagnetic Theory Quantum Mechanics Bonding Main group elements Transition elements Organic chemistry Naming organic compounds Biochemistry Nuclear Chemistry Practice problems LEVEL: College/University Introductory Chemistry High School: AP or honors	Electrostatics Electromagnetic theory Pre-Quantum experiments Quantum mechanics Special relativity Nuclear structure LEVEL: College/University Introductory General Physics High School: AP or honors

General Chemistry Table of Contents • Quick Tour • General principles • Math review • Ideal gases • Kinetic theory of gases • Acids and bases • Equilibrium • Thermodynamics part-1 • Thermodynamics-part 2 • Electrochemistry • Electromagnetic theory • Pre-Quantum experiments • Quantum mechanics • Bonding • Chemical kinetics • Solids • Main group elements • Transition elements • Practice problems LEVEL:	Organic Chemistry Table of Contents • Quick Tour • Overview of organic chemistry • Stereochemistry and isomerism • Chemical bonds • Acid-base reactions • Organic reaction types • Nomenclature • Alkenes and alkynes • Alcohols • Ethers • Aromatic compounds • Aldehydes and ketones • Carboxylic acids • Amines • Biochemistry LEVEL:

College/University General Chemistry High School: AP or honors	College/University Introductory Organic Chemistry High School: AP or honors

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