Classroom Technology Reviews

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Energy and the Chemistry of Life. 1996. United Learning (6633 W. Howard St., Niles, IL 60714, (800)424-0362). Videotape. 28 min. Purchase $135.

This two-part program, intended by the producer for use in biology classes in grades 9-12 explains the basic physical and chemical processes that allow energy to be stored and used by organisms. Part one provides lessons in simple physics and chemistry. The physical concepts of matter and energy are explained, the structure of atoms is described, and students learn how subatomic particles join to form elements, how elements combine to form molecules and compounds, and finally, carbohydrates, lipids, proteins, and nucleic acids are presented.

Part two describes the formation and use of ATP as a source of energy used in life. Here the physical and chemical concepts presented in part one are used to analyze the metabolic processes of photosynthesis and aerobic respiration.

Discussion of these topics is very general and, frequently, overly simplistic. Descriptions of photosynthesis and respiration are incomplete and sometimes inaccurate. Although much of the photography is eye-catching and interesting, it often has no clear relationship to the topic of discussion. Monotone narration bores students.

The teacher's guide and materials include student objectives, follow-up activities, a useful script of recorded narration, and a series of blackline masters. The masters include four quizzes that are not particularly useful, but the three pages of vocabulary, one overhead transparency of the relationship between photosynthesis and cellular respiration, and a short crossword puzzle could be helpful with the right audience. The right audience is probably middle school and lower-level grade 9-10 students. Here it is best used as a review tool and in bits and pieces rather than in one or two sessions.

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Viruses: The Deadly Enemy. 1997. Human Relations Media (175 Tompkins Ave., Pleasantville, NY 10570, (800)431-2050, *www.hrmvideo.com*). Videotape. 23:45 min. Purchase $189.

This video particularly interests me because it is a single concept program that can be integrated into a discussion of viruses. It is brief enough to be an introduction to the topic with enough time left in the class period to introduce additional material or to conduct a discussion. It is sufficiently thorough in its depiction of viruses so students at all levels can develop a concept of them and be able to contemplate the details of viral infections and the implications of viral transfer.

Examination of virus structure and comparison of virus characteristics with those of living organisms follow the introduction, describing discovery of viruses through the diseases they cause. Excellent graphics in the abbreviated viral replication cycle are simple yet particularly lucid. The concluding segment is a survey of significant viral diseases of humans today, including herpes simplex, ebola, HIV, and polio. The program moved seamlessly to developments in immunization and treatments of viral diseases.

My first impression of this program was that it was produced for middle school life science or high school biology students, and, although that is what the producer intended, I consider the content and the presentation equally appropriate for most college level courses in biology or introductory microbiology.

The teacher's resource packet includes a program summary, a complete script of the narration, nine student activity sheets, a glossary, and a bibliography. These materials do seem to be designed for middle school or junior high school level students.

This is a particularly effective introduction to viruses. The combination of animation, electron photomicrography and photographs of individuals with viral disease make an interesting and informative examination of the existence and role of viruses.

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"That's Really Cool!"

Using Kinetic Imaging Software To Learn About Protein Molecules

Sometimes technology can solve teacher's problems. Biology teachers know that teaching about protein molecules is a major challenge. In contrast to DNA molecules, which have a regular, repeating structure, proteins only have a few small, predictable structures, beyond which they get very complex, specific, and hard to visualize. When teaching students about these structures in the past, we have been highly dependent on artist renderings in textbooks, pictures drawn on the chalkboard, and our own ability to come up with descriptive metaphors. The ability to see and manipulate molecules in three dimensions provides a great advance in biology instruction. This article describes the successful instructional use of a computer modeling program called MAGE in my biology classes at Athens Academy.

Since 1990, Athens Academy, an independent college preparatory school in Athens, Georgia, has been involved in partnership with the Bertelsmann Foundation of Guetersloh, Germany. It designed to integrate media and technology throughout the liberal arts curriculum. The goal is to go beyond increasing students' technological competence, and find ways to use technology resources to improve instruction and enhance learning. This is where MAGE comes in.

MAGE in the Classroom

MAGE is a scientific illustration tool, created by Duke University biochemist David C. Robinson. MAGE enables the visualization and manipulation of the three-dimensional structure of biological molecules. It is freely distributed on the Internet by the journal *Protein Science* [http://www.prosci.uci.edu], which includes protein "kinemages" (kinetic images) with many of the articles it publishes. As described on the Protein Science Web site, a kinemage

> is a scientific illustration presented as an interactive computer display. Operations on the displayed kinemage respond within a fraction of a second: the entire image can be rotated in real time, parts of the display can be turned on or off, any point can be identified by picking it, and the change between different forms can be animated. Kinemages are created from Brookhaven Protein Data Bank files using the program PREKIN. The program MAGE is used to view them [http://prosci.org/Kinemage].

After exploring MAGE, I decided it could be a valuable resource for the protein molecule unit of my honors and AP biology classes. Rather than replace the lectures I had been using, MAGE would facilitate the addition of a self-directed activity using the computer laboratory in the multimedia center.

The first step in developing such an activity was aligning the goals of the unit with particular MAGE files or kinemages, downloaded from the Internet. Each file contains one protein, and it took quite a bit time to look through them all. After determining which kinemages demonstrated what I wanted the students to see, and in what order, I installed the program and the files on the computers in the media center, as well as on the Academy server. Placing MAGE on the lab computers ensured we could work with the program even if the server was down; having it on the server enabled student access from modem-connected home computers.

After approximately two weeks of lectures on the structure of proteins and other macromolecules, classes went to the computer lab where they spent two to four class periods working through the MAGE activity in pairs. Most students finished during class time. Those who did not were encouraged to work on computers at home or use study hall periods to go the media center.

The self-directed exercise was designed to lead students through some of the complexities of protein and enzyme structure. By following the steps of the activity, they also learned the full capabilities of the MAGE program. Most of the students are already competent with computers and the program is easy to use. The first section of the activity introduced students to the program using a demonstration kinemage. Each file includes text describing the protein, as well as one or more three-dimensional images that can be rotated in any direction to a new position by clicking and dragging the mouse. (Some of the texts are very technical, but the worksheet keeps students from getting lost in them.) Clicking in a row of boxes to the side of the image can temporarily delete or highlight different elements of the protein. This enables one to see how different parts of a protein are related and bonded.

After going through the demonstration file, students were directed to other files and asked to complete exercises and answer questions about specific proteins. Exercises included drawing portions of the proteins pictured and comparing the three-dimensional kinemages to two-dimensional artist renderings in the textbook. Some of the questions asked students to describe the shape of protein parts; others asked about the effects of mutations or missing parts of proteins. Finally, students in the senior year AP class accessed either a folder I placed on the Academy server or the Protein Science Internet site, where they selected and downloaded a new kinemage, and answered questions about it. Students in the freshman level honors class could do this exercise for extra credit. Overall, the MAGE activity emphasized a deeper understanding of what was discussed in the classroom lectures, leading students from the simplest aspects of protein structure to some very complex ones.

Evaluation

It is one thing to incorporate technology into curricular activities. It is another to ensure that technology use enhances instruction and learning. An important part of the Athens Academy / Bertelsmann Foundation partnership is ongoing evaluation of the effectiveness of technology in improving education. Near the end of the 1995-1996 school year, the Academy administration and educational researchers from the University of Georgia decided that biology would be a good course for quantitative evaluation. I had learned about MAGE a few months earlier, and I decided to test whether this technological advance made a difference in student learning, particularly their long-term retention and depth of understanding. Students in the 1995-1996 biology classes, the year before we started using MAGE, provided a control group. At the end of the school year, seven months after the unit on protein structure, they were asked to fill out a comprehensive questionnaire that tested how much they remembered. Since I was not sure what knowledge would be most important for evaluation, the instrument included just about everything we covered on protein structure and function, from the very basic to the quite complex. While I did not expect them to remember everything, I included certain questions about protein shape and the complementarity of structure and function. This is an important emphasis in the unit, and something the MAGE program was particularly good at depicting. The questionnaire, or evaluation instrument, was quite long: six pages and mostly short essay questions. Students were told this was for a long-

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term study, and that they were not being personally graded.

One year later, again seven months after completing the unit on protein structure, the 1996-1997 biology students were administered the same questionnaire. The unit had been taught the same way, with the same lectures as the previous year. The only difference was the addition of the MAGE activity, which added three or four extra class days to the protein unit. As expected, students who used MAGE retained much more knowledge of protein structure in much more detail. For instance, when asked to draw an alpha-helix, students in the control group drew a simple spring structure, similar to what had been drawn on the chalkboard. In contrast, the drawings of students who had used MAGE actually showed bond angles within the spiral and depicted the formation of hydrogen bonds—a much more sophisticated and specific understanding. As described in the executive summary of the evaluation study (Hannafin & Hawkins 1997, p. 6), students using MAGE

> significantly outperformed their counterparts who did not have access to the technology [the year before] on a long-term retention test... Analysis of test data by subtest found improved quality and processes of learning as well as better application of learned material to novel situations... MAGE made both teaching and learning about complex proteins and enzymes easier. Learning was more engaging for students, with communication and collaboration improving as well. The implication is that use of the technology tool MAGE is an effective aid to improving learning about complex protein and enzyme structures.

As demonstrated in the surveys administered by Hannafin and Hawkins (1997, p. 45), students enjoyed using MAGE. The program's video-game-like quality—the manual, real time manipulation of colorful and interesting on-screen images—plays to a strength of many high school children. Hearing students exclaim, "Oh that's really cool" while learning about protein molecules is a "really cool" experience for a biology teacher.

Conclusion

There was a confident expectation that students using MAGE would remember the details of three-dimensional structure better than the control group, but what surprised me was that they remembered everything better, from tiny details to the big ideas. Incorporating a MAGE activity into the protein unit makes my class more fun for students, enabling them to achieve more learning objectives in an enjoyable way. It also employs computers in accordance with the Academy's technology use guidelines, particularly that the "adoption of new technologies must make use of the unique capabilities and qualities of those technologies" [this is the third of five main guidelines; all are listed in Reid 1994, p. 53]. The computer's ability to produce real time three-dimensional images, requiring millions of computations per second, helps students visualize complex protein structures without spending hundreds of dollars on models that will be used only a few days a year and will only show a small number of variations.

Using MAGE requires computers for students to use and a little bit of experience with computer systems and the Internet in order to download and set up the software and files. Since we used MAGE to enhance rather than replace the already existing curriculum, it was a little more expensive in terms of time. But at Athens Academy we feel the benefits—the deeper understanding and long-term retention demonstrated by the evaluation—are clearly worth the costs.

References

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