The Visionlearning Project

Evaluating the Design and Effectiveness of Interdisciplinary Science Web Content

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Although the proliferation of teaching resources on the Internet is extensive, little is known about these materials' use or utility. The Visionlearning project (available online at www.visionlearning.com*) is a multiyear effort to design and evaluate web-based interdisciplinary science teaching resources. The Visionlearning resources are modular in nature and integrate text, simulations, news, history, and interactive exercises into a comprehensive overview of scientific concepts. Students using these resources in a traditional college science course scored significantly higher on a standardized assessment quiz than students who used a printed textbook. Those students who reported frequent use of the website scored better than their classmates who reported less frequent use. This research demonstrates that well designed web-based learning materials can significantly improve science education.*

As advances in science, medicine, and technology play ever-larger roles in everyday life, public interest in science grows. Unfortunately, less than 17 percent of Americans feel they are able to understand modern scientific achievements. Although no one factor is responsible for the current inadequacies of science education, there is growing evidence that poor textbooks and insufficient curricular materials are a substantial part of the problem (AAAS 2000a).

With the information revolution that was catalyzed by the development of the Internet in the early 1990s, science educators gained access to more extensive and advanced curricular materials than ever before (Cailliau 1995). Educators cite Internet use as the most valuable aspect of computer technology for teaching, and more than 60 percent of teachers use the Internet to locate curricular material (Becker 1999). Unfortunately little research exists to document the effectiveness or pedagogical design of online teaching resources. This article reports the latest results from the Visionlearning project (available online at *www.visionlearning.com*), a multiyear effort to evaluate the design, use, and pedagogical value of online science teaching resources.

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Project Prototype

In 1998, we designed and launched a prototype Internet science teaching resource, *The Natural Science Pages* (available online at *web.jjay.cuny.edu/~acarpi/NSC/index.htm*), to increase students' comprehension, performance, and retention in an interdisciplinary undergraduate science course at John Jay College of the City University of New York. This prototype was extensively tested in 21 different sections of the target course (with approximately 30 students per section) over a 2-year period.

Standardized exam scores and student retention data demonstrated that the resource significantly improved science comprehension and performance in the target course (Carpi 2001). Student evaluations revealed that the site also helped improve communication and interest in the course. The site also generated broad public interest and was widely used by instructors outside of John Jay College, logging over 140 000 visits to date.

As a result of the prototype's success, we began in 2000 to work on a public science education web portal, the Visionlearning project. Internal and external user evaluations from the prototype project were used to clarify strengths and identify improvements for the design of the Visionlearning website (Carpi 2001). In addition, the *National Science Education Standards* and their college equivalents were used in the development of the site lessons to ensure that they would promote inquiry, place subject matter in the context of current and historical research discoveries, and place emphasis on understanding by inte-

grating related scientific concepts (Siebert and McIntosh 2001; AAAS 2000b; NAS 1996; Pratt 1997; NSF 1997). In August 2000, the Visionlearning website was publicly launched for evaluation.

Resource Design

The core aspect of the Visionlearning portal is a library (called *Our Library*) of interdisciplinary science education modules written by educators. The layout of these modules is based on educational website design standards, and individual modules can be combined in any order in the *My Classroom* section of the Visionlearning portal to allow instructors to customize the resources to fit their curriculum as recommended by teaching professionals (Manske 2001; Brown 1997). The education modules on the site are designed with consistent and distinct categories to facilitate classroom use.

Each module contains a core lesson written by a professional educator. These lessons cover fundamental scientific concepts that are widely taught in introductory science courses. All technical terms in the core lesson are linked to an external pop-up glossary, which allows students to spend less time looking up terms and more time focused on the subject matter. The core lessons also include concept animations that help illustrate the scientific concepts covered and promote student interaction.

During our early evaluation of the prototype website, we found that students benefited from using external links on the lesson pages; however, students reported that they would benefit more if the external links were categorically arranged (Carpi 2001). In response, we incorporated a standard set of link categories into the design of the Visionlearning modules.

In this way, each module serves as a homepage for a specific scientific concept, allowing users to explore the topic in as much detail as desired. For instance, the first category seen on any of the site lessons is *News & Events*, which integrates current news articles and research discoveries and presents science in the context of research and societal perspectives. *Experiment!* links incorporate material that permits user interaction and discovery. *Questions?* links provide access to communication resources such as student discussion boards and "Ask-a-Scientist" pages. *Biography* links add scientific history by integrating the life stories of key scientific figures. *Classics* links provide actual historical articles, recordings, or speeches of scientists. *Quotations* help ground concepts in real-life thoughts and statements. A *Further Exploration* section provides links to complementary lessons that allow students or instructors to easily explore a subject in more detail. Finally, a *Resources* area provides material such as interactive practice tests, instructor overheads for class presentations, scientific calculators, and more.

Project Evaluation

To assess their design and pedagogical effectiveness, we used and evaluated the Visionlearning modules in an interdisciplinary, nonmajors science course (*NSC 107: Introduction to Science in Society*) at John Jay College ($n = 454$ students) in the fall of 2000. The course was taught in eight large lecture sections ($n = 42$ to 73 students per section), which shared the same syllabus and core requirements. The eight course sections were broken into three groups that used different educational resources to support the faculty lectures.

Group 1 consisted of three sections that relied solely on a series of education modules on the Visionlearning website for required readings (*www.visionlearning.com/myclassroom/courses/NSC107_Carpi_index.htm*). Group 2 (which had four sections) relied on a combination of a published introductory science textbook (used previously in the course) and the earlier prototype website that was developed for the course (*The Natural Science Pages*). Group 3 (one section) relied solely on the published introductory science textbook.

At the end of the fall semester, a standardized, multiple-choice assessment quiz was administered to all eight sections. The assessment quiz focused on core scientific principles taught in the course and was reviewed by the introductory science faculty to ensure fairness and relevance. Results from this assessment quiz indicate that the Visionlearning resources significantly improved science comprehension (see Table 1). Students in group 1, the Visionlearning group, earned 24 percent higher scores on the assessment quiz than other groups. The Visionlearning students had an average quiz score of 77 points, significantly higher ($P < 0.001$) than the 62-point average of students in all

TABLE 1

Mean scores.

Student scores on an assessment quiz in eight sections of NSC107 ($n = 454$ students).

Mean quiz score ± 95% CI listed by section	Group number
77.0 ± 3.0 76.3 ± 3.9 77.8 ± 3.3	1: Class sections using the Visionlearning website
61. ± 4.7 61.3 ± 2.8 66.1 ± 4.7	2: Sections using prototype website and textbook
62.8 ± 3.5 54.8 ± 6	3: Section using textbook only

other course sections. The course sections that used the textbook and *The Natural Science Pages* website scored significantly higher on the quiz than the one section using the textbook alone ($P \leq 0.04$), confirming our earlier findings that this resource was pedagogically beneficial (Carpi 2001).

Additional data were collected during classroom testing to ensure the evaluation's accuracy and objectivity. Students were asked to self-report their use of the Visionlearning website during the assessment. This is an important factor to measure because many students do not complete required course readings; and, because the Visionlearning modules are publicly available, students were able to access them regardless of the class section in which they were enrolled.

Students who categorized their use of the Visionlearning website as "often" had an average score of 75.6 on the assessment quiz, which was more than 7 points higher than that of students who used the site less frequently ($P \leq 0.007$, Table 2). Students who reported "occasional" use of the website scored significantly higher (mean = 68.5) than those who reported "never" using the site (mean = 61.6). No statistically significant difference in quiz scores was found between students who reported "seldom" use and those who reported "never" using the site.

Students who used the Visionlearning modules were also asked to report their satisfaction with the materials in a separate, anonymous survey instrument. Approximately 70 percent of students responding to the survey (n = 184) felt that the Visionlearning content helped improve their performance in the required course. More significantly, more than 90 percent of students responded that the Visionlearning materials helped increase their understanding of science.

To evaluate the use and utility of the external links and simulations on the modules, students were asked to report on the survey instrument how often they used these materials. The most commonly used resources were the *News & Events* links and the concept simulations, with approximately 75 and 70 percent of students, respectively, reporting frequent use of these tools. Approximately 50 percent of students reported using the *Experiment!* links and the glossary definitions; approximately 30 percent reported using the *Biography* and *Further Exploration* links (these readings were not required in the course). Almost 75 percent of students reported that these external links helped increase their understanding of science.

Students were asked to list additional module features that would be helpful on the survey instrument. The two most commonly listed features were practice quizzes and communication tools. In response, interactive practice tests were added to the *Resources* section of all lessons in June 2000. In addition, the *Questions?* category was added to all modules in July 2000 to add advanced communication features such as an online tutoring system and an "Ask-a-Friend" discussion board.

FIGURE 2

Mean quiz score.

Scores are categorized by student use of the Visionlearning website.

Website use	Mean score ± 95% CI
Often (once or more per week)	75.6 ± 2.0
Occasional (once or twice per month)	68.5 ± 5.1
Seldom (once or twice during the semester)	64.4 ± 4.4
Never	61.6 ± 2.2

Web Resource Effectiveness

Despite the rush to place educational materials on the Internet, relatively little is known about these materials' value or pedagogical effectiveness. This project demonstrates that well-planned web-based materials can be more effective than a traditional textbook in teaching science. This project also suggests that the design of these web materials plays a critical role in determining their effectiveness and use.

Web-based teaching materials must be carefully planned and must integrate text, animations, interactive features, communication tools, and the wealth of existing web content to effectively leverage the robustness of the Internet. The advantages of the web are far more extensive than its ability to recreate the printed word, and so web resources must go beyond the tendency to simply place text online.

Equally as important, though, is the fact that students do not learn in random steps. Therefore, interactive features, simulations, and external links should be organized into a coherent presentation that complements subject readings. The resources developed in this project integrate text, animations, news, and history to present students with scientific principles in the context of their discovery and modern application.

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