Multimedia and Internet Reading Resources for Science Students

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Instructional technology is becoming a vital part of education at all levels, but the trend is particularly clear in universities. The 1997 Campus Computing Survey (USA), for instance, reported that an increasing number of campuses now have a computer competency or computer instruction requirement for all undergraduates. The survey indicated that almost a third of all college courses use e-mail, almost a quarter use Internet resources, and more than one-eighth use multimedia.

Not surprisingly, the use of instructional technology was highest in research universities. Such institutions train large numbers of students in science and technology fields, for whom electronic communications and resources are important even before they begin their careers. For such students, Internet resources can provide the most current information, often as a necessary supplement to textbooks which are quickly outdated in many fields because of the acceleration of scientific discoveries. In addition, instructional technology gives science students experience with advanced search procedures, access to scientific sites and institutions, and communication with other students and researchers around the world. To maintain their competitiveness in the international science community, major universities everywhere understand the necessity of integrating instructional technology across the science curriculum.

English instruction for science students

The importance of educational technology for content courses in science overlaps with a similar trend in English-language instruction. The language of modern science is overwhelmingly English. Every type of scientific discourse is conducted predominantly in English: general discussions, correspondence, conferences, professional articles. Yet, most of the scientists in the world are not native-speakers of English, and most of the universities training young scientists are not in English-speaking countries.

Given the range, content, and accuracy requirements of scientific communication, the need for quality English instruction for science students is obvious. However, English instructors who do not have a strong science background may feel somewhat uncomfortable with the nature of the material, technical vocabulary, and/or discourse modes in science. Instructional technology offers considerable assistance in this regard. The instructor does not need to be an expert in any particular scientific field, but does need to understand the language requirements of science students and how

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to organize relevant resources for students. Multimedia software and Internet resources such as the World Wide Web (WWW, or "Web") provide an abundance of content materials at all levels. The Internet has several bonuses: the most up-to-date information in science and technology fields, where information changes most rapidly; an increasing number of interactive sites which can be adapted for different language skills; and a framework in which students can optimize their individual learning strategies. By using the Internet, the instructor can tailor language courses to group or individual student needs. In addition, students are able to develop skills in electronic communication and information-accessing that will be essential in their science careers.

Cognitive science and the learner-centered approach

Cognitive theory stresses the relationship between the external factors (lessons, instructional materials, teacher) and internal factors such as attitude, aptitude, attention, memory, etc. Content of materials is converted to actual (retained) knowledge in a complex process that has been the object of research especially in the last three decades, and a number of theories have been incorporated in the design of instructional technologies (Schuell, 1992). The link to technology is that interactivity seems to promote learning by enhancing intellectual skills, attention and memory (Gagne, Briggs & Wager, 1988). Interactivity promotes learning in general, but in language learning it is essential because it is a factor in communication itself (Yang, 1998, p.78). Any methodology which promotes interactivity is worth consideration, and the Internet does this in a way that is convenient and accessible to different skill levels. Technology can also optimize individual learning strategies and allows students to control the pace (e.g., number of repetitions for certain exercises or review of information) without self-consciousness

An English reading course for science students

English reading courses for science students can be greatly enriched by a combination of multimedia and Internet resources. Multimedia CD-ROM programs now available are often simplified in content to appeal to a wide public; however, for foreign language instruction purposes, they make for good base course material which can be supplemented by materials available on the World Wide Web. The Web offers the additional bonus of links to related information, institutional sites, and museums. Since a large number of sites on the Web are also interactive, students can often practice communication skills in English through discussion groups and/or other mechanisms which allow user input as they develop their reading proficiency. Use of such resources in language courses also motivates independent reading on the part of students.

A freshman English reading course for first-year physical science students (Shizen-A) at the University of Tsukuba was designed with the object of raising reading proficiency to scientific text

level relative to students' respective fields. Since at this university the first-year students in the physical sciences are grouped together (e.g., physics, mathematics, chemistry, geology), it is a challenge to present up-to-date readings that accommodate all needs and interests. Use of Internet resources made it possible to accomplish this. However, given the diversity of the students' fields and technical quality of the subject matter, some preparatory work in vocabulary, concepts and general background information was necessary. For this reason, the course was organized in three phases corresponding to the three-semester program at Tsukuba University. These phases targeted (a) general vocabulary expansion and broad areas of informational text (news articles); (b) specific science material in simplified form (multimedia and science news articles for general readers); and (c) technical levels of science reading (Internet resources).

Phase 1: General news articles

In the first semester, while a new multimedia lab with a projected Internet connection was still under construction, the course focused on increasing general vocabulary, especially idiomatic expressions commonly used in the media. In this phase, news articles, including a few science topics, were used. Students were given one or two readings each week. The core text was a reader which included Japanese translations of vocabulary (especially helpful with idioms), with an additional few short science news articles toward the end of the semester. For each of the readings, students were given study questions and vocabulary lists, and during each class period the students practiced reading techniques: comprehending general and specific points of the article, understanding the construction of the information (general statements, supporting details), and learning to infer meaning where information was more indirect. Each assignment was completed in class, collected and graded. By the end of the semester, general vocabulary had increased, and students were able to read several sections of an English newspaper quite adequately.

Phase 2: Multimedia material

In the second semester the course shifted to science topics exclusively, first in multimedia presentations and then in longer and more challenging news articles in science. The multimedia material was a new experience for the students, and one that captured their interest. A CD-ROM program, *Eyewitness Encyclopedia of Science*, was used as the base. This program contains a wide range of science topics (natural science, chemistry, physics, mathematics) presented in text, graphics and video clips, with optional sound for the main parts of the text. There are also biographical articles on major science personalities, a topic index, and a question-answer component. Since the readings in *Eyewitness Encyclopedia* are simplified (approximately junior-high school level for native speakers of English), it is possible to make abstract scientific concepts more accessible for

non-native speakers. The additional features of graphics and animations are attractive to students, and facilitate the absorption of more complex material (e.g. Einstein's theory of relativity), an important consideration in a foreign language.

For the instructor, multimedia programs of this type allow flexibility and options of focus: for instance, it is possible to limit a topic (e.g. general relativity) or link to related topics (e.g. special relativity) and to relevant biographical information (e.g. Einstein). The readings are short, so combinations are easily managed, and it is possible to present all the material twice, or even three times, in a seventy-five minute period—a necessity for this class, where students viewed the presentation as a group and had to work fairly quickly to answer questions on a handout study guide.

In this case, for each multimedia lesson the class first reviewed the (handout) study questions and vocabulary with the instructor. This was followed by a quick viewing of the multimedia presentation (text, graphics) to familiarize the students with the material and to associate the study questions with the relevant sections of the presentation. Finally, the multimedia was presented again slowly, and the class worked through the questions. The presentation was shown a third time so that students could check their answers. As in the first semester, the assignments were collected at the end of each class. This allowed for careful monitoring of students' ability, both in comprehension and in reading speed.

Toward the end of the semester, science news articles were added. These readings were at a more difficult level than the articles selected for the first semester, but were still aimed at the general reader. Most were related to topics covered in the multimedia presentations, but the science news articles contained much more vocabulary than the multimedia readings, and conceptually were more technical than the similar topics in *Eyewitness Encyclopedia*. The two types of materials seemed to be a necessary combination to prepare the students for the readings in the third semester.

Phase three: Internet resources

In the third semester, the reading class shifted to Internet reading sources exclusively. To orient the class, one session was given over to demonstrations and practice in locating different topics via search engines, selecting articles for appropriate content, level and length, experimenting with links to visual scientific sites, and checking a few of the best Web sites, such as Scientific American (which is highly recommended: *www.sciam.com*). The Internet was very motivating for the students. The major concern was that, given class-time constraints, the students would not be able to locate articles of appropriate length and level. Level, in particular, can present problems for science readings. First, students vary individually in this regard, with some able to handle quite advanced material earlier than others. Second, the particular subject matter affects level also, so

that readings in some fields of science might be inherently more challenging than readings in another field. It is important to prepare students for these differences so they can learn to match their reading selections to their abilities across different topics. However, with a little practice, these students learned to skim the articles as they located them, and to identify subject matter of interest at a level they could manage. One by-product of this effort was a compilation of Internet sites recommended by the students.

During the third semester the class alternated between a "class selection" one week , and a "self-selection" the next week. The class selection was a reading chosen by the instructor, accompanied by specific study questions and a vocabulary list. For the self-selection readings, students located their own readings on the Internet and the study questions were more general (e.g. main idea, supporting details, brief critique of the content). Students also ranked the self-selection article on a scale of 1-5 for level of difficulty and their personal enjoyment. The alternation between class-selection and self-selection was motivated by the necessity of tracking students' vocabulary development and comprehension, because monitoring actual reading progress was somewhat difficult in the self-selected material. Class-selections could also be evaluated objectively; so the two exams for the third semester were based only on readings selected for the whole class.

The self-selection approach presents pedagogical risks. Students are more on their own for vocabulary development, and it is not as easy to monitor individual reading, even though students submitted copies of their articles with the study guide responses. Self-selection also means more work for the instructor—in this case, some 48 articles to read in a self-select week instead of one in a class-select week. On the other hand, the self-select mode can be very gratifying. The students in this class were quite adventurous, and spontaneously broadened their reading range beyond their particular fields. They located many interesting articles, and were honest in their evaluations of level of difficulty and level of enjoyment. It was a pleasure to note that they were early to arrive at the lab and slow to leave.

Benefits of electronic reading courses

For science English instruction, there are four important benefits to be realized in using the Internet for reading courses. First and foremost, the Internet makes it possible to accommodate efficiently a wide range of science students with authentic and current material. It is otherwise difficult for the instructor to locate an appropriate selection of readings for a diverse group of science majors, and even more difficult to ensure that the materials are up-to-date, given the rapid changes in modern science.

The second substantial benefit of using the Internet is that it encourages students to explore topics that might otherwise be of only peripheral interest. This was an unexpected surprise that

emerged in the independent readings in this class. Because of the increasing trend toward interdisciplinary work in science, the willingness among the science students to expand their topics should definitely be encouraged. The Internet makes this a much easier process.

A third benefit of the use of the Internet is that it can offer students some independence over their reading development in English, and a crucial part of that independence may be the exploration of links to scientific sites (e.g. major space and astronomical stations, animated mathematical sites, museums). Web links to related topics, authentic sites, and interactive components are very helpful to the instructor, since such links reinforce students' understanding of difficult material and heighten reader interest—significant features where the instructor must accommodate different scientific fields. . For these students, some of the most popular topics for both class-selections and self-selections—e.g. quantum mechanics, black holes, fractals—would have been difficult in the students' native language. Related science sites with colorful visuals and/or animations provide substantial reinforcement for challenging readings. Furthermore, such sites introduce science students—usually for the first time—to authentic in-progress scientific investigations all over the world.

Students definitely enjoy the stimulation and independence presented by use of the Internet. In this class they did not squander the opportunity but seriously challenged themselves. Even with the considerable pressures imposed upon them, e.g. to locate an article and to complete all or most study questions by the end of class, most students in this group found the Internet experience exciting.

Use of the Internet as a resource for reading material can make it possible to dispense with paper. With a proper lab setup, paper copies of articles, and handouts can be replaced with electronic files. With the present technology, all reading material, study questions and answers, vocabulary, and many other aspects of a reading course can be completely electronic. Many instructors using instructional technology today make a course web page containing the syllabus, notices, and all the course materials. For a reading course such as this one, an instructor can download to a class file a selection of readings from which students can choose. Study questions, vocabulary and answers can all be made available in electronic files, for instance in a web page or intra-net set up. This general approach to course design is becoming more common, and it is very popular among students. It requires some time for the initial set up, but may well save time in the end. Although the fully electronic design was not utilized in this particular course, it is recommended.

Conclusion

The possibilities of instructional technology are tremendous for students and instructors, especially as the demands for relevant materials increase. In the near future, use of multimedia and Internet

facilities will hardly be an option for science students, given the related needs of having the most current information available and becoming proficient in using the Internet. Certainly at the university level, courses of all types will routinely be set up in electronic form in order to keep up with the volume of new information, and the Internet in particular will be a central source of material. Although teachers are always pressed for time, it is well worth the effort to become better acquainted with the potential benefits to students

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