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A high school physics instructor's website: Design, implementation, and evaluation

Richard Neal White

A HIGH SCHOOL PHYSICS INSTRUCTOR'S WEBSITE: DESIGN, IMPLEMENTATION, AND EVALUATION

A Project

Presented to the

Faculty of

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Approved by:

[redacted]

Amy Leh, Ph.D., First Reader — 11-21-02 Date

[redacted]

John Ruttner, M.E.S., Second Reader

ABSTRACT

There are many college and university courses that have Internet web sites associated with them, and research indicates that these sites can have a positive effect on learning. There are currently very few high school course-related web sites, however, and little research regarding their value.

This paper describes the *crashwhite.com* web site, which was designed to supplement classroom instruction in the author's Physics and AP Physics courses at Berkeley High School. The site was designed according to accepted instructional design principles, and offered increased access to classroom materials, and included an online discussion board that students used to communicate with each other. The usefulness of the site was evaluated using both a written survey of students who were familiar with the site, and videotaped usability tests of students using the site for the first time. The majority of students stated that the web site did a good job of providing support materials for the class and helped them to learn physics better.

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DEDICATION

To my parents: my first, and best, teachers.

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CHAPTER ONE

BACKGROUND

Introduction

Increasing numbers of high school and college students have access to the Internet, either at school or at home. As students have grown more familiar with using the World Wide Web (WWW) to access information and communicate with others, teachers have started to develop websites that are associated with the classes they teach. These websites vary in scope widely. Some provide no more information than would be available on a course syllabus handed out by the teacher at the beginning of the year, while others offer more extensive resources, including additional references for the course, supplemental activities, content material associated with the course, and the ability to communicate on-line with the instructor and other students.

The vast majority of these course-oriented web sites are offered by college instructors. The uses of these websites and their effect on student performance have been documented. Websites associated with high school courses are found far less frequently, and an informal survey of the ones that do exist reveals that they are much more limited in scope. Their

effect on students and student learning in high school courses has not yet been explored.

At Berkeley High School in Berkeley, California where this study was conducted, most of the seniors enrolled in physics courses have access to the Internet from home, and every classroom at the school has at least one computer with Internet capabilities. In this "Internet-aware" environment, the author created an extensive website to supplement classroom instruction for two different physics courses taught at the school. Important elements of the website included a course syllabus, the ability to view one's grade online, sample problem and test review materials, and an electronic "bulletin board" that student could use to communicate with the teacher and each other.

Creating such a large website involves more than simply putting up a number of pages and linking them to each other. For the site to be educationally effective, principles of instructional design should be followed. The site should be built in such a way that it is easy to implement and maintain. And of course, the site needs to be constantly evaluated in terms of its usefulness to the students--

students must find the site easy to use and beneficial to their progress in the course.

This paper will discuss the development of the Berkeley High Physics website. It will begin by looking at the site in terms of instructional design, then explain some of the technical details involved in implementing the website, and finally present the results of two different instruments that attempted to evaluate the site's effect on students and learning in the courses.

Purpose of the Project

In order to test the ability of the Internet to supplement classroom instruction, an instructor-authored WWW site was developed for two Berkeley High courses: Advanced Placement (AP) physics, and a college-prep physics class. The website was intended to supplement classroom instruction by making classroom materials available to students and parents outside the classroom, and to facilitate increased teacher-parent, teacher-student, and student-student communication. The website would be hosted on a commercial server, and be accessible to anyone with a web browser and an Internet connection.

The project had its beginnings in October, 1998, when two simple web pages were created and posted on the Internet: one page had a series of review problems that physics students could download to prepare for a unit test, and the other contained a series of homework solutions for the AP Physics course. Instructors have used websites for similar purposes at the college/university level (Chandler, 1998) with some success, and the initial response from students at the high school level was encouraging: the majority of students in each class printed out the posted material from a home computer and used it in studying.

Although these initial web pages were rather simplistic and had few of the features that a high quality website should have (Maddux, 1999), the fact that the information on the website was so widely used by students was encouraging. In addition, there seems to be some evidence that a well-designed website may help motivate students to participate more in the learning process (Arnone, 1999). Design and development of a larger-scale website for the physics classes began immediately.

Context of the Problem

Berkeley High School (BHS) is a large urban high school located in Berkeley, California, just east of San Francisco. The school has existed for over one hundred years, and currently serves an ethnically diverse population of over 3000 students. The BHS Science Department is generally acknowledged as one of the strongest departments on campus, and employs twenty-five teachers who conduct a full range of classes, from remedial biology and physical science classes to Advanced Placement courses in Biology, Chemistry, and Physics. For many years now, lab-based science courses at the school have been conducted in "double-periods": each course meets for two consecutive 45-minute periods per day. All other classes at the school meet only 45 minutes per day.

The author of this project is in his fifth year teaching physical sciences at BHS, including the Advanced Placement physics course and a "normal" college-prep physics course. The students in these courses tend to be very bright and motivated. These students and their parents, many of them professors at the nearby University of California, Berkeley, have high expectations of the courses and the teachers who conduct them. Specifically, it is expected that courses will

be taught at a relatively advanced level, and teachers are expected to provide students with many support materials to improve their chances of success. Parents of students in these courses expect to be able to communicate with the teacher from time to time.

Along with the challenge of conducting high-level courses, Berkeley High teachers face many other difficulties that are often found at urban high schools. Textbooks are in short supply. The photocopy machines used to make class handouts often are broken. There is no public address or intercom system. An arson-caused fire two years ago destroyed an entire building of classrooms and administrative offices. The school has had 4 different principals in the last 7 years, and this year's principal abruptly left several months into the academic year. Teachers have limited access to telephones for calling parents. Amidst these difficulties, it is somewhat ironic that the school is in its third year as a Digital High School grant recipient--all classrooms have at least one Internet-connected computer installed in them.

As the school administration struggles to deal with the school's larger problems, classroom teachers are left to carry on as best as they can. It is up to teachers to find

their own means of delivering quality instruction in the classroom, supporting that instruction with appropriate materials, and communicating with parents. Initially, the decision to build an Internet-delivered component for the physics courses was a logical solution to the problems of limited photocopying capabilities and telephone access. Ultimately, the website that was created came to play a far more important role in the courses than originally anticipated.

Significance of the Project

Instructors' websites for high school students are relatively rare. Of the 170+ teachers at BHS, there are only four teachers who provide any kind of Web-based material for their students, and one of these is simply a compiled list of links prepared by one of the history teachers. It is unfortunate that although many Berkeley students seem to have adapted very well to the Internet--all 28 students in the AP Physics class have e-mail addresses, as do the majority of students in the regular Physics classes--most of their high school teachers have lagged behind in taking advantage of new technologies.

The dearth of educational websites extends even to science courses, where teachers tend to be more accepting of technological developments like the Internet. More specifically, the Internet's potential as an educational tool for high school physics instructors, with some rare exceptions (Gosselin, 2000; Quinton, 1999) has been largely unexplored.

Research conducted at the university level, however, suggests that websites associated with classes increase learning (Becker, 2000, Burge, 1994, and Kayany, 1998). There is certainly evidence that a well-designed website may help motivate students to participate more in the learning process (Arnone, 1999). Associated with this, a survey of 78 studies determined that course websites have the potential to increase students' levels of class preparation, participation, attention, and increase interaction between instructors and students (Kayany, 1998).

With such documented successes at the college level, it is natural to expect that websites designed to accompany high school classes would have benefits. A large-scale website designed to accompany the Berkeley High physics classes would conceivably increase learning, and would almost certainly

benefit students by providing additional support materials for their courses.

Assumptions

The following assumptions were made regarding the project:

1. All students would have Internet access, either at home or at school.
2. All students would have a personal e-mail address, from their own Internet Service Provider, from a web-based e-mail provider such as Yahoo or Hotmail, or provided by the school district.

Definition of Terms

The following terms are defined as they apply to the project.

- Computer-Mediated Communication (CMC)--CMC refers to communicating, either synchronously or asynchronously, via a computer network. The two most common examples of CMC are e-mail and discussion boards.
- Computer Conferencing (CC)--Communicating via a discussion board.

- Discussion Board--Also called a Bulletin Board, this allows users to post electronic messages on a web site, where they may be read by others.
- Domain Name--The domain name identifies, using letters and numbers, the address of a particular web site or web page. "www.crashwhite.com" is the domain name under which the web site for the physics classes in this project was stored.
- Host--In the context of this study, a host is a computer which stores the HTML documents that describe the website. Users who use their browser to access a given URL will be able to view the documents located on the host.
- HyperLink (Link)--A hyperlink is a segment of text or a graphic on a web page that, when clicked with a mouse, will display another cross-referenced document on the user's browser. Synonymous with hypertext.
- HyperText--This term was created by Ted Nelson to refer to text that contains a cross-referenced "link" to another document. The term may also refer to linked pictures, sounds, and video.

- HyperText Markup Language (HTML)--HTML is the computer programming language that is used to create text, hypertext, and multimedia documents on the WWW.
- Internet--The Internet (capital "I") is a world-wide network of interconnected computers that allow for the transfer of information from one computer to another.
- Internet Service Provider (ISP)--Internet Service Providers are companies that provide access to the Internet, usually for a fee. To access the Internet, the user may use a home computer with a modem to "dial up" and connect to the ISP, which in turn connects the user's home computer to the Internet. The most popular ISPs are commercial providers such as America Online and Earthlink.
- Uniform Resource Locator (URL)--an Internet address that includes the domain name, along with other information that allows a computer to find and display a particular web page. The page that contains "Help" information for the physics class is identified by its URL, "http://www.crashwhite.com/physicsclass/physicsclasshelp/physicsclasshelp.html"

- Usability--In this study, usability refers to a measure of how easily users are able to do the things they want to do on a website. Additional measures of usability, such as how quickly a user can find information, are also included.
- User--A generic term for a person using a computer to access the crashwhite.com web site in this study.
- Web Browser (Browser)--a web browser is a computer program that allows the user to view HTML documents, or web pages. The two most common web browsers are Netscape's "Navigator," and Microsoft's "Internet Explorer."
- Web Page--A web page is an HTML document on the WWW that usually contains text or graphics, and is often linked to other documents on the Web.
- Web Site (Site)--A web site is a collection of web pages--usually connected to each other by hyperlinks--that are developed and provided by a single person or group. The crashwhite.com web site was the focus of this project.
- World Wide Web (WWW, or Web)--One of the primary features of the Internet, the WWW allows users to view

Web Pages and follow HyperText links from one page to another.

- www.crashwhite.com (crashwhite.com)--This is the domain name that the physics and AP physics course web sites were stored under.

Organization of the Thesis

The thesis portion of the project is divided into five chapters. Chapter One provides an introduction to the context of the problem, purpose of the project, significance of the project, limitations and delimitations and definitions of terms. Chapter Two consists of a review of the relevant literature in the fields of instructional design, website implementation issues, computer-mediated communication, and evaluation and usability testing. Chapter Three documents the steps used in developing the project, from initial design of the website through implementation and evaluation. Chapter Four presents the results and discussion of the project. Chapter Five presents conclusions drawn from the implementation of the project, and recommendations for future areas of study.

CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

There are two primary sources of research literature concerning educational uses of the Internet. The traditional sources, and arguably the most reliable, are education- and psychology-related journals. As Internet use in university-level courses has increased, researchers have found a steady source of research subjects; the results of many "Education on the Internet" investigations are being published traditional journals.

The second source, of course, is the Internet itself. The ease with which one can "publish" information on the Internet has made a vast amount of information available to anyone with a personal computer and a modem. Of course, self-published research on the Internet does not offer the same assurance of high quality as publication in a peer-reviewed journal, so one is justified in treating results that do not come from more traditional sources with some skepticism. Fortunately, a number of journals are starting to make their articles available online, and in many cases, the researchers

themselves are creating online versions of their publications (see McCabe, 1998 for example).

The literature review for this project focuses on four areas: instructional design, implementation considerations, computer-mediated communication, and evaluation and usability testing.

Instructional Design for the Web Site

Instructional design involves designing a system of content delivery according to the tenets of learning and instructional theory. If the design is successful, the learner's ability to acquire the content material is enhanced.

In the case of creating the instructional design of an educational website, there are two challenges to be faced: content that is to be delivered on the website must be developed and organized, and an interactive user interface must be designed that will allow, and encourage, access to that content (Ebersole, 1997).

The *crashwhite.com* web site discussed here was designed primarily to supplement two high school physics courses that met daily, so online presentation of the curriculum was not

necessary. Instead, the material delivered on the site consisted mostly of various administrative materials (course syllabus, class schedule for the semester, problem-solving strategies) and online versions of classroom materials (lab handouts, review problems, and practice tests). Thus, the many instructional challenges of designing curricular content for teaching on the Web (Hoffman, 1997) are beyond the scope of this paper.

But the problem remains: what does successful instructional design look like on the WWW? Georgiadou (1998) points out that current cognitive theory views learning as a process that is highly dependent on the learner's active construction of knowledge. In order to facilitate that construction, a number of instructional design factors need to be taken into account, including content structure, learner control, feedback, interactivity, and screen design.

The importance of "designing for comprehension" in order to increase readability in an online hypertext document is clearly spelled out by Thuring et al. (1995). A reader's ability to understand and remember text depends on maximizing its local and global *coherence* and minimizing *cognitive overhead*.

Increasing *local coherence* refers to reducing the fragmented appearance of text in a document, and using standard grammar and sentence composition when presenting text. The power of hypertext is its ability to allow for links to other documents, but indiscriminate linking in the middle of a body of text can disrupt comprehension. Increasing *global coherence* refers to ensuring that readers are able to make the large-scale connections between separate chunks of text, whether they are two different sentences or two different chapters. Thuring et al. (1995) cites evidence that linear text with a well-defined structure and rhetorical cues that reflect that structure will facilitate coherence at both levels.

Cognitive overhead is characterized by Conklin (1987) as "the additional effort and concentration necessary to maintain several tasks or trails at one time." The human brain has a limited ability to handle different tasks simultaneously, so reducing cognitive overhead will allow increased processing power for comprehension. In a hypertext document, cognitive overhead is often dedicated to handling orientation (a sense of where one is in the website), navigation (a sense of how to make one's way through the

website), and user-interface adjustment (changing presentation formats or reconfiguring windows on the screen) (Thuring, 1995).

There are a number of design features, then, that a web site can use to increase coherence and minimize cognitive overhead. Five hundred years of familiarity with the concept of printed matter (in the form of books) gives the web designer a convenient metaphor to use in organizing information (Lynch, 1994a). Chunking material into units, or even chapters, allows the user to understand the relationship between different screens of text, and a map of the web site, with links to all the different pages on the site, may serve as a table of contents.

Another means of increasing local coherence involves simply making sure that text on the screen is legible. Nielsen (2000) suggests the following basic rules:

- Use colors with high contrast between the text and background.
- Use plain-color backgrounds behind your text. Background graphics make it harder to recognize letters.
- Use font sizes large enough to be easily seen.

- Make blocks of text left-justified--users can read faster when they can easily find the start of the line.
- If using a relatively small text size, use a sans-serif font such as Arial or Verdana. Although most people can read serif fonts (such as Times or New York) better in print, most computer screens do not have enough resolution to clearly display the serifs.

Consistency is an important feature in site design. A consistent screen layout within the site will allow the user to quickly and easily understand the content on each page. This layout will dictate where titles are located, where important blocks of text will be placed, where graphic images will appear, and positions for buttons or navigation elements. Lynch (1994b) says that "abrupt or arbitrary changes in the layout of interface screens will distract and disorient the reader," thereby increasing cognitive overhead.

In addition to consistent layout, a consistent means of navigation is important. Icons are often used to indicate various control functions on web browsers, and web designers may be tempted to design interfaces that also use symbols or pictograms. Unfortunately, there are currently no standards

regarding icon use and design. Arbitrary or non-standard graphic symbols on a web page are distracting at best (Apple, 1995); at worst, the icon graphics increase page load time (Hoffman et al., 1997) and actually confuse the user; either way, cognitive overload is increased.

Hoffman also cites a number of studies that show navigating in hypertext environments is often confusing and disorienting. Unless a very clear, natural, and consistent navigation system is provided by the site designer, users will be forced to stop and think about their path, which results in frustration and an increase in cognitive load.

At all times, users should have a strong sense of "where they are" in the site, whether it's on the home page or buried several layers deep in a series of links. Allowing users to click on links that immediately take them to another page is a powerful capability, and research reported by McKnight et al. (1996) gives several reasons why nonlinear organization of information may be advantageous to some users. But research reported by Eklund (1995) suggests that many users get lost trying to click their way through a poorly designed site. Lynch (1994c) points out that there is "no widely agreed-upon spatial topologies or other organizing

principles for a multi-dimensional electronic information space," and suggests that in the meantime, web sites use literary metaphors such as indexes and tables of contents to help users stay oriented.

A detailed analysis of a new user's cognition while using the web is provided by Hess (1999), who observed a doctoral level graduate student using the Internet for the first time. The subject, who had a fear of computers in general, verbally reported her thoughts as she tried to figure out a website:

> How do I reach a site? . . . oh, okay. I just click on the words that are underlined in blue and I am sent automatically to that site . . . [Ann reaches the site] . . . I can't seem to find it . . . oh . . . It must be at the bottom under this passage, but how can I get there? . . . I can scroll down using the arrow on the side of the window. I need to understand this navigator system better! (Hess, 1999, p. 8)

This monologue reveals the subject's relative inexperience in using the computer interface, and represents a perfect example of cognitive overload. Further examples of this overload occur later in an interview, when the subject states that she felt she was "drowning" in information while exploring the WWW.

The measure of how well a web site reduces cognitive overload is called "usability" by some authors. More specifically, usability is a measure of how easily users can perform tasks or find information. Nielsen (2000) states that page design should be simple, allowing users to focus on content. Pages should work on all popular browsers (Netscape's Navigator and Microsoft's Internet Explorer are the two most popular), look acceptable on relatively small monitors, and load reasonably quickly via a modem.

With all of these challenges facing the designer, one has to ask: Why create a web site at all? What advantages are there to providing information for students via the Internet, particularly when many media comparison studies suggest that there may not be any particular advantage in using one medium over another (Clark & Sugrue, 1995)?

One obvious answer concerns motivation. One of the tenets of a cognitive theory of learning is that:

> . . . our attitudes, beliefs, and values influence our motivation to learn. Motivation is typically measured by either our willingness to engage in a task...and/or to invest effort in a task we have selected to perform... Motivation is one of the necessary components of learning. (Clark & Sugrue, 1995, p. 358)

Many teachers have observed that students seem to enjoy using computers, and Lepper (cited in Becker, 2000) points out that before a student can learn material, he needs to be engaged by it. Lepper's research shows that:

- computer activities that *challenge* motivate students to solve problems
- computer activities that *stimulate curiosity* motivate students to solve problems
- computer activities that provides a sense of *independent control and mastery* motivate students to work longer, and with increased effort.

Certainly many instructors who have constructed web sites to support their classroom instruction have reported increased student engagement, even beyond what they might have expected (Reeves & Dehoney, 1998). While most of these instructors are well aware that this may be simply due to the novelty of working in a new medium, they do not argue with the results.

Finally, there is increasing evidence that the interactive aspect of some web sites makes the Internet significantly different from other types of media. Burge (1994) cites evidence that *computer conferencing* may help students develop more sophisticated learning styles and strategies. The benefits of computer conferencing will be discussed in more detail later in this chapter.

Implementation Considerations

The process of creating an educational web site to accompany a course can be relatively simple or maddeningly complex, depending on the features and scope desired for the site. A full description of the mechanical process of writing web pages and assembling a web site is beyond the scope of this project; the technical process of writing HyperText Markup Language code, testing that code, transferring the

files to a central server computer via File Transfer Protocol, etc. are subjects that can easily be acquired online or from any number of commonly available instruction guides (see DiNucci et al., 1998, for example).

Technical details aside, there are a number of implementation factors to be considered when discussing the creation of a web site. Many amateur web sites begin as a small collection of pages haphazardly pieced together, but a more deliberate and systematic development approach is mandatory for creating a high-quality educational site. Boettcher and Schwartz (1997) recommend a six-step planning process in which one considers the Purpose of the site, the intended Audience, the Content that will be presented, the presentation Techniques (What hardware will be used? What software will be used to develop the site? What layout, colors, graphics, and multimedia will be used?), user Participation (Will there be a Discussion Board?), and Ambition (How extensive do you plan to make the site?).

For teaching-related web sites, there are additional factors to consider: how much instruction will be conducted online? Three modes of online instruction have been identified: adjunct, in which the site only supplements

regular classroom instruction; mixed, in which some instruction occurs via computer-mediated communication (e-mails or discussion board); and totally online, where the site is actually used to deliver content (Harasim et al., as cited in Annand, 1997).

In Davis and Boyer (1998), the web site design recommendations of the design team for the University of Nebraska at Omaha's Library are outlined. When implementing a web site, guidelines be established that will ensure the site is:

- *accessible*. Pages need to be created so that all standard browsers will be able to display them. Pages should be well-designed, and links should be up-to-date and correct.
- *responsive*. The content of the site needs to be regularly and appropriately updated as required by users.
- *appropriate*. The web site will be publicly viewed, and should reflect and enhance the public's perception of the teacher and the course.

Administering a web site--managing both the content and the form of the web pages that make up the site--can be

logistically difficult. Although a large commercial web site may have an entire team working to develop and maintain it, small-scale sites are almost always managed by a single person. It is legitimate to ask how much time is required to develop a course web page, particularly for someone who is relatively new to the technology. In a survey of college and university instructors, significant amounts of time were spent learning HTML (4 hours to 40 hours total), planning and designing the web pages (12 hours total to 10 hours per week for the semester), preparing and organizing the actual content (15 minutes to 3 hours per lecture), and maintaining and upgrading the pages (estimated from one-half to two hours per lecture, to 5-10 hours per week). It should be noted that these time values can vary significantly from site to site: not all sites provide lecture content, not all pages require regular upgrading, and learning HTML is not necessarily a prerequisite for developing a web site. Still, most of the faculty members in this survey felt that "the total time investment in the project is many times more than what they had originally imagined or could afford" (Kayanay, 1998).

Formosa (1998) recommends that any faculty member who wishes to create an educational site should have an

understanding of the basics in educational psychology, instructional design, principles of instructional delivery, and web page design.

The actual content material that goes onto an educational website can be broken down into four categories (Kayany, 1998):

- *Organizational material*, which includes those materials that might ordinarily be distributed to students on paper or posted on a classroom bulletin board: the class syllabus, course calendar, assignments, and grades
- *Links* to other online resources
- *Course content*, including lecture notes or other presentations
- *Student Work*

While it might be argued that the best educational web sites will contain all four types of content, most sites do not, perhaps because of the overwhelming amount of work that goes into creating a web site. An adjunct-mode web site such as the *crashwhite.com* site examined in this paper will have fewer functions than a full-featured online teaching web site. Indeed, for the individual instructor who is just

beginning site development, features may be implemented piece by piece as development time allows. If the most valuable features are the ones that should be developed first, it may help to examine a study done at the University of Reno, in which research revealed how university students actually used their instructors' adjunct-mode web sites (Chandler & Maddux, 1998). In this study, 86% of all surveyed had seen their instructor's web site, and the most popular items were the homework assignments and the class schedule. Links to other relevant sites were also popular, as well as lecture notes. Students did not like pages that played annoying sounds, and having to wait for graphics to download.

Finally, in terms of development tools, it is certainly possible to implement a full-featured website using no more than a simple text editor. However, a community college instructor in Maryland found it helpful to use development software (in this case, Microsoft's Front Page) to create the science division's web site. This program allowed him to create web pages without having to actually write HTML code, as well as create simple layout design using a "what you see is what you get" (WYSIWYG) style word processor. The software also allowed him to manage graphics files and hyperlinks. The

Personal Web Server software does not run on all large servers, but the college found it simple enough to install the server software on personal computers (Bird, 1998).

The Discussion Board as Computer-Mediated Communication

It has already been noted that many university professors have begun to use web pages to provide supplemental information for their courses (Maddux, 1999). While there may be some minor advantages to providing students with electronic versions of documents that were previously distributed on paper, there is another educational application for the Internet that has much greater potential for improving student learning. *Computer-mediated communication* (CMC) refers to the use of a computer network--usually the Internet--for communicating, sometimes synchronously (in real time) but more often asynchronously. In the literature, many authors consider e-mail, discussion (or bulletin) boards, chat rooms, instant messaging, voice messaging, and discussion lists (listservs) all to be types of CMC, but the most common examples discussed are e-mail and discussion boards.

Why would an instructor encourage computer-mediated communication? Wagner (as cited in Miller & Miller, 1999) states that there are at least 12 positive outcomes from using online communication, among them increased participation, improved communication, feedback, support of learner control and self-regulation, motivation, team building, discover, exploration, and clarification of understanding. Whether an instructor chooses to use e-mail, a discussion board, or a chat room as a medium will be a decision based on what goals the instructor has for the course, and how willing he is to experiment with the technology.

Of particular interest for this project is the discussion board, a sort of electronic bulletin board maintained on a central computer where users can leave messages, and retrieve messages left by other users. Using such a bulletin board to conduct a discussion among many users is referred to as *computer conferencing* (CC), and Harasim (as cited in McCabe, 1998) describes five features that make it a valuable tool:

- It allows for communication between many different participants at the same time.

- Messages may be posted from any computer connected to the Internet.
- Messages may be posted at any time.
- Messages are text-based.
- Messages are computer-mediated.

Educational use of computer conferencing has recently become popular, particularly in the field of distance learning: students in different geographical locations can use a bulletin board to engage in extended online classroom discussions. It has been suggested, however, that a discussion board will enhance student learning even in traditional classroom-based courses. McComb (as cited in Kayany, 1998) states that use of discussion boards can "extend learning beyond the classroom, enable inclusion of outside experts in the course, help balance the power between the instructor and students, increase student responsibility and initiative, facilitate student access to learning resources, and increase focused class participation."

The fact that a discussion board increases collaboration between students can be interpreted from a constructivist viewpoint, in which knowledge is constructed internally by the student as he tries to make sense of experiences.

Numerous studies cited by Miller and Miller (1999) suggest that the conversations that occur on discussion boards are resulting in the creating of new learning communities--students that collaborate in this new medium are taking responsibility for their own learning.

In a wonderfully detailed description of the web-based techniques he uses to supplement a classroom-based reading course, Estes et al. (1999) points out that "ordinary classroom discourse, to say nothing of college lectures, is generally not characterized by a discernible level of peer-driven dialogue." He uses a Web-based discussion group to force students into becoming active designers of their own learning, as described here:

> The course discussion group is an online threaded discussion in which all students participate. Though the professor does not usually contribute to this, he is able to monitor the discussion and respond to individuals or the group via the discussion or in class. Students choose the topics of their discussion, and these are usually related to an issue

> that is brought up in class. As a starter for the semester, each student is asked to make a first entry on the topic, "why I am taking this course." From that point onward, the discussion meanders as most discussion do, taking on a life somewhat of its own. (Estes et al., 1999, p. 3)

Estes states that data analysis of the conversations held in the discussion group indicates, among other things, that a strong "community of emergent professionals" develops, and that both instructor and students reported stronger "student-instructor relationships."

In a valuable survey of six college instructors by Annand and Haughey (1997), the authors concluded that the value of computer conferencing varied considerably from class to class, depending upon the instructor's philosophy of learning and what kinds of instructional techniques they used in moderating the discussion boards. The various techniques used could all be grouped into the categories of encouraging student participation, clarifying information, handling

conflicts, compensating for lack of non-verbal cues, summarizing and weaving practices, and pacing.

There are, to be sure, challenges in using computer conferencing well. McCabe (1998) points out that in addition to some of the stated benefits of discussion boards (equal opportunity for participation among learners, active learning and collaboration, increased attentiveness to written contributions, a written record of students' interactions), there are potential drawbacks. Students who have difficulties reading, writing, or typing may find it more difficult to communicate on a discussion board. The tremendous volume of text that accumulates on the board may overwhelm some students. The hypothetical "equal opportunity," which would presumably arise from a lack of physical and verbal cues, can be replaced by new cliques of students, which form based on characteristics of messages which affect the perceived status of the students who post them. Finally, and perhaps most significantly, the lack of non-verbal cues (gestures, facial expressions, and voice intonation) may actually inhibit the free flow of ideas and expression.

Evaluation and Usability Testing

The effectiveness of any web site must be tested, throughout the development process as well as during the final implementation. By analyzing the intended target audience, performing a task analysis for each task users will perform on the website, building prototypes of the website, and carefully observing users while they interact with the prototype (Apple, 1995), the site designer can help ensure that the final web site will perform as expected.

Nielsen (2000) writes about increasing usability from a commercial perspective--"usability has assumed a much greater importance in the Internet economy than it has in the past"--but his lessons on making web sites well designed and easier to use have clear implications for educators. As mentioned above, students who have difficulty using a web site experience higher levels of cognitive overload, which interferes with the learning process.

Evaluation of the website can be performed in a number of ways. Smith (1997) performed her own qualitative evaluation of hospital websites, which included responses to a number of different questions, including: Is it usually possible to reach the site? Is using the site intuitive? Do

parts take longer than ten seconds to load? This survey is limited by the number of respondents (one) and the qualitative nature of the questions; the author acknowledges that the answers to many of the questions are subjective.

In a survey of online reference materials (Csir, 1996), libraries received both qualitative and quantitative ratings to 17 questions grouped into five subject areas:

1. Web site currency, accuracy, and relevance
2. Web site organization and structure
3. Web site presentation
4. URL (link) maintenance
5. Web site feature

While still performed by a single person, this survey is a little more quantitative in nature, allowing for quick determinations on the relative value of different web sites.

Liu (1999) poses questions to the libraries themselves, and summarizes their self-reported responses and ratings in various areas. There are obvious difficulties with this kind of evaluation. When asked "How do you rate your library's overall collections and services to the academic community since the establishment of your website?" 83% of libraries in the survey rated themselves "Much better." This is an

admirable figure, but one wonders how well that number corresponds with the *users'* impressions of the web sites.

In order to assist libraries in compiling lists of acceptable reference sites, Livengood (1997) developed and tested an extensive evaluation instrument. The survey itself asks users to check Yes/No/Not Applicable in response to a long series of questions, in addition to providing space for optional written comments. By means of a weighted calculation, the tester's comments can be reduced to a single value rating, which makes it easier for librarians to quickly scan through the recommendations. The advantage to this type of evaluation is that both quantitative and qualitative data are collected; the disadvantage is that the average time to complete the survey for a single web site was 38 minutes, and in some cases took as long as an hour.

Increasingly, written evaluations of web sites are being supplemented with field studies, or user observations. This kind of evaluation involves carefully observing users while they interact with the web site in order to understand where people are having difficulty. Disadvantages to this type of evaluation include the lack of quantifiable results, and the time-consuming nature of one-on-one observations, but most

designers feel that this kind of feedback is invaluable, particularly when designing the site's structure and interface.

In the excellent *Human Interface Principles*, Apple (1995) provides a list of ten guidelines to follow when conducting user observations. These include:

1. Introduce yourself and describe the purpose of the observation (in very general terms). Most of the time, you should not mention what you will be observing.
2. Tell the participant that it is OK to quit at any time.
3. Talk about the equipment in the room.
4. Explain how to think aloud.
5. Explain that you will not provide help.
6. Describe in general terms what the participant will be doing.
7. Ask if there are any questions before you start; then begin the observation.
8. During the observation, stay alert, ask questions or prompt the participant, and be patient.
9. Conclude the observation.
10. Use the results.

Notes, audio tape, and even video tape can be used to review the observation session later on, and serve as a record that can support later design decisions.

Field observations may be supplemented with interviews that reveal more insight into what users think about a website. When asking questions during an interview, Nielsen (2002) reminds the interviewer not to ask yes/no questions, not to ask leading questions, not to use jargon, and not to draw attention to specific issues. The field tester is interested in observing and understanding the user's behavior, not modifying it.

For those designers without the time or money to conduct full site observations and evaluations, it is possible to conduct "discount usability engineering" (Nielsen & Sano, 1994). These methods are informal and less valuable statistically then a rigorous evaluation and observation, but they have the advantage of being very fast, and in some cases, do not even require a computer. An example of just one of these methods is given here.

Card sorting is used to understand what sort of mental model users develop when they think about information in a

web site. In Nielsen and Sano's study, 51 types of information services that they planned to offer on a web site were written down on cards, one type of service per card. The cards were scattered at random on a desk, and when a user sat down at the desk, they were asked to sort the cards into piles that contained similar services. Users were also asked to create a name for each pile of similar cards. Ultimately, information gained from watching four users perform this exercise was used to create named menu structures on the web site, structures that corresponded to how users intuitively thought about the items listed in each menu.

Summary

Research on educational uses of the Internet has improved, both in quantity and quality, in the last few years. The literature review for this project has focused on four areas: instructional design of educational web sites, factors to consider when designing and implementing the site, what effects computer-mediated communication (specifically discussion boards) has on learning, and methods of evaluation and usability testing.

CHAPTER THREE

PROJECT DEVELOPMENT

Introduction

Producing an effective website, especially an educational site, is a multi-stage process. While different authors vary somewhat in terminology--DiNucci et al. (1998), for example, split web site creation into Design, Production, and Distribution phases--all effective websites require the same steps:

- *Site Design*

  The goals and intended audience of the web site are carefully defined, and used to develop both content and site structure.

- *Site Implementation*

  Content is created and programmed so that it will be correctly distributed on the site, and then uploaded to a server for public distribution via the Internet.

- *Evaluation*

  The site's effectiveness is evaluated, in tests conducted during the Design and Implementation phases and via feedback from actual users.

- *Modifications*

  Based on the Evaluation, the site's design and content are modified in order to improve its value, effectiveness, and usability.

This chapter will focus on the Design and Implementation phases in the production of the *crashwhite.com* web site, with some additional comments regarding later modifications that were made in response to informal feedback from users.

Web Site Design

The two primary considerations when creating site content and navigation structures are the goals of the site and the intended users.

Goals for the *crashwhite.com* Site

The purpose of the site was to supplement physics instruction for students in the author's Physics and AP Physics classes at Berkeley High School, primarily by a) providing students with increased access to course materialsm and b) increasing course-related communication. The course materials provided online were not initially intended to include curriculum--content delivery for these courses occured daily in the classroom--but rather documents that might ordinarily be distributed on paper: course syllabus,

class schedule, handouts, worksheets, and lab descriptions. Communication would be increased by providing an easy means of reaching the instructor (via e-mail) for both students and parents, and increased access to current grades on assignments (via an online spreadsheet-style grade list). These two initial forms of communication were later supplemented with a third form, an online discussion board.

Intended Users

The intended users for the site were the 12th-grade students in the author's physics classes (Physics and AP Physics) at Berkeley High School, a large urban school. The majority of these students were already very successful in a traditional college-prep school setting, and most of them had access to computer and Internet technology at home and were "technologically literate."

Students met with the teacher in the classroom for approximately 90 minutes every day, and were able to fully participate in the class without ever having to access the website. The instructor encouraged student use of the website for communication and downloading of classroom materials, but access to a computer was not considered mandatory for full participation in the class.

An important consideration in the design process is what kind of Internet access the intended users will have. Based on an initial, informal survey of BHS physics students conducted in 1999, it was determined that although the majority of students had a personal computer and Internet access at home, some did not. For those students that did not have home access, it was important to have access to a computer at school--a computer available in the author's classroom was especially helpful for these students. Although most students with home computers accessed the Internet via a broadband cable modem or DSL line, many used a dial-up connection via a phone line, which is not able to deliver information to the user's computer as quickly as broadband. This has implications that will be discussed below.

Content

Developing new content for the *crashwhite.com* web site was not a major consideration in this project. Most of the content presented on the site was simply an electronic version of documents that would have been distributed on paper in class--these "paper documents" already existed in electronic form as word processing files, so the process of converting the files to web pages was relatively simple.

A more detailed discussion of converting existing documents to HTML files is given in the "Implementation" section below.

Site Structure

The overall structure of the site--what it looks like and how it is organized--determines how easily one is able to use the site. Knowing one's location within the site, knowing how to navigate to somewhere else on the site to find new information, and being able to easily access and read that information are all determined by how the site is structured. Well-designed sites are easy to read and navigate, and users are able to quickly find the information they are looking for. Poorly designed sites are difficult to read or understand, and do not clearly indicate where users are, or how they should go about finding the information they want.

In particular, there are four aspects of site structure that should be considered while developing the design: orientation, navigation, readability, and page load times.

Orientation

Maintaining a user's sense of orientation while using the web site is one of the most effective ways of reducing cognitive overhead. By organizing information into logical

categories and presenting it in those categories, the user will have a better sense of where they are in the site. As discussed in Chapter 2, the site designer may even solicit feedback in this area *before* the site is designed using the card sorting technique described in Nielsen and Sano (1994).

The materials on the *crashwhite.com* website were grouped into categories roughly based on content type: "Administration," "Class Materials," "Links," "Help," "About *crashwhite*," and "e-mail Mr. White" (see Figure 1). These categories were listed in a "rail menu" located along the left side of each screen, which is a fairly common convention for many web sites. Each category in the rail menu was a hyperlink that would lead the user to a new screen containing information regarding that category, and a series of new links. The current category was written in bold-faced text, allowing the rail to be used as an orientation tool as well as a navigation too. A thin black line was used to separate the left rail menu from the main "content area" portion of the screen, further distinguishing hypertext links from the text.

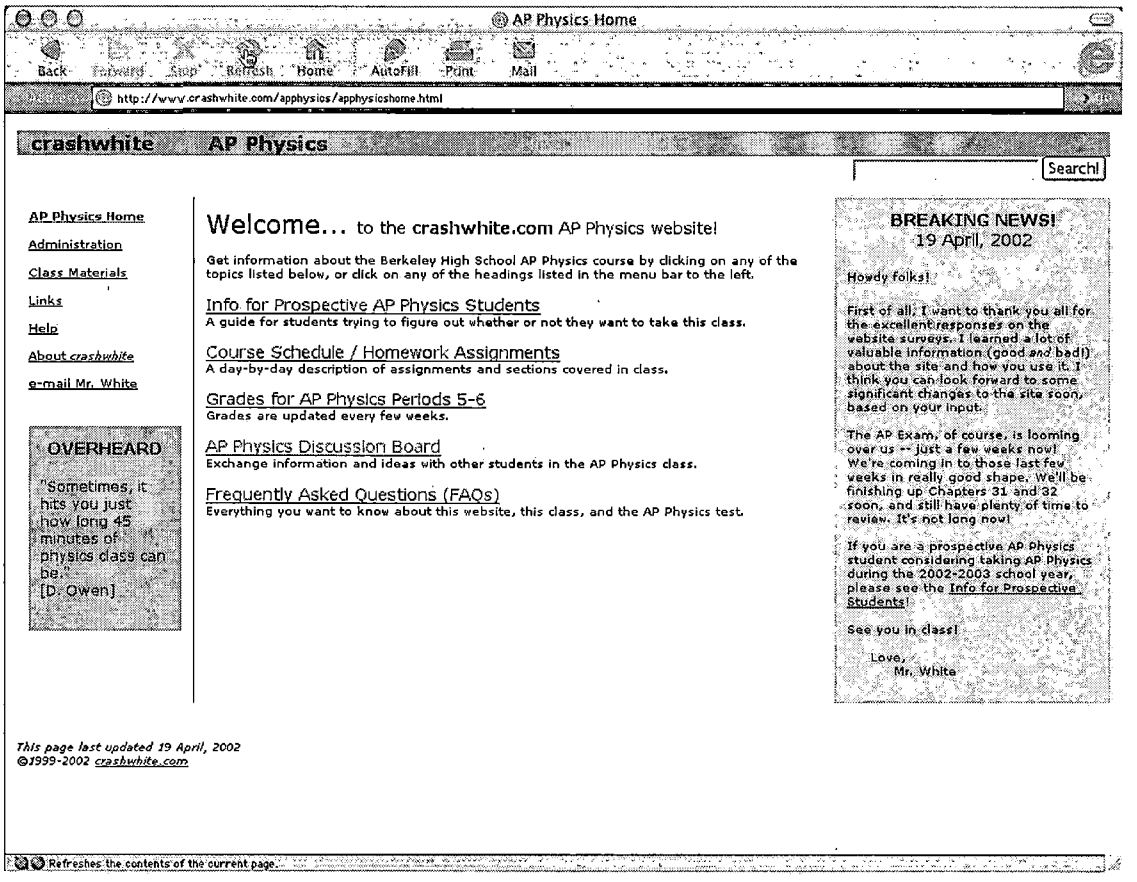

Figure 1. Advanced Placement Physics Home Page

This particular rail also incorporated a "fisheye view" aspect, in which clicking a given content area had two effects: a new page was opened up, containing information regarding that content type, and the rail menu opened up to show a number of sub-topics available to the user (see Figure 2). The original content types remained listed in the rail, allowing users to maintain a sense of their location within the larger context of the web site. On a large-scale web site

with more complexity, this fisheye effect may be used three or four layers deep into the site's structure. The *crashwhite.com* site used this feature only one level deep.

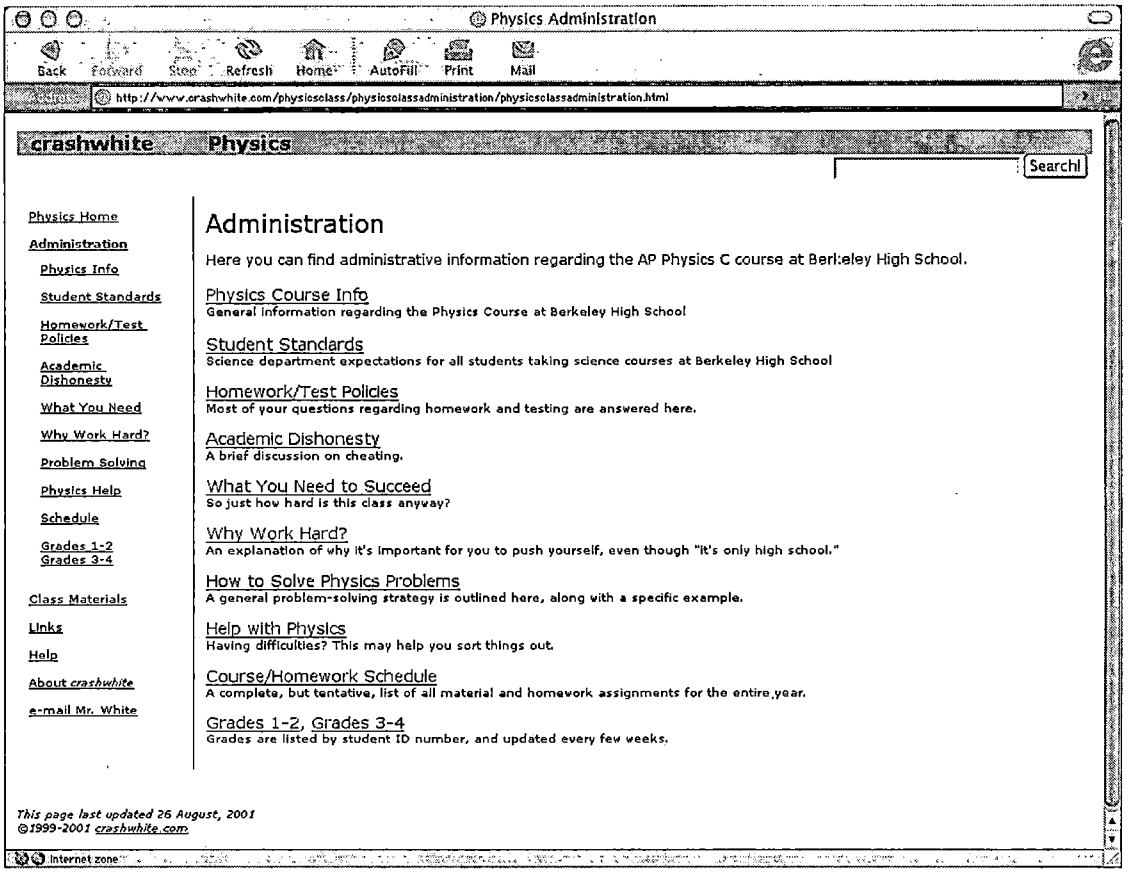

Figure 2. Rail Menu with Indented Sub-Menu

On a smaller scale, the contents of each page were consistently located on the page, with the express purpose of decreasing cognitive overhead in the user. With a few rare exceptions, all pages on the site contained the 150-pixel wide left rail menu, and a thin black vertical line

separating this menu from the main content located on the right side of the page. All pages have a search function located on the upper right, and all pages have "last update" date at the bottom, along with a copyright notice and a link that allows them to e-mail the instructor.

Just as it is important for users to have a sense of location within the web site and on the page, it is important for them to maintain their sense of orientation with respect to the World Wide Web itself: users need to be able to easily identify whether or not a given page is part of the class's web site. By including some consistent means of identification on each and every page in the site--a logo, or at least a consistent color theme--disorientation is reduced. The *crashwhite.com* website used a thin blue bar of across the top of every page (grade reports and discussion boards excluded) with the word "crashwhite" and the name of the course, either "Physics" or "AP Physics."

Navigation

Closely related to Orientation is Navigation, the means by which a user is able to move through a site. All navigation on the World-Wide Web is accomplished by using a mouse to click on links that perform other actions, most

often opening up a new screen of information for the user. For web sites that provide Computer-Assisted Instruction (CAI), the issue of when and how to present effective links to online learners is complex. In the context of the *crashwhite.com* site, it was important to make sure that users could recognize hypertext on the page as links, as opposed to just colored text.

To ensure that users could identify links, and again to decrease cognitive overhead, the standard identifying characteristics of links were used: hypertext links were underlined, in blue text if they had not been clicked on yet, and in magenta if they had been clicked on. Using the standard has the effect of increasing usability, as described by Nielsen (2000):

> . . . users have grown accustomed to blue being the link color, so they have zero delay in figuring out how to work with a page if it uses blue for unvisited links. They just go: blue, boom, click. The few milliseconds lost from reading a few words more slowly [because blue text is slightly harder to read] are more than made up for with the several seconds

> saved in cognitive overhead pondering a non-standard set of page colors and with the several minutes saved from improved navigation when users *know* what links they have visited before. (Nielsen, 2000)

Readability

Reading text on a computer screen is very different from reading text printed on a paper. Most printed documents have a vertical, "portrait" orientation, while the computer screen has a horizontal "landscape" orientation, and the resolution of computer screens, at 72 to 96 dots per inch, is much less than the resolution of the typical printed magazine page of 1200 dots per inch (Lynch, 1994).

For the *crashwhite.com* website, the ability to render highly-detailed graphics images was not critical--the few graphics on the site are schematic in nature, designed to allow the student to understand the basic analysis of certain problems. The content emphasis on the site is text, so readability of text was an important issue.

Font style (sans-serif versus serif), font (Times vs. Georgia, for example), font size (10 point vs. 12 point, for example), text color, background color, background texture,

use of margins and white space surrounding text, and the age of the user are all reported to have an effect on on-screen readability, but the research results are not always consistent (Tullis et al, 1995; Lynch, 1994b; and Bernard, 2002). It has been commonly reported, for example, that serif fonts such as Palatino, Bookman, and Times are easier to read in print, while sans-serif fonts such as Arial and Verdana are easier to read on a computer screen, but Bernard (2002) cites a study that found the serif font Georgia produced significantly higher levels of comprehension than the san-serif font Verdana. He also cites other studies that found no difference in comprehension between the two font styles, but found that both older adults and children *prefer* reading sans serif fonts on the computer screen (see Figure 3).

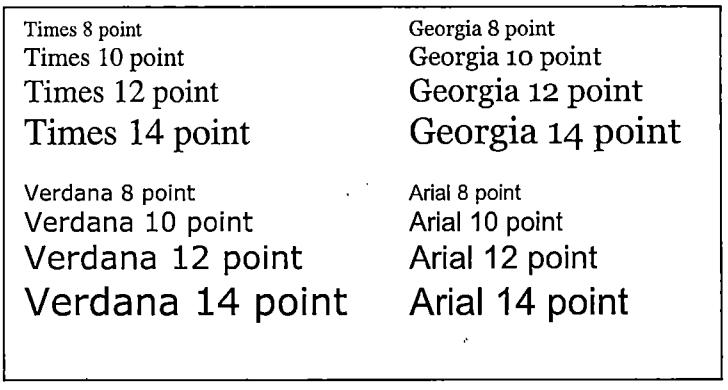

Figure 3. Fonts and Point Sizes

Other studies (Hill & Scharff, cited in Bernard, 2002) reveal that textured backgrounds interfere with legibility, and that dark characters on a light background are better than light characters on a dark background.

There are other readability factors in addition to fonts and color. Morkes and Nielsen (1997) point out that users read web sites differently from the way they read print sources. In particular, they seem to want concisely written, easy-to-scan text that makes liberal use of "headings, large type, bold text, highlighted text, bulleted lists, graphics, captions, topic sentences, and tables of contents." Nielsen (2000) recommends that traditional printed text be edited and rewritten for the Web according to three guidelines:

1. Text should be succinct, as much as 50% less than in the same printed document.
2. Text should be scannable, chunked into short paragraphs, with subheadings and bulleted lists.
3. Long blocks of text should be split into multiple pages that are linked with hypertext.

The *crashwhite.com* website was designed with the following usability features: the sans-serif font Verdana was used almost exclusively, with font sizes that range from 9 to

18. With minor exceptions, all text was displayed in black on a white background. Lists of items were often displayed as bullet or numbered items. Lists of links were usually given with the main link in a larger font size, with a brief explanation of the link in a smaller font size just below the link.

The writing format of the material presented on the website presented a difficulty. Current accepted practice is for online material to be split into smaller chunks of text that will fit into a single 800x600 pixel screen without scrolling, and displayed in a sans-serif font. For online material that is primarily intended for the user to print out on paper, it is suggested that a serif font be used, and the document formatted using Adobe's Portable Document Format (PDF) in order to preserve layout. These two types of presentation are mutually exclusive, so unless the site designer wants to make two copies of all documents--one for on-screen display and one for printing--compromises will have to be made. It was decided that on-screen text appearance (sans-serif) would take precedence over printing appearance. However, because students would be printing many of the screen pages, longer documents were *not* split into separate

screens of information. This was somewhat inconvenient for students viewing material on-line--they would have to scroll down to find off-screen information on the bottom of the page, but had the advantage of allowing them to use the Print command only once to print the entire document, as opposed to viewing different screens of information and printing each one separately. Also, this format allowed the author to quickly import word-processing documents without extensive rewriting.

Page Load Times

There is some evidence that using graphics can enhance learning in certain situations, and in many cases increase the material's "attraction and interest value" (Merrill & Bunderson, 1981), but this attractiveness comes at a price. Every graphic displayed on a web page has to be delivered to the computer via the Internet connection, and depending on the speed of the connection and the detail of the picture, the time it takes to download these graphics can be maddeningly slow.

In a study of a National Park Service web site, "speed for all features and the need for balance between inviting graphic design and acceptable [downloading] speed were...

important lessons" (Parmley et al., 1998). Lynch (1994) cites two studies pointing out that human-computer interactions must take into account time delays as the computer processes information:

> Feedback from the user interface should be immediate and unambiguous, in the form of visual or auditory signals that the computer has received input from the user and is acting upon that stimulus. Even small gaps in time (0.25 - 0.50 seconds) between the user's actions and any reaction from the computer can confuse the relationship between cause and effect, or force the user to assume that the computer or software has misinterpreted the user's actions. (Lynch, 1994, pg 6)

Preliminary versions of the *crashwhite.com* site included some graphics, based on feedback from students who wanted visually stimulating pages. A graphic *crashwhite.com* logo was displayed on each page, and there were photos of the classroom and students working in class, and even some video footage of a competition featuring the 6-foot tall "battlebot" designed by the school's Robotics Group.

While the graphics certainly enhanced the site in some ways, there were a number of disadvantages, including:

- *increased development time*

  Each photo and thumbnail image had to be individually prepped and formatted for uploading to the server.

- *additional server space required*

  Graphics take a much larger amount of memory space on the server.

- *increased download times for site visitors*

  Graphics take a much longer time to load onto a page for display.

After almost a year of experimenting with graphics on the web site, it was decided that the majority of them should be removed. The emphasis on the site was physics content material, so all "non-essential" graphics were removed. The latest version of the website featured a few schematic diagrams for sample problems and lab handouts, a small picture of the instructor on his biography page, and a handful of photos from a ski trip contributed by some members of the AP Physics class.

Removal of the extra pictures dramatically improved page load times so that, for the majority of pages, there was no

noticeable difference between broadband and dial-up Internet connections.

Implementation

Implementation refers to the actual writing of computer code that will cause the web site's pages to be properly displayed, and the process of uploading that code to a server computer so that the user's computer will be able to access it. While the process is discussed here separately (see Uploading Files), it is important to note that implementation factors should be taken into consideration long before the coding actually happens. Design decisions--whether or not to include lots of graphics in the site, for instance--may have major implications for the implementation process, particularly for high school teachers who often find themselves a little short on time.

Creating Web Pages

Creating web pages consists of assembling the content material that is to be presented on-screen, and coding it so that it appears correctly. Most high school teachers with any experience already have a significant amount of content material in the form of paper documents used in their

classes. The challenge is to convert those documents into electronic versions suitable for publishing online.

As mentioned in Chapter 2, an extended discussion concerning the mechanical process of writing individual web pages is beyond the scope of this paper, but there are a number of excellent references available (DiNucci, 1998; Tittel, 1997). Beginning web authors may consider the "Save as Web Page..." function found in many word processing programs, or more specialized web page development software such as FrontPage (Bird, 1998).

Some documents to be posted on the site were in the form of spreadsheets. The instructor used Microsoft's Excel software to develop the course schedule for the year and to keep track of students' grades. The Export function in Excel allowed these spreadsheets to be converted automatically to web pages, saving the site designer the trouble of writing the HTML code by hand. Most software designed for making calendars and tracking grades now has an "Export to HTML" or "Save as Web Page" feature. (It should be noted that some parents or students may be justifiably concerned with public posting of grades. Obviously, students' grades should not be

identified with their real names, but rather a pseudonym that the student creates, or the students' school ID numbers.)

Regardless of what tool one uses to write the HTML file, there are a few important aspects of creating web pages that the aspiring Internet educator should be aware of. Keeping in mind the page layout, orientation, and site navigation principals discussed above, perhaps the single most important step in creating web pages is creating a *template* for the site. This template, actually an HTML file that contains instructions for displaying information on the website, will be used as the starting point for every page written, and will help to maintain a consistent layout for the entire site. Whether written by hand using a simple word processor or prepared using one of the commercially available web page authoring programs, this template is the architectural foundation of the site. A sample HTML template for the *crashwhite.com* web site is given in Appendix A.

Once the template has been prepared and tested--usually a matter of some hours, in the beginning--a teacher can create new pages simply by taking the content from handouts, syllabi, assignment sheets, etc., and plugging it into the appropriate positions in the template. Given a template that

has already been prepared and a class handout in word processing form, a new web page can be created within seconds simply by copying material from the original word processing document and pasting it into the HTML template.

Another important aspect of creating the web site is file organization. A high school instructor's new web site will probably start small, consisting of no more than a few simple pages, and the idea of putting those pages into separate file folders on the teacher's home computer, grouped by category, may seem a little silly. One soon finds, however, that additional pages need to be added to the site. Having a preplanned structure for the site, which is reflected in folders that store different types of documents, will greatly ease the chore of keeping all those files organized.

The first file posted online for the author's AP Physics students was a single page that listed the answers to some homework problems. The site has grown in the last few years so that now there are over 300 separate files for that class alone. They do not all need continuous updating, but they do need to be organized. See Figure 4 for a partial list of file folder organization for the *crashwhite.com* site.

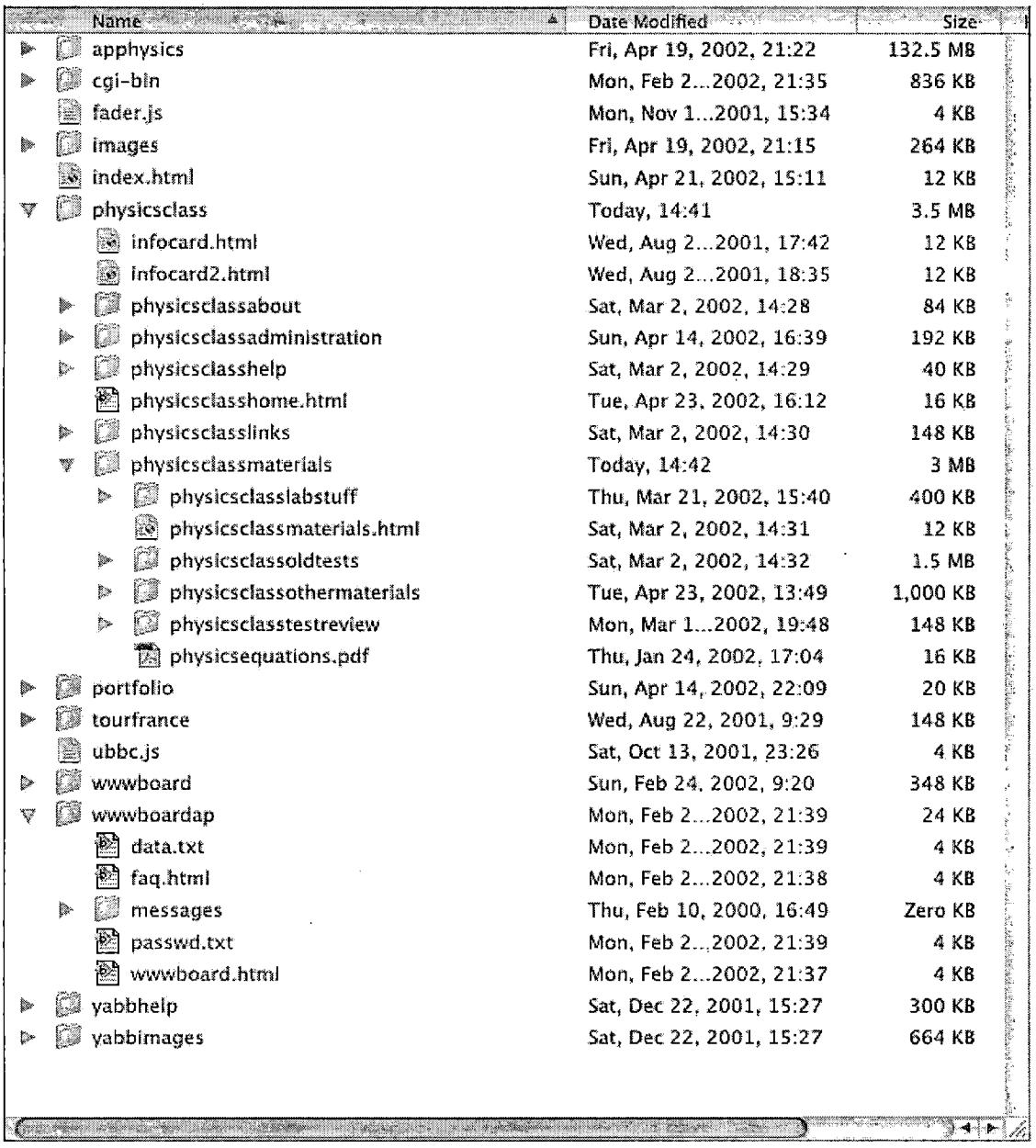

Figure 4. File Structure for Web Site

Uploading Files

Once a web page has been created, it must be transferred to the host computer, where it can be accessed by anyone who types in the correct URL for that page.

The host computer is simply a computer connected to the Internet that stores the files used to display web pages. Many ISPs (America Online, Earthlink, etc.) provide a limited amount of disk space to each subscriber for developing one's own web site. Unfortunately, the "user agreement" for subscribers usually restricts the amount and types of activity permitted on these sites. For the purposes of this project, the "crashwhite.com" domain name was purchased, and hosted on a dedicated hosting service specifically designed to accommodate the heavier activity that it was expected *crashwhite.com* might generate.

One transfers HTML files from a home computer to a host computer by using a File Transfer Protocol (FTP) program. There are many FTP programs, including some very good ones that are free (FTP Explorer for Windows-based computers, Fetch for Macintosh computers). A detailed discussion of the mechanics of using an FTP program to transfer HTML files to the host computer is beyond the scope of this paper, but

there are a number of excellent online resources available--most Internet Service Providers (including AOL and Earthlink) provide detailed FTP instructions to their customers who wish to post web pages.

Informal Evaluation and Modifications

A full discussion of the formal evaluation of the web site will be given in Chapter 4. Before that formal evaluation occurred, however, there were a number of occasions on which users gave the author informal feedback on various features of the site.

The *crashwhite.com* web site has been under continuous construction for a number of years now, with occasional modifications and "tweaks" that came from student input and the desire to improve instructional design. While these small-scale modifications improved the site somewhat, there were two major additions that drastically changed the way students used it: the discussion board, and online content delivery.

Discussion Board

Approximately one year after the first pages were developed, one of the author's students who was particularly adept at programming decided to develop a Discussion Board

for the class. A discussion board acts as a type of online bulletin board, where students can leave messages, and read messages that others have posted. A link from *crashwhite.com* led to the student's discussion board, and almost immediately, it became one of the most popular features used by students.

The messages on a message board remain posted for a long time, up to several months, so asynchronous "threads" of conversation can continue as long as students are willing to contribute. The "discussions" that occur in these threads do not take place in real time, but rather occur over a series of days as students check the board to see what has been happening, and occasionally offer their own contributions to the discussion.

Three months after the student posted his discussion board, the author decided to create his own discussion board, to be included as an integral part of the class web site. The decision to host the board internally was based on logistical concerns (it was felt that the instructor should have editorial control over postings on the board, if necessary) and practical ones (the student who created the first board was graduating soon). Although there are certainly

difficulties and challenges involved in hosting a discussion board, positive student response to this feature made it worth the extra work.

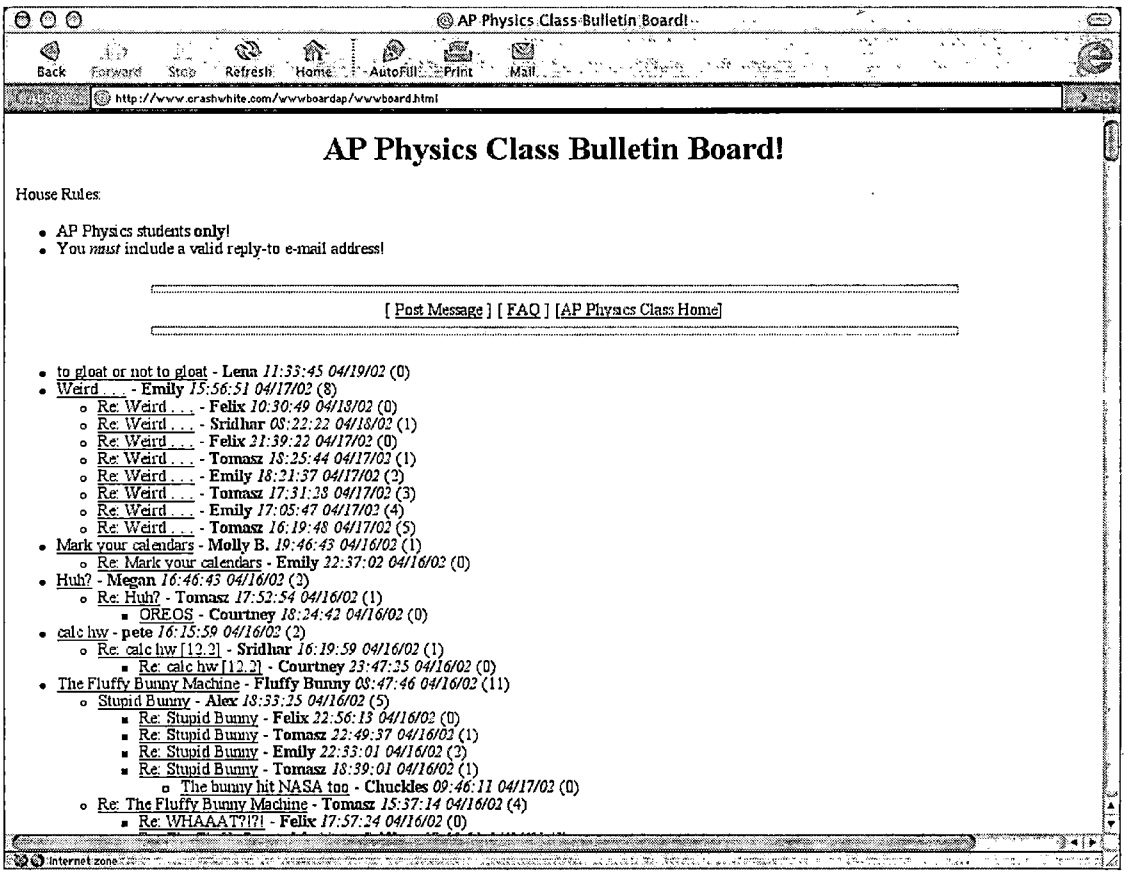

Figure 5. Advanced Placement Physics Discussion Board

As stated earlier, the primary purpose of the author's website was to supplement classroom instruction, and not to deliver content. Thus the discussion board feature was not used by the teacher to deliver material, but rather by students, as a way to communicate with each other (see Figure

5). Miller and Miller (1999) point out that discussion boards are ideal for developing "communities of learning" as described by constructivists, and that was certainly the case on the discussion board, especially a night or two before tests and assignment due dates. A typical exchange went something like this:

> *Posted by Emily (12.233.244.46) on March 26, 2002 at 22:07:51:*
>
> What about 29? How do you do it?
>
> *Posted by zoe (65.184.72.49) on March 26, 2002 at 22:18:19:*
>
> ya...
>
> *Posted by Megan (12.233.45.192) on March 27, 2002 at 09:35:29:*
>
> Well, ya' see, Mr. White failed to teach us somethin' semi-important, at least to do this problem. That is, potential energy(U)= -MUxB. (Sorry, there's no symbol for mu on my computer.) So, using this formula, you know that min. U occurs

when mu and B are directed the same way. This means that the min. is when the needle is pointed north at 48.0 degrees below horizontal. You can also figure out that max. U occurs when mu and B are perpendicular to each other. So, max U occurs when the needle is directed south at 48.0 degrees above horizontal.
Does this help? The book explains on page 916 toward the bottom.

Posted by Emily (12.233.244.46) on March 27, 2002 at 10:38:42:
Oh I see. I sorta got part a by intuition, but then for part b I tried to do Torque cross Theta cause I thought that might be similar to Force times Distance. Hmm. Guess not.
Thanks! That definitely helps.

The course instructor encouraged, but did not require, student use of the discussion board for sharing class information. Rossman (1999) presents recommendations on how

to facilitate discussions in asynchronous learning situations such as this, but because of the classroom-heavy orientation of these high school courses, online features such as the discussion board were not aggressively promoted.

It was anticipated that students might occasionally use the discussion board to post messages that were not entirely curriculum related. In most cases, this kind of posting was allowed and even encouraged: random comments posted by students from time to time and the subsequent discussions seemed to foster a sense of community in the course, and students occasionally even posted photos that they had taken or stories that they had written. The students occasionally used the board to discuss homework from their other classes as well. In a few rare cases, offensive or derogatory comments with vulgar language or subject matter were posted, usually anonymously, and these posts were deleted by the instructor. Objectionable posting was exceedingly rare, but did point out the potential benefits of incorporating some sort of password-protection scheme into the discussion board system.

Online Content Delivery

As stated before, the primary purpose of the web site was not to deliver content: these courses met for an hour-and-a-half every day, so there was plenty of time for teaching the curriculum in class.

There were several occasions, however, when the instructor was unable to come to school to work with the students. For the teacher of a regular college-prep course, missing a day or two of instruction did not significantly hurt the class's progress. The Advanced Placement students, on the other hand, had the national AP exam to prepare for--every day of class instruction missed affected their progress. In order to minimize the disruption caused by the instructor's absence, two "online lectures" were prepared and posted on the web site. Students were given instructions to view the online lectures at home, after which they should use class time to help each other work on problems that had been assigned.

There are a number of significant challenges that must be faced when preparing effective curricular material for online presentation. The first is the fact that online presentations should consist of more than simple text and

graphics--the students in these classes already had access to excellent textbooks, but had repeatedly expressed some frustration with the presentation style. They insisted, as many students do, that they learn more from a good lecture. If students were to benefit from an online presentation of material, it needed to include not only text and graphics, but sound.

On the other hand, audiovisual material that is too complex is not easily distributed via the Web, due to the difficulty of transmitting information quickly enough via a standard modem connection. Even broadband access (DSL and cable) does not allow movies with sufficient detail to be effectively delivered over the Internet.

A computer-based AP Physics program for gifted students has been in development at Stanford for a number of years (Ravaglia et al., 1999), and many of the ideas incorporated in their program were adopted for *crashwhite.com*'s online lectures:

> A computer lesson usually begins with a lecture, in which a student listens to digitized sound recordings and watches graphics table writing (or formatted text

> and graphics) appear on the computer screen in real time, synchronized to the voice, so that the net effect closely resembles that of a teacher writing on a chalkboard while lecturing . . . It is worth noting that these lectures have been designed so as to preserve the informal nature of spoken physics as contrasted with the more formal prose style of textbooks. This is important since it has been observed by many people, but not studied as thoroughly as it should have been from a research standpoint, that oral lectures are an important part of learning the mathematical and physical sciences. (Ravaglia et al., 1999, p. 5-6)

A search of the Web led to the discovery of the AudioGraph software package (New Zealand Educational Software, 2002), which was used to develop two, short (approximately 15 minutes long) lecture presentations. This free software allows the presenter to convert PowerPoint

presentations into a Web-ready format, and the ability to record a spoken voice-over soundtrack that accompanies the presentation.

Although the instructor's lectures were not normally presented using PowerPoint, it was a relatively simple matter to prepare a small number of slides presenting the main points covered in the day's lesson. These were accompanied by a few graphics images and an example problem demonstrating general problem-solving procedures for the subject.

Much more challenging was the process of recording the voice-over narrative that would orally develop the main points in more detail, describe the problem-solving process during the example problem, and discuss the finer points of the material. Interestingly, although the instructor enjoys working with students in the classroom and enjoys lectures and discussions, the act of recording a lecture was somewhat intimidating. The give-and-take that occurs in the classroom, the occasional jokes, and the spontaneity that comes from live delivery was obviously missing during these recordings. Both instructor and students, when viewing the completed lectures, noticed "something was missing" during these presentations.

Perhaps the most significant difficulty encountered occurred at the final step, when the lecture was actually delivered to the student via the web. In order to be able to view the online Audiograph lectures, it was necessary for students to download a "plug-in" that would allow their browsers to present the lectures as designed. Obtaining this plug-in required that students go to the Audiograph website, download the plug-in for their browser, and then go back to view the lecture. This additional step was a minor inconvenience for some students, but for others, it effectively ended their online learning experience: the plug-in available at that time did not always work as expected with all browsers.

These brief experiences with online content delivery gave the author anecdotal evidence that:

1. for a number of reasons, classroom instruction is generally more effective than distance-learning;
2. preparing good web-based lectures is an extremely time-intensive process, and thus probably not an option for most full-time high school teachers;

3. online delivery of classroom material still has some technical issues to be worked out before it becomes easy enough for students to use.

Summary

There are many factors that need to be taken into account during the development of an educational website. Design and Implementation are particularly critical, as they have the strongest influence on how well users will be able to interact with the site. During the four-year development of the *crashwhite.com* site, informal feedback from students resulted in a number of changes in site design, including the addition of two major features: an online discussion board, and two examples of online delivery of instruction.

CHAPTER FOUR

EVALUATION

Introduction

Careful attention to instructional design theory and the needs of users dictates web site design and implementation. Once the web site is operating, its effectiveness needs to be tested to determine whether or not it is performing as expected.

As discussed in Chapter Two, web site evaluations are performed in a number of different ways. Increasingly, users' written evaluations of a web site are being supplemented with "usability" field tests, in which users are observed, directly or indirectly, while using a site.

Following this model, evaluation of the *crashwhite.com* web site was conducted using both a survey and usability testing. The survey, a written evaluation, was distributed to students in the author's classes who presumably already had some familiarity with the web site. The usability testing was conducted with four physics students who were not in the author's classes, and who had no previous experience with the website. All students whose results are reported here were required to sign Consent Forms (Appendix B).

Survey Development

All of the surveys examined in the literature review were concerned with the availability of features on a wide range of web sites; specific surveys of users regarding the use of a single site were difficult to find. Thus, the development of the written survey for this project consisted of defining the expected outcomes of using the web site--being able to easily e-mail the instructor, being able to post messages, having homework solutions or review problems available, etc.--and asking students what their behaviors were regarding the site.

The primary area of interest in the survey was students' use of the *crashwhite.com* web site. Additionally, there were questions concerning students' use of the Internet in general, their familiarity with the site, their feelings regarding posting on the discussion board, and how useful the web site had been in helping them in the class. There were 43 "multiple-choice" questions, most of these requiring responses based on a 5-point scale. There were also three open-ended questions asking for specific written comments regarding favorite and least favorite features of the web

site, and a solicitation for suggested improvements (see Appendix C).

The surveys were distributed in the classroom approximately three-fourths of the way through the 2001-2002 school year, and the 74 students in the three sections were given one class period (45 minutes) to complete them.

Because some of the questions were designed to determine how familiar uers were with the web site, students were not permitted to use the computer in class while completing the survey.

Usability Testing

In contrast to the survey of students who presumably had already used the web site, the usability testing observed students who had never seen the site before. The purpose of the usability testing was to determine how easy it was for a first-time visitor to find their way around.

Because students in the author's class were already aware of the site's existence, subjects for this study were selected from students in another teacher's classroom. During the usability testing, these students were videotaped while using an Apple Macintosh iBook laptop computer (with a mouse attached) to access the site. The laptop computer is ideal

for this kind of testing: it is portable, it may be used any place there is an Internet connection, and the LCD screen display appears clearly in the videotape, as opposed to the noticeable screen flickering that may appear when a standard computer monitor is recorded. A colleague, rather than the author, conducted the usability interviews, in an attempt to reduce any bias that might have occurred as a result of the web site designer conducting the tests himself. During the testing, students were given a short series of tasks to perform, and asked to explain their thought processes while navigating through the site (see Appendix D). The four tasks that students were asked to perform were:

1. finding the homework assignment for a specific date;
2. looking up the instructions for the "Pendulum Lab";
3. e-mailing the instructor for the course (using an e-mail link on the site); and,
4. finding instructions for using the Solver function on a Texas Instruments calculator.

Because of the time-intensive nature of this type of testing, only four subjects participated in the usability testing.

Results of Evaluations

The results of the written evaluations, completed by students that were already familiar with the web site, are summarized in Appendices E and F. Selected transcripts from the usability tests with students who were not familiar with the web site are given in Appendix G.

Survey

A total of 56 of the author's students responded to the written evaluation of the web site, 20 from the Advanced Placement Physics class and 36 from two regular college-prep Physics classes. Each of the two different classes had its own section of the *crashwhite.com* site, with nearly identical features, and it was originally anticipated that the surveys from the two different courses would be combined for analysis. It became apparent in the course of analyzing the data that responses from the students in each course were similar in many ways, but revealed distinctly different patterns of use in other ways. Thus, the two groups of data were compiled separately. Some of the highlights of those results are presented here.

In terms of general Internet use, students from the two classes were similar in many ways. Nearly all students had

home Internet access, with approximately two-thirds using a PC-compatible of some sort and one-third using an Apple Macintosh. Over half of all students had some sort of broadband access (cable modem or DSL) at home, and just less than half used a standard dial-up modem. Most students used Internet Explorer to access the web site, although a significant number used Netscape Navigator, underscoring the importance of testing layout and design in both browsers.

The students in both courses tended to be technologically literate, with the *capability* of using the Internet, but there was a noticeable difference in how many of them actually *used* it. Just over half of the regular Physics students "surfed" the Internet for fun at least once a week, as opposed to over 75% of the AP students. Likewise, 58% of the regular Physics students reported using the Internet for a specific task (looking up information, purchasing something) at least once a week, compared with 80% of the AP students. Additionally, e-mail use by the two groups varied: a little over one-third of the regular students reported using e-mail to communicate with someone at least every other day, while over half of the AP students used e-mail this frequently.

Another difference in Internet communication was the use of "instant messaging," in which text messages are sent in real-time to other users (commonly known as "buddies") who happen to be using the Internet at the same time. A full 30% of the AP students reported using Instant Messaging "very often" to communicate with other students for course-related purposes. *None* of the regular students reported using Instant Messaging that frequently, and less than 3% reported using it for this purpose "Often."

Regarding specific use of the *crashwhite.com* site, the students in both courses generally tended to be satisfied with the design, layout, and navigation. With the exception of one student, all students' browsers were able to display the pages on the website Very Often, and only two students mentioned that pages did not load quickly on their computers. Over 90% of all students felt that the site was logically organized, and 100% of students felt that it was easy to navigate. Approximately 85% of the students in each class felt that there were "just the right amount" of colors used on the web site, which may suggest that students primarily used the site for information and not for entertainment: there are essentially *no* colors used on the site anywhere,

with the exception of a small colored title bar at the top of each page. Only one student of the 56 surveyed was not aware of the fact that a calendar of the courses' day-to-day activities was available, and all students in both classes knew that lab handouts and test review materials were available on the site.

Before discussing differences in students' reactions to the site itself, it should be noted that there are a number of differences between the Physics and AP Physics sections of *crashwhite.com*. The regular Physics section included both Test Review Problems *and* Practice Tests, while the AP section only provided Test Review Problems. The AP Physics section included a series of detailed sample problems and solutions, while the regular Physics section did not. And most importantly, although each section of the site included a discussion board devoted specifically for students in that class, the AP discussion board typically got new postings from students almost *daily*, while a much longer period of time, sometimes several weeks, would pass between postings on the regular Physics discussion board.

It is not surprising, then, to note the following differences. A full 65% of the AP students reported that they

posted messages on the discussion board Occasionally, Often, or Very Often; only 35% of the regular students used their discussion board that often. More than three times as many AP students read messages on the bulletin board Often or Very Often (70%) as in the regular course (21%). Of the AP students, 95% reported having benefited from material posted on the discussion board, while only 53% of the regular students had. Clearly, the AP students made more use of, and benefited more from, the discussion board, compared with the students in the regular Physics class.

The last two questions on the survey asked students to rate the perceived benefits of using the site, according to a five-point scale. To the statement "The class website does a good job of providing you with support materials for the class," 65% of the AP students Strongly Agreed, and 30% Agreed. To this same question, 50% of the regular students Strongly Agreed and 44% Agreed.

Both classes were slightly less positive regarding the statement "The class website has helped you to learn physics better": 75% of the AP Physics students Agreed or Strongly Agreed, while 71% of the regular Physics students Agreed or Strongly Agreed.

In addition to the "multiple-choice" questions, there were three "free-response" questions at the end of the survey. The questions "What do you like *least* about the web site?", "What do you like *most* about the web site?", and "In what ways could the class web site be improved?" were designed to elicit more specific feedback concerning the different features of the site. Many students commented extensively on the site, its design and features, its implementation, and the way they used it.

Generally speaking, students appreciated many features of the site, including the availability of online grades, the course schedule, test review materials, sample problems (AP only), sample tests (Regular only), and the discussion board (more strongly favored by AP students than Regular students). Many mentioned the clean, spare, "professional" look of the site that allowed fast, efficient, access to information. At the same time, many students professed a desire to see many more materials made available online, including lecture notes, additional sample problems, and more complete solutions to sample problems. Several students wanted to see links to other physics "web sites of interest." Some wanted more color and graphics on the site; a few mentioned the

potential for implementing some sort of chat room. A number mentioned that they found the format of the calendar somewhat confusing, and many suggested that the discussion board be updated or improved, and that the grades be updated more frequently.

A more complete sample of comments received by students, broken down by course and question number, is given in Appendix F.

Usability

Analysis of the videotapes made of the four students using the *crashwhite.com* web site for the first time revealed some weaknesses in the site. A partial transcript from some of the tests is provided in Appendix G. Specific aspects of the test, and subjects' performances, are given here, with comments.

When asked, all four subjects were easily able to find the "e-mail Mr. White" link listed at the bottom of the left side menu on every page. All four subjects were also able to find the "Course Schedule and Homework Calendar," although 3 of the 4 had some difficulty interpreting the calendar's format, and only one actually found the homework assignment for the specified day. This result confirmed some of the

written comments of students in the class: one student wrote, "I don't like the format of the class calendar, I think it is very hard to look at. Maybe if the days were in bold and the notes were regular and there was color, it would be easier."

Three out of four students were able to find the Pendulum Lab instructions without much difficulty. Although there was no link clearly labeled with the word "Lab" on the home page, these students correctly surmised that this type of material would be found under a menu heading "Classroom Materials."

It was anticipated that students would have difficulty finding the instructions for using the Solver function on the Texas Instruments calculator: this page, for lack of a better organizational heading, was stored under the "Links" menu. Indeed, only one student was able to find the correct page, and he stumbled upon it accidentally while looking for a link to the Texas Instruments web site. It was anticipated that students looking for this page would resort to using the web site's Search function, which is located at the top of every page.

Interestingly, only one subject tried using this Search strategy, and that was after he had already spent several

minutes clicking on various links in hopes of finding the page he was looking for. This reluctance to use the Search function was corroborated by the fact that only 2 out of 56 respondents in the written evaluation preferred to use a Search function. One might conclude that most web sites are designed so well that users do not usually *need* to use the Search function, although it is probably more likely that the Search function on many web sites is not successful often enough to make it useful.

In the case of *crashwhite.com*, the author had known for quite some time that the Search program did not provide very useful results. The Search program was based on a "freeware" script obtained off the Internet, and does not have some of the more useful features of advanced, commercial, search scripts. Based on the observations of students during usability tests, it can be concluded that the Search function was not only ineffective, but detrimental to the user's experience--the one subject who used it spent several minutes just trying to understand what the Search results were telling him.

Summary

Two common ways of evaluating the effectiveness of a web site are written evaluations of users' experiences, and "usability" field tests, in which users are observed while using the site.

The *crashwhite.com* web site was evaluated based on written surveys completed by 56 students in the author's classes, and videotaped observations of 4 students while they attempted to perform a number of different tasks on the site.

The results of these evaluations suggest that the site had many features that students in the AP and Regular Physics courses found helpful, particularly test review materials, online grades, and a course schedule. AP students found the online discussion board especially beneficial, while Regular students generally did not seem to find it very useful. Students felt that there were a number of relatively minor improvements that could increase the effectiveness of the site--more frequent grade updates, a more readable course schedule, and a more user-friendly discussion board, among other things--but overall, they tended to be fairly satisfied with the site. Over 95% of these students agreed that the site had done a good job of providing them with support

materials, and over 70% of them agreed that the site had helped them learn physics better.

Usability tests suggest that students who had not had time to familiarize themselves with the site and its content found it much more difficult to navigate. In particular, the site's Search function did not work well enough to actually help users find the information they were looking for.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Introduction

As both teacher and student use of the Internet has increased, so has the number of course-related web sites, particularly for college and university students. There are many fewer course-related web sites for high school classes. The purpose of this project was to test whether a web site could effectively supplement the author's Physics and AP Physics courses at Berkeley High School. It was expected that the web site would increase communication between parents, students, and teacher, and perhaps have some positive effect on learning by improving access to materials and information normally available only in the classroom.

The *crashwhite.com* web site was constructed according to accepted instructional design principles, with an emphasis on reducing cognitive overhead. Screen layout, navigation systems, and choice of colors and font styles were all considered when designing the site. Materials available on the site included the course syllabus, the course schedule, homework assignments, and test review materials. The most interesting features of the site were the online discussion

board, which allowed students to leave messages for each other, and two attempts at delivering instruction online.

In order to test the usefulness of the site, a written survey was developed and administered to the students. Additionally, four videotaped interview sessions were conducted with students who had never seen the web site before.

Information from these surveys and interviews suggests that the *crashwhite.com* web site was largely effective in supplementing the author's Physics and AP Physics classes at Berkeley High School. Applying instructional design principals in the development and implementation of the site resulted in a site that was relatively easy to use. Increased communication and access to instructional materials made the site extremely popular with students, the majority of whom felt that the site had done a good job of supplying them with materials, and helped them to learn physics better.

Conclusions

Student feedback regarding the *crashwhite.com* web site resulted in a number of major conclusions.

While students in both types of physics classes at Berkeley High are very technologically literate, the AP

physics students actually *use* the Internet more frequently than the regular physics students. Students generally enjoy and benefit from being able to leave messages for each other on an online discussion board, although again, the AP students used the board more frequently.

Although a number of students expressed interest in having course material available on the web site, implementing effective online delivery of content (as opposed to supplemental materials) is probably prohibitively difficult, both in terms of currently available technology and the time that would be required of most high school instructors.

Most students who used the *crashwhite.com* web site appreciated having online access to grades, test review materials, sample problems, and the discussion board. The vast majority of students (95% in the AP class, 94% in the regular class) Agreed or Strongly Agreed that the web site did a good job of providing support materials for the class. The majority of students (75% in the AP class, 71% in the regular class) Agreed or Strongly Agreed that the web site helped them to learn physics better.

Recommendations

The recommendations resulting from the project are as follows.

1. High school instructors who are interested in incorporating the Internet into their courses may want to consider implementing a classroom web site. Some additional time to implement the site is required.
2. Creating an online discussion board for high school courses has potential benefits, both in terms of encouraging curriculum-related communication and a sense of community between students in the course. Some students would probably benefit from a brief "training session" at the beginning of the school year.
3. Students expect to see the grades and and other materials on the site frequently updated.
4. Having a Search function on the web site may be helpful, but it is more important to have the site logically organized: users are more likely to click around, looking for what they want, rather than use the Search function.

5. Future improvements to the *crashwhite.com* site will include improving the Search function (possibly by incorporating free functions from PicoSearch.com or Google.com), modifying the format of the calendar so that it is easier to read, and installing a new discussion board that has a more understandable and convenient format.
6. Some research has been conducted on course-related web sites at the college level, but there has been little research done on similar types of courses at the high school level. Additional research on high school course-related web sites would almost certainly give results that could guide the future efforts of high school instructors/site designers.

APPENDIX A

A SAMPLE HTML TEMPLATE FOR THE *CRASHWHITE.COM* WEB SITE

```
<head>
   <title>About This Website</title>
   <meta name="resource-type" CONTENT="document">
   <meta name="generator" CONTENT="Me!">
   <meta http-equiv="author" CONTENT="Richard White">
   <meta http-equiv="description" CONTENT="Richard White's
Berkeley High School Physics classes">
   <meta http-equiv="keywords" CONTENT="White, Richard White,
Berkeley High School, Berkeley, Berkeley High, BHS, Physics,
Berkeley High School Physics, Advanced Placement Physics, AP
Physics, AP">
   <meta http-equiv="distribution" CONTENT="Global">
   <base href="http://www.crashwhite.com/physicsclass/">
</head>

<!-- ********************************************** -->

<body bgcolor = "ffffff">
<center>
<table border=0 cellspacing=0 cellpadding=0 width=100%>

<!-- ***** This is the header row at the top ******** -->
   <tr valign=top>
      <td width="150" bgcolor="3399cc">
      <font face = "Verdana, Arial, Helvetica, sans-serif" SIZE
=  4><b>  crashwhite</b>
     </td>
      <td width="1" bgcolor="3399cc">
      <img src="../images/cleardot.gif" HEIGHT=1 width=1
border=0>
     </td>
      <td bgcolor="3399cc">
        <font face = "Verdana, Arial, Helvetica, sans-serif"
SIZE  =  4><b>  Physics</b>
     </td>
   </tr>

<!-- * This is the search row just below the header * -->

   <tr>
      <td colspan = "3" align = "right">
        <form method="post"
action="http://www.crashwhite.com/cgi-bin/fetch.pl">
          <input type="text" size="30" name="keyword">
          <input type="submit" value="Search!">
          <input type="hidden" name="connector" value="or">
          <input type="hidden" name="case" value="insensitive">
          <input type="hidden" name="show_summary" value="no">
          <input type="hidden" name="result_num" value="20">
        </form>
     </td>
```

```
  </tr>

<!--  This is a spacer row between the search row  -->
<!--  and the main part of the page                -->

  <tr>
    <td> 
    </td>
  </tr>


<!-- This is the row with the main part of the page -->
<!-- including the MENU and the body -->

  <tr valign=top>
  <!-- *  This is the menu on the side * -->
    <td width = "150">
      <!-- * This table holds the menu  -->
      <!-- cell padding keeps text in from borders -->
       <table border=0 cellspacing=0 cellpadding=10 width =
100%>

<tr valign=top>
        <td>
         <font face = "Verdana, Arial, Helvetica, sans-serif"
SIZE = 1><a href="physicsclasshome.html">Physics Home</a>
       <!-- Current page is shown in bold -->
        <p>
        <a
href="physicsclassadministration/physicsclassadministration.h
tml">Administration</a><br>
        <p>
        <a
href="physicsclassmaterials/physicsclassmaterials.html">Class
Materials</a><br>
        <p>
        <a
href="physicsclasslinks/physicsclasslinks.html">Links</a><br>
        <p>
        <a
href="physicsclasshelp/physicsclasshelp.html">Help</a><br>
        <p>
        <a
href="physicsclassabout/physicsclassabout.html"><b>About
<i>crashwhite</i></b></a><br>
<!-- Imbedded table to get indent -->
         <table border=0 cellspacing=0 cellpadding=10
width=100%>
           <tr valign=top>
             <td>
```

```
                <font face = "Verdana, Arial, Helvetica, sans-
serif" SIZE = 1><a
href="physicsclassabout/crashwhitefaqs.html">crashwhite
FAQs</a>
                <p>
                <a
href="physicsclassabout/history.html">Website  History</a>
                <p>
                <a
href="physicsclassabout/credits.html">Website  Credits</a>
                <p>
                <a
href="physicsclassabout/termsofservice.html">Terms  of
Service</a>
                <p>

<a  href="physicsclassabout/whitebio.html">Mr.  White's
Biography</a>
             </td>
           </tr>
         </table>  <!-- imbedded menu -->
          <a href="mailto:rwhite@crashwhite.com"> e-mail Mr.
White</a><br>
        </td>
      </tr>
      </table>  <!-- that holds the menu -->
    </td>

<!-- This is the line that separates the menu -->
<!-- from the main area                       -->

     <td width="1" bgcolor="000000">
       <img src="../images/cleardot.gif" HEIGHT=1 width=1
border=0>
    </td>

<!-- *** This is the main area **************-->
    <td>
       <table border=0 cellspacing=0 cellpadding=10
width=100%>
       <!-- This table holds the body of the page -->
       <tr valign=top>
         <td>

<!-- Information specific to this particular page would be
inserted  -->
<!-- here. All other coding on this page is common to all the
pages, -->
<!-- with only minor adjustments necessary as new pages are
created. -->
```

```
        </td>
      </tr>
       </table>  <!-- that holds the body of the page -->
    </td>
    </tr>

</table>  <!-- that holds the main part of the page -->
</center>
<!-- Update, copyright, and e-mail link goes below -->
 
<p>
<font face = "Verdana, Arial, Helvetica, sans-serif"
SIZE=1><i>This page last updated 26 August, 2002</i><br>
<font face = "Verdana, Arial, Helvetica, sans-serif"
SIZE=1><i>&copy;1999-2002 <a
href="mailto:rwhite@crashwhite.com">crashwhite.com</a></i>
</body>
</html>
```

APPENDIX B

CONSENT FORMS

Survey Consent Form

I, _____, agree to participate in the research entitled *A High School Physics Instructor's Website: Design, Implementation, and Evaluation*. This research is being conducted by Richard White of Berkeley High School (e-mail *rwhite@crashwhite.com*, telephone 510-845-6348). I understand that this participation is entirely voluntary. I can withdraw my consent at any time without penalty and have the results of the participation returned to me, removed from the experimental records, or destroyed.

The following have been explained to me:

1. The reason for the research is to understand what effects the physics courses' website has on high school students' learning.

2. The procedure I will be involved in consists of approximately 30 minutes answering a survey concerning my use of the Internet and the *crashwhite.com* website.

3. The purpose of the survey is to allow the researcher to determine how subjects use the *crashwhite.com* website.

Results from the survey will be used to determine how the educational effectiveness of the site may be improved.

4. Individual survey results will not be made publicly available. Within two weeks of compiling surveys, original surveys will be destroyed.

5. My participation will not in any way affect how I am evaluated in my regular class, and will involve no risks of any kind.

6. The results of this participation will remain confidential, and will not be released in any individually identifiable form. All information will be given on a voluntary basis.

7. This research has been approved by the Institutional Review Board of California State University, San Bernardino.

8. The investigator will answer any further questions about the study either now or during the course of the investigation.

9. Subjects may receive a copy of the survey results by contacting Richard White at the e-mail address or phone number listed above.

10. Subjects who have questions or concerns as a result of participating in this study may contact Richard White at the e-mail address or phone number listed above.

_____

Signature of Participant

_____

Signature of Parent

_____

Date

_____

Signature of Investigator

Please sign both copies of this form. Keep one and return the other to the investigator.

Videotape Consent Form

I, _____, agree to participate in the research entitled *A High School Physics Instructor's Website: Design, Implementation, and Evaluation*. This research is being conducted by Richard White of Berkeley High School (e-mail *rwhite@crashwhite.com*, telephone 510-845-6348). I understand that this participation is entirely voluntary. I can withdraw my consent at any time without penalty and have the results of the participation returned to me, removed from the experimental records, or destroyed.

The following have been explained to me:

1. The reason for the research is to understand what effects the physics courses' website has on high school students' learning.

2. The procedure I will be involved in consists of approximately 30 minutes being interviewed and videotaped while examining the *crashwhite.com* website.

3. The purpose of the interview and videotaping is to allow the researcher to observe and analyze how easily subjects are able to use the *crashwhite.com* website.

Videotapes of student behaviors and verbal explanations of what they are doing while using the website will be examined by the researcher, and used to improve the website's usability. If you agree to allow the videotape of your participation to be studied by the research team for use in the research project, please initial here: _____.

4. The videotape will not be made publicly available. Within two weeks of recording, videotape will be destroyed.

5. My participation will not in any way affect how I am evaluated in my regular class, and will involve no risks of any kind.

6. The results of this participation will remain confidential, and will not be released in any individually identifiable form. All information will be given on a voluntary basis.

7. This research has been approved by the Institutional Review Board of California State University, San Bernardino.

8. The investigator will answer any further questions about the study either now or during the course of the investigation.

9. Subjects may receive a copy of the survey results by contacting Richard White at the e-mail address or phone number listed above.

10. Subjects who have questions or concerns as a result of participating in this study may contact Richard White at the e-mail address or phone number listed above.

I have read the above description and give my consent for the use of the videotape as indicated above.

_____

Signature of Participant

_____

Signature of Parent

_____

Date

_____

Signature of Investigator

Please sign both copies of this form. Keep one and return the other to the investigator.

APPENDIX C

STUDENT INTERNET USE SURVEY

WEBSITE SURVEY

Please take a few moments to complete this survey regarding the website for your physics class.

A. Gender _____

B. Ethnicity _____

C. Which Physics class are you enrolled in?

1. Physics
2. AP Physics

D. What type of computer do you usually use to access the Internet?

1. PC-compatible
2. Macintosh
3. Other _____

E. Where do you usually access the Internet from?

1. Home
2. School
3. Work
4. Other _____

F. What type of Internet connection do you usually use to access the Internet?

1. Phone modem

2. Cable modem

3. DSL Line

4. Don't know

5. Other_____

G. What type of web browser do you usually use to access the Internet?

1. Netscape Navigator

2. Internet Explorer

3. AOL

4. Don't know

5. Other _____

H. How often do you "surf" the World Wide Web (WWW) for fun?

1. Never

2. Rarely

3. Several times a month

4. Once or twice a week

5. At least every other day

I. How often do you use the WWW for a specific purpose (looking up information, purchasing something, etc.)?

1. Never

2. Rarely

3. Several times a month

4. Once or twice a week

5. At least every other day

J. How often, in general, do you use e-mail to communicate with someone?

1. Never

2. Rarely

3. Several times a month

4. Once or twice a week

5. At least every other day

K. How many time have you visited, or do you visit, the website for this class?

1. Never

2. Rarely

3. Several times a month

4. Once or twice a week

5. At least every other day

L. Have you bookmarked the *crashwhite.com* website?

1. Yes

2. No

3. Don't know

M. If you have bookmarked the website, which page on the site have you bookmarked?

1. The generic *crashwhite.com* splash page"

2. Your class homepage

3. Other _____

N. How often do you e-mail the instructor for this class?

1. Never

2. Rarely

3. Occasionally

4. Often

5. Very Often

O. How often do you e-mail other students in the class for course-related purposes?

1. Never

2. Rarely

3. Occasionally

4. Often

5. Very Often

P. How often do you use "instant messaging" to communicate with other students for course-related purposes?

1. Never

2. Rarely

3. Occasionally

4. Often

5. Very Often

Q. How often do you *post* messages on the class discussion board?

1. Never
2. Rarely
3. Occasionally
4. Often
5. Very Often

R. How often do you *read* messages on the class discussion board?

1. Never
2. Rarely
3. Occasionally
4. Often
5. Very Often

S. Have you ever benefited from course-related material posted by students on the class' discussion board?

1. Yes
2. No
3. Don't know

T. Have you ever been reluctant to post a message on the class' discussion board?

1. Yes
2. No
3. Don't know

U. If you do not immediately know where to find something on the *crashwhite.com* web site, what strategy do you use more often to try to find the information?

1. I usually use the Search function to try to find it.
2. I usually click around through the links, trying to find it.
3. I sometimes use the Search, and sometimes click around through the links.
4. None of these

V. The browser on your computer is _____ able to display the pages on the website.

1. Never
2. Rarely
3. Occasionally
4. Often
5. Very Often

W. Pages on the class website load quickly on your computer.

1. Yes
2. No

3. Don't know

X. There are _____ spelling errors on the class website.

1. Never
2. Rarely
3. Occasionally
4. Often
5. Very Often

Y. There are _____ grammar errors on the class website.

1. Never
2. Rarely
3. Occasionally
4. Often
5. Very Often

Z. The class website is logically organized so that I can find things.

1. Yes
2. No
3. Don't know

AA. It is easy to navigate through the class website.

1. Yes
2. No

3. Don't know

BB. There are links to other useful web sites from the class website.

1. Yes

2. No

3. Don't know

CC. On the class website, it is easy to identify which areas on a page are links that will take you to another page when you click on them.

1. Yes

2. No

3. Don't know

DD. On the class website, it is easy to identify *where* a link will take you before you click on it.

1. Yes

2. No

3. Don't know

EE. The links on the class website all work.

1. Yes

2. No

3. Don't know

FF. It is possible to e-mail the instructor from the class website.

1. Yes
2. No
3. Don't know

GG. There is a date indicating when the page was last updated on each page of the website.

1. Yes
2. No
3. Don't know

HH. There are _____ graphics (images) on the class website.

1. far too many
2. too many
3. the right amount of
4. too few
5. far too few

II. There are _____ colors on the class website.

1. far too many
2. too many
3. the right amount of
4. too few

5. far too few

JJ. A class schedule (calendar) is available on the class website.

1. Yes

2. No

3. Don't know

KK. Notes from the instructor's lectures are available on the class website.

1. Yes

2. No

3. Don't know

LL. Lab handouts are available on the class website.

1. Yes

2. No

3. Don't know

MM. Test review materials are available on the class website.

1. Yes

2. No

3. Don't know

NN. Recent announcements from the instructor are available on the class website.

1. Yes

2. No

3. Don't know

OO. The class website is easy to use.

1. Strongly Agree

2. Agree

3. Neutral

4. Disagree

5. Strongly Disagree

PP. The class website does a good job of providing you with support materials for the class.

1. Strongly Agree

2. Agree

3. Neutral

4. Disagree

5. Strongly Disagree

QQ. The class website has helped you to learn physics better.

1. Strongly Agree

2. Agree

3. Neutral

4. Disagree

5. Strongly Disagree

RR. What do you like *least* about the class website?

SS. What do you like *most* about the class website?

TT. In what ways could the class website be improved?

APPENDIX D

USABILITY TESTING PROTOCOL

Usability Testing Protocol

I. ORGANIZE TESTING SITUATION

A. RECRUIT SUBJECTS.

Explain that they will be observed and videotaped while using a computer to visit an educational website, and that they will need to sign a waiver. The complete test should last no more than 30 minutes. Have subject sign waiver, and make appointment for test.

B. SET UP COMPUTER

Before each subject comes in, the computer should be connected to the Internet (preferably via a broadband connection, >56 kB/s). Either Netscape Navigator or Internet Explorer should be running, with the page at "http://www.crashwhite.com" loaded. Make sure that the browser's history has been cleared between tests so that all links in the browser window will appear blue (not yet visited) when the user first examines them.

C. SET UP VIDEOCAMERA

Camera should be pointed at screen, from slightly behind and to the left of the user, with as much of user's profile in the camera as possible.

II. WHEN SUBJECT COMES IN, INTRODUCE YOURSELF, HAVE SUBJECT SIT DOWN AT COMPUTER, AND READ/SAY THE FOLLOWING:

A. INTRODUCTION

SAY: "Hi, my name is _____. I am going to be observing you today while you visit a website that has been designed for students to use. The designer of the website knows that there may be some problems with the website, things that might make it difficult to use, so I am going to be watching you to see what kind of problems you might have while you use it."

B. BAIL-OUT OPTION

SAY: "Although you may run into some difficulties while using the website, I do not want you to feel overly frustrated or uncomfortable. If at any point you want to stop, please let me know and we will stop the study immediately."

C. EQUIPMENT

SAY: "I will be videotaping while you use the computer to visit the website, so that there is a record of the work 'we did."

D. THINKING ALOUD

SAY: "In order for the designer to understand how you use the website, it will also be helpful if you speak aloud what comes into your mind while your working. Here is what I mean: If I ask you to try to go to the AP Physics website from this page (the *crashwhite.com* "splash screen"), you might say, "Okay, you want me to go the AP Physics website. Well... I see the words 'AP Physics' here, so I guess I'll try to click on those words... hey! It worked!"

SAY: "This may seem kind of awkward at first, but it is actually quite easy. If you forget to think aloud, I will remind you to keep talking while you are working."

E. NO HELP

SAY: "I will not be providing any help for you while you visit the website. Even if you have some difficulty with a task, I will not be able to immediately provide any assistance or hints--the reason for this is that we need to see you using the website in a realistic situation, where you will not have someone sitting here to help you."

SAY: "Even though I will not be able to answer your questions, it will help us if you ask them out loud anyway. For instance, if you cannot figure out where you are supposed to click, you might say 'Where the heck am I supposed to click on this dumb thing?' That is important feedback for the designer to hear and see."

SAY: "At the end of the exercises, if you still have any questions I will be happy to answer them for you."

F. TASK DESCRIPTION

SAY: "In just a moment, I am going to ask you to perform a series of tasks using the website. I will ask you to complete those tasks one at a time, and we will be recording what you do and what you say while you are working. Do you have any questions about anything I have told you?"

III. BEGIN OBSERVATION

Give the subject a maximum of 3-5 minutes to perform each of the following tasks. If the subject begins to get overly frustrated at any point, remind him/her that it is the *website* that is being tested, not them. If you feel that the subject is getting too frustrated to complete the task,

suggest that they stop that task and move on to a different one. When the subject *does* complete a task, give them positive feedback, and proceed on to the next task.

Remind subjects to keep talking while the work!

TASKS TO BE PERFORMED:

A. SAY: "Go to the AP Physics website." (This was already discussed during the introduction, so they should not have any difficulty with this task.)

B. SAY: "Find what problems should be done for homework on Wednesday, February 20, 2002."

C. SAY: "Find out information about what will be done during 'The Pendulum Lab.'"

D. SAY: "Send an e-mail to Mr. White, the instructor of this course."

E. SAY: "Find instructions on how to use the *Solver* function on a Texas Instruments calculator."

IV. CONCLUSION

Once all of the tasks have been completed (or if the subject decides to halt the experiment early), read/say the following:

SAY: "Thank you for helping us out! We were interested in seeing how people use this website, and your work today

will help us understand what needs to be done to make the site better."

SAY: "Do you have any questions that I can answer now?"

(Answer all questions.)

If you noticed any interesting behaviors during the study, please ask them about them now...

SAY: "You know, I noticed that during the test, when you had to _____perform some task_____, you _____state their behavior_____, and I thought that was really interesting. What were thinking about during that task?"

V. GOODBYE

Thank subject again for their help. Turn off video recorder.

APPENDIX E

WEB SITE SURVEY RESULTS

QUESTION ---->		A. Gender		B. Ethnicity	C. Which physics class are you enrolled in?		D. What type of computer do you usually use to access the Internet?		E. Where do you usually access the Internet from?		F. What type of Internet connection do you usually use to access the Internet?		G. What type of web browser do you usually use to access the Internet?	
RESPONSES ---->		1. Male 2. Female		Free Responses	1. Physics 2. AP Physics		1. PC-compatible 2. Macintosh 3. Other _____		1. Home 2. School 3. Work 4. Other _____		1. Phone modem 2. Cable modem 3. DSL Line 4. Don't know 5. Other _____		1. Netscape Navigator 2. Internet Explorer 3. AOL 4. Don't know 5. Other _____	
AP Physics		Raw	Percent		Raw	Percent	Raw	Percent	Raw	Percent	Raw	Percent	Raw	Percent
Total Responses ->		20	100.00%		20	100.00%	20	100.00%	20	100.00%	20	100.00%	19	100.00%
Answer #	1	16	80.00%		0	0.00%	14	70.00%	20	100.00%	6	30.00%	4	21.05%
Answer #	2	4	20.00%		20	100.00%	5	25.00%	0	0.00%	5	25.00%	12	63.16%
Answer #	3	0	0.00%		0	0.00%	1	5.00%	0	0.00%	8	40.00%	2	10.53%
Answer #	4	0	0.00%		0	0.00%	0	0.00%	0	0.00%	1	5.00%	1	5.26%
Answer #	5	0	0.00%		0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		36	100.00%		36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%
Answer #	1	23	63.89%		36	100.00%	24	66.67%	35	97.22%	13	36.11%	6	16.67%
Answer #	2	13	36.11%		0	0.00%	11	30.56%	1	2.78%	6	16.67%	21	58.33%
Answer #	3	0	0.00%		0	0.00%	1	2.78%	0	0.00%	14	38.89%	9	25.00%
Answer #	4	0	0.00%		0	0.00%	0	0.00%	0	0.00%	2	5.56%	0	0.00%
Answer #	5	0	0.00%		0	0.00%	0	0.00%	0	0.00%	1	2.78%	0	0.00%

QUESTION ----->		H. How often do you "surf" the World Wide Web (WWW) for fun?		I. How often do you use the WWW for a specific purpose (looking up information, purchasing something, etc.)?		J. How often, in general, do you use e-mail to communicate with someone?		K. How many time have you visited, or do you visit, the website for this class?		L. Have you bookmarked the crashwhite.com website?		M. If you have bookmarked the website, which page on the site have you bookmarked?	
RESPONSES ----->		1. Never 2. Rarely 3. Several times a month 4. Once or twice a week 5. At least every other day		1. Never 2. Rarely 3. Several times a month 4. Once or twice a week 5. At least every other day		1. Never 2. Rarely 3. Several times a month 4. Once or twice a week 5. At least every other day		1. Never 2. Rarely 3. Several times a month 4. Once or twice a week 5. At least every other day		1. Yes 2. No 3. Don't know		1. The generic crashwhite.com " splash page " 2. Your class homepage 3. Other _____	
Total Responses ->		20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%	10	100.00%
Answer #	1	1	5.00%	0	0.00%	0	0.00%	0	0.00%	10	50.00%	5	50.00%
Answer #	2	3	15.00%	0	0.00%	3	15.00%	1	5.00%	10	50.00%	5	50.00%
Answer #	3	1	5.00%	4	20.00%	2	10.00%	4	20.00%	0	0.00%	0	0.00%
Answer #	4	7	35.00%	4	20.00%	4	20.00%	4	20.00%	0	0.00%	0	0.00%
Answer #	5	8	40.00%	12	60.00%	11	55.00%	11	55.00%	0	0.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		36	100.00%	36	100.00%	36	100.00%	35	100.00%	35	100.00%	22	100.00%
Answer #	1	1	2.78%	0	0.00%	0	5.56%	0	0.00%	22	62.86%	15	68.18%
Answer #	2	11	30.56%	2	5.56%	2	11.11%	2	5.71%	13	37.14%	7	31.82%
Answer #	3	3	8.33%	13	36.11%	1	16.67%	12	34.29%	0	0.00%	0	0.00%
Answer #	4	11	30.56%	12	33.33%	2	27.78%	15	42.86%	0	0.00%	0	0.00%
Answer #	5	10	27.78%	9	25.00%	7	38.89%	6	17.14%	0	0.00%	0	0.00%

QUESTION ----->		N. How often do you e-mail the instructor for this class?		O. How often do you e-mail other students in the class for course-related purposes?		P. How often do you use " instant messaging " to communicate with other students for course-related purposes?		Q. How often do you post messages on the class discussion board?		R. How often do you read messages on the class discussion board?		S. Have you ever benefited from course-related material posted by students on the class' discussion board?	
RESPONSES ----->		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Yes 2. No 3. Don't know	
Total Responses ->		20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%
Answer #	1	9	45.00%	10	50.00%	11	55.00%	3	15.00%	0	0.00%	19	95.00%
Answer #	2	8	40.00%	5	25.00%	2	10.00%	4	20.00%	2	10.00%	1	5.00%
Answer #	3	3	15.00%	3	15.00%	1	5.00%	6	30.00%	4	20.00%	0	0.00%
Answer #	4	0	0.00%	1	5.00%	0	0.00%	5	25.00%	5	25.00%	0	0.00%
Answer #	5	0	0.00%	1	5.00%	6	30.00%	2	10.00%	9	45.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%
Answer #	1	20	55.56%	24	66.67%	27	75.00%	15	75.00%	8	22.22%	19	52.78%
Answer #	2	15	41.67%	11	30.56%	4	11.11%	14	70.00%	8	22.22%	14	38.89%
Answer #	3	1	2.78%	0	0.00%	4	11.11%	3	15.00%	12	33.33%	3	8.33%
Answer #	4	0	0.00%	0	0.00%	1	2.78%	2	10.00%	5	13.89%	0	0.00%
Answer #	5	0	0.00%	1	2.78%	0	0.00%	2	10.00%	3	8.33%	0	0.00%

QUESTION ----->		T. Have you ever been reluctant to post a message on the class' discussion board?		U. If you don't immediately know where to find something on the crashwhite.com web site, what strategy do you use more often to try to find the information?		V. The browser on your computer is _____ able to display the pages on the website.		W. Pages on the class website load quickly on your computer.		X. There are _____ spelling errors on the class website.		Y. There are _____ grammar errors on the class website.	
RESPONSES ---->		1. Yes 2. No 3. Don't know		1. I usually use the Search function to try to find it. 2. I usually click around through the links, trying to find it. 3. I sometimes use the Search, and sometimes click around through the links. 4. None of these		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Yes 2. No 3. Don't know		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often		1. Never 2. Rarely 3. Occasionally 4. Often 5. Very Often	
Total Responses ->		19	100.00%	20	100.00%	20	100.00%	20	100.00%	19	100.00%	19	100.00%
Answer #	1	1	5.26%	0	0.00%	0	0.00%	20	100.00%	7	36.84%	10	52.63%
Answer #	2	16	84.21%	14	70.00%	0	0.00%	0	0.00%	12	63.16%	8	42.11%
Answer #	3	2	10.53%	6	30.00%	0	0.00%	0	0.00%	0	0.00%	1	5.26%
Answer #	4	0	0.00%	0	0.00%	1	5.00%	0	0.00%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	19	95.00%	0	0.00%	0	0.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		34	100.00%	35	100.00%	36	100.00%	35	100.00%	34	100.00%	34	100.00%
Answer #	1	4	11.76%	2	5.71%	0	0.00%	33	94.29%	12	35.29%	14	41.18%
Answer #	2	29	85.29%	25	71.43%	0	0.00%	0	0.00%	22	64.71%	20	58.82%
Answer #	3	1	2.94%	7	20.00%	0	0.00%	2	5.71%	0	0.00%	0	0.00%
Answer #	4	0	0.00%	1	2.86%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	36	100.00%	0	0.00%	0	0.00%	0	0.00%

QUESTION ----->		Z. The class website is logically organized so that I can find things.		AA. It is easy to navigate through the class website.		BB. There are links to other useful web sites from the class website.		CC. On the class website, it is easy to identify which areas on a page are links that will take you to another page when you click on them.		DD. On the class website, it is easy to identify where a link will take you before you click on it.		EE. The links on the class website all work.	
RESPONSES ----->		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know	
Total Responses ->		20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%
Answer #	1	20	100.00%	20	100.00%	11	55.00%	19	95.00%	17	85.00%	17	85.00%
Answer #	2	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Answer #	3	0	0.00%	0	0.00%	9	45.00%	1	5.00%	3	15.00%	3	15.00%
Answer #	4	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%
Answer #	1	32	88.89%	36	100.00%	11	30.56%	33	91.67%	27	75.00%	20	55.56%
Answer #	2	3	8.33%	0	0.00%	5	13.89%	2	5.56%	3	8.33%	2	5.56%
Answer #	3	1	2.78%	0	0.00%	20	55.56%	1	2.78%	6	16.67%	14	38.89%
Answer #	4	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%

QUESTION ----->		FF. It is possible to e-mail the instructor from the class website.		GG. There is a date indicating when the page was last updated on each page of the website.		HH. There are _____ graphics (images) on the class website.		II. There are _____ colors on the class website.		JJ. A class schedule (calendar) is available on the class website.		KK. Notes from the instructor's lectures are available on the class website.	
RESPONSES ----->		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. far too many 2. too many 3. the right amount of 4. too few 5. far too few		1. far too many 2. too many 3. the right amount of 4. too few 5. far too few		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know	
Total Responses ->		20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%
Answer #	1	14	70.00%	8	40.00%	0	0.00%	0	0.00%	20	100.00%	2	10.00%
Answer #	2	1	5.00%	0	0.00%	0	0.00%	1	5.00%	0	0.00%	12	60.00%
Answer #	3	5	25.00%	12	60.00%	15	75.00%	17	85.00%	0	0.00%	6	30.00%
Answer #	4	0	0.00%	0	0.00%	5	25.00%	2	10.00%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%
Answer #	1	32	88.89%	14	38.89%	0	0.00%	0	0.00%	35	97.22%	1	2.78%
Answer #	2	1	2.78%	2	5.56%	0	0.00%	0	0.00%	0	0.00%	24	66.67%
Answer #	3	3	8.33%	20	55.56%	26	72.22%	31	86.11%	1	2.78%	11	30.56%
Answer #	4	0	0.00%	0	0.00%	10	27.78%	5	13.89%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%

QUESTION ----->		LL. Lab handouts are available on the class website.		MM. Test review materials are available on the class website.		NN. Recent announcements from the instructor are available on the class website.		OO. The class website is easy to use.		PP. The class website does a good job of providing you with support materials for the class.		QQ. The class website has helped you to learn physics better.	
RESPONSES ----->		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. Yes 2. No 3. Don't know		1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5. Strongly Disagree		1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5. Strongly Disagree		1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5. Strongly Disagree	
Total Responses ->		20	100.00%	19	100.00%	20	100.00%	20	100.00%	20	100.00%	20	100.00%
Answer #	1	20	100.00%	19	100.00%	19	95.00%	17	85.00%	13	65.00%	6	30.00%
Answer #	2	0	0.00%	0	0.00%	0	0.00%	3	15.00%	6	30.00%	9	45.00%
Answer #	3	0	0.00%	0	0.00%	1	5.00%	0	0.00%	1	5.00%	5	25.00%
Answer #	4	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Answer #	5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Regular Physics Summary of Responses (by Answer Number)		Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent	Raw Values	Percent
Total Responses ->		36	100.00%	36	100.00%	36	100.00%	36	100.00%	36	100.00%	35	100.00%
Answer #	1	36	100.00%	36	100.00%	34	94.44%	21	58.33%	18	50.00%	7	20.00%
Answer #	2	0	0.00%	0	0.00%	0	0.00%	14	38.89%	16	44.44%	18	51.43%
Answer #	3	0	0.00%	0	0.00%	2	5.56%	1	2.78%	2	5.56%	8	22.86%
Answer #	4	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	2	5.71%
Answer #	5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%

APPENDIX F

SAMPLE OF WRITTEN COMMENTS FROM SURVEY

Question: What do you like least about the class website?

Sample of AP student responses:

1. It is not updated frequently enough.
2. The menu bar on the left causes problems when printing lab handouts or review questions.
3. Message board often loads excruciatingly slow.
4. Just when valuable info is not available - for example, when the answers to even number problems are missing, and also how there are not sample problems for later chapters.
5. At times, it seems kind of boring, like nothing has changed. Also, not every chapter is represented for "Sample Problems" and "Test Review."
6. There were not enough online lectures and it was hard to make them work.
7. More study materials would be helpful. For example, the sample questions are listed, but those problems and solutions are not available. Also, if notes or lectures were available, the site would help more with coursework.
8. First off, I should say that I seldom use the site, not because of any inadequacies on its part, but

because my modem is prohibitively slow and unreliable. I do have a problem that the posted lab descriptions refuse to print with images on my computer.

Sample of Regular student responses:

1. I don't like the practice tests that have the answers already on the paper.
2. The class website should include notes from the instructor's lectures.
3. What I like least about the website is that I still don't know how to use the discussion board.
4. It is a matter of what I like least about my computer - it's slow. Thus making it harder to go to the website often.
5. I least liked the fact that too few people used the discussion board. I felt that it was a great opportunity for students to communicate and help each other with questions, but was not used enough by the kids.
6. Doesn't show how to solve problems. Diagrams and step-by-step answers would be a great addition
7. Grades haven't been updated recently

8. You need some funny picture in there to lighten up the serious physics stuff.
9. I don't like the format of the class calendar, I think it is very hard to look at. Maybe if the days were in bold and the notes were regular and there was color, it would be easier.
10. The lack of good links to helpful instructive physics websites that relate directly to the material.
11. I think that people (including myself) could use the discussion board more often and for academic purposes. It is a great resource that is not utilized enough.
12. It is boring and straight forward. Maybe it would be better if you put pictures, or used nice grafix.
13. Having to download stuff from it. I'd rather just have a hand out. This way I don't forget.
14. At first I had a hard time locating things on the web site.
15. I don't like that the photocopied answers to the practice tests have their own separate page so it takes longer to print. (Of course I prefer having the answers than not at all.)

Question: What do you like most about the class website?

Sample of AP student responses:

1. Test Review AP problems, homework schedule, and answers to even-number problems are used on a regular basis, and fulfill their purpose excellently. I would also like to compliment the general layout and appearance of crashwhite.com. It is free of obnoxious colors and fonts, and looks professional.
2. Easy access to class schedule, review materials, and AP test links. Easy communication with teacher and class through message board.
3. Information. It's done a really good job of providing information to us, and it's updated constantly.
4. The discussion board, your comments to us on the right-hand margin, the links to Serway and to BHS, the test review problems, and the grades and class schedule. Oh, I love all the quotes you have on the crashwhite intro page.
5. It allows me to get a hold of materials when I want them (i.e. review questions, help on discussion board,

homework answers), and it acts as a great community builder.

6. It is, overall, very useful. You can get questions answered. The discussion board is the best part.
7. The discussion board is wonderful. The resources are wonderful - links to Serway, answers to even problem, class calendar, grades, and extremely well-organized and incredibly easy to use! Also, I like the overheards - that's a really nice touch. The website really serves to form a community.
8. Being able to find out what the assignments are and what the answers are is great. Also the website allows everyone to communicate and work together in the physics learning process.
9. Message board :-) Test review problems are helpful. Grades are also helpful; we don't have to nag you for them like in other classes.
10. I think providing review problems for each test has helped me the most with the class. They are concise, provide good example problems, and are easy to find.
11. The ability to check the schedule and figure out what's coming up is important... The discussion board

is certainly the highlight of the site, and on more than one occasion has helped me with problems. The organization strikes me as the best feature of the site as a whole. The Breaking News gives links to upcoming labs and information about events, while the center of the page is devoted to the most important sections of the site. This makes navigation extremely easy. The review problems are the best method I have found of studying for tests, either individually or as part of a group.

12. As opposed to most websites, this one is unquestionably alive, continually maintained by its creator and enriched by its visitors. It is elegant and streamlined to serve a utilitarian purpose, yet its quotes and messages give a human touch.

Sample of Regular student responses:

1. I like to be able to see my grade at any point during the semester, and it's nice to have good test reviews.
2. I can check my grades and get all the review materials from there. Also e-mail Mr. white. When I'm absent, I can just check the homework board and get what I need.

3. It's just a really great system. It's nice to be able to have access to class materials outside of class.
4. I like being able to check my grade (sometimes) ask questions if I need help, read announcements, and download materials such as lab info or review problems.
5. I like that it's easy to find what I'm looking for, it's a great thing to have to keep me on track and knowing what's going on.
6. You can check the homework and practice tests. You can check your grade.
7. The thing I like most is the class schedule and grades posted. The schedule is helpful when you're absent and you also don't have to constantly ask for your grade.
8. The whole thing. I love it because it's easy access for me. I can check grades, homework assignments, labs, etc. Anything I need to know.
9. Its simplicity and the fact that the lab and review materials are available.
10. The discussion board provides a forum where questions can be answered during all hours of the day.

11. Physics discussion board - reading others' posts - Also recent announcements and labs. Of course the quotes.

12. The accessibility to the review problems and practice tests with answers provided. I also like to be able to check on my updated grade. I also feel that if I get into trouble by forgetting assignments I can check the website and get updated.

13. The labs that are available to view/copy online.

Question: In what ways could the class website be improved?

Sample of AP student responses:

1. A chatroom for each class would be great, and is definitely in the realms of possibility as they are simple to apply and cost nothing.
2. Clear the message board more often, to keep it from bogging down and taking so long to load.
3. You could have a section on current events in physics research, esp. anything that uses what we're learning in class. Also an interactive section on good physics/science books to read. It would be really cool if we could tie-in with any other physics discussion boards that might exist in the world, or maybe

convince a few physicists to visit the site regularly, make comments, answer questions, etc.

4. The message board is in need of a more organized format - it looks messy and distracting. The "breaking news" should be updated more often, as should the grades.
5. A way to make printing easier, more online lectures, more overheard quotes, links to the Serway solution by clicking on the assigned problem, lab handouts and review questions should be accessible in one-click.
6. This year lots of non-physics students posted. It could be useful to install a mechanism by which non-physics students couldn't post. Also, it would be great (but a lot of work) to put up class notes.
7. Update some of the stuff (like answers to even # problems), etc. I don't really have anything critical to say, because I can't think of very many bad things about the site.
8. If more sample problems were given for each chapter that would be extremely helpful. Problems using the basic principles from each chapter.

9. On IE (5.1, I think) using Mac OS9, the calendar and grades pages do not scroll properly sideways. In other browsers, it is okay. There should be a registration type of message board (It could show some details about the person...it would cut down on fake posts.)
10. More pictures, more online lectures that are easy to use.
11. Free response problems with the test reviews. - More sample problems for the E/M chapters. - Maybe notes from lectures (pdfs, audio recordings, pictures of the white board from class) - a chat --> yeah it's a server hog, but maybe an IRC java applet that connects to some other server on a dedicated physics room. - more frequent grade updates... although I know you don't have all the time in the world :-)
12. The Search function definitely needs some work. The results given are just links, not summaries of each page. It also does not recognize colloquial terms for useful items, such as 'Equation Sheet.'
13. A simpler, less cluttered discussion board would make that feature more effective. If original posts were titles of folders, and those folders contained

all follow-ups, students could access the information they wanted in a location isolated from the other 500 plus messages. This would shorten the length of time required to find a particular topic (e.g. one homework assignment). Again, more information to help with coursework would improve the effectiveness. Simply scanning in lecture notes and listing them on a page would allow students to make up for missed lectures or get a little extra help. Links to more different types of problems would also be an asset.

14. Ideally, crashwhite could contain either links to extracurricular content or postings on the site - things of intrinsic interest to make us feel that we're not simply studying for a test all year. Physics has to be mm ore than that, and in this class it generally is; so the website should reinforce that feeling and spark the imaginations of those with extra time and enthusiasm.

Sample of Regular student responses:

1. It would be nice if the grades section had a total points possible and a total points earned space.

2. Teach people how to use the discussion board and how to post messages.
3. If there were two sets of review and practice problems, one with answers, and one without.
4. More example problems, maybe post up hard problems from the homework.
5. It would be helpful if lecture notes were provided or maybe a summary of the major concepts for the day, so if people are absent they won't be totally lost.
6. More Color. All I see is Black, white, and orange and blue links. It's boring. Add effects and class pictures and stuff.
7. The website functions as a sound educational tool, as is. it is easy to use and anything else that could be added would only be repeated in class.
8. More multimedia (physics related), macromedia Flash also enhances any web site.
9. Maybe include notes for people who miss a day, like I said above, maybe better printability.
10. Update grades more quickly.
11. Make test review stuff easier to get to, or put a link to it directly on the first page.

12. Nice grafix and more pictures.

13. Lecture notes.

14. It would be cool if there was a "buddy list" like on AOL, and when you went to the website you could see who else was there and could IM them, of if there was a chat room on the site. I don't post things because I think it would take too long to hear back, but if there was a chat room that would be cool.

15. Change the categories so material is easy to locate.

16. A few more colors and pictures would help me learn more. The layout is good and not too text dense.

17. I would like to see outlines of lectures like they do in college about each chapter's information.

18. Have chapter summaries or notes or something.

APPENDIX G

SELECTED USABILITY TEST TRANSCRIPTS

Subject #1

Interviewer: Your next task is to find what problems should be done for homework on Thursday, April 18.

Subject: OK, so it's homework. It looks like there's a "homework assignment" link, it says so right there, so I'll click there. What day did you say it was?

Interviewer: Thursday, April 18.

Subject: April 18, well, it looks like it's going to be in Week 11. In his class, I don't know how he arranges his homework, but it looks like it's going to be right here in week 11, between the 15 and the 19. (Subject unable to pinpoint exact day or assignment.)

Subject #2

Interviewer: Your next task is to find out information about what you will be doing during the pendulum lab.

Subject: Back at this page... I guess that would still be course schedule... Let me see... I'm not familiar with this page... I guess these are days of the week (looking at Course Schedule)... I don't see the Pendulum Lab (Moves back to home page)... Discussion board?...Maybe class materials? (Subject

clicks on Class Materials, then finds a link to the Lab Materials.) Physics lab materials... which lab was that?

Interviewer: The pendulum lab.

Subject: The pendulum lab (finds it). There we go.

Subject #3

Interviewer: Your next task is to find instructions on how to use the Solver function on a Texas Instruments calculator.

Subject: Ummm... I'm first going to go to Class Materials to see if he has calculator listed in here with corresponding information. (Clicks Classroom Materials link.) Doesn't seem to be here, so I'm going to head to "Help"...(doesn't find it)... I'm going to head back to Home". My inclination is to go to Search. (Subject types in "graphing calculator solver" into Search text box and gets a list of results that he finds confusing. Reads through search results. Clicks on a few entries...) Uhhh... Doesn't seem to be here either... I'm going to head back to "Help." It's not in "Frequently Asked Questions." I'm going to head

back to "Home" to see if I missed anything.... I can't find it...

Interviewer: (At the end of the test:) Any questions I can answer for you?

Subject: Where *is* the information on the Solver for the TI Calculator?

Interviewer: Another student found it in the "links" section.

Subject: I would assume "links" to be other AP what not...

Interviewer: You used the search engine twice, which was, I think, really interesting. What did you think about the results that it gave?

Subject: It was like, all of the links came up, and I can't really sift through that. How they do it on other search engines is, they'll give you a link, and then a little summary, or whatever text was highlighted....

Subject #4

Interviewer: Your next task is to find out information about what you will be doing during the pendulum lab.

Subject: Okay, so I'm going to... well, I don't see anything about the Pendulum Lab on here, so I'm going to go back to the other list of things. (Student returns

to Home Page.) Hmmm. Okay, I'm looking at these things, and I don't know quite which one to go to. It's not "Prospective Students." It's not about grades. "AP Physics Discussion board?" (Clicks on discussion board link.) This doesn't look this has anything to do with labs... I'm going to go back again. (Returns to Home Page.) I'm going to go [to schedule] again. (Student returns to Course Schedule and begins looking through, but doesn't find it after several minutes.)

REFERENCES

Alexander, S. (1995). Teaching and learning on the world wide web. Retrieved February 12, 2002 from the World Wide Web: http://ausweb.scu.edu.au/aw95/education2/alexander/

Annand, D. & Haughey, M. (1997). Instructors' Orientations towards Computer-mediated Learning Environments. *Journal of Distance Education/Revue de l'enseignement à distance*. 12 (1).

Apple Computer, Inc. (1995). Macintosh Human Interface Guidelines. Reading, MA: Addison-Wesley. Retrieved February 12, 2002 from the World Wide Web: http://developer.apple.com/techpubs/mac/HIGuidelines/HIGuidelines-2.html

Arnone, M., & Small, R. (1999). Evaluating the motivational effectiveness of children's websites. *Educational Technology, 39,* (2), 51-55.

Becker, H. J. (2000). Pedagogical motivations for student computer use that lead to student engagement. *Educational Technology. 40,* (5), (Sept.-Oct.), 5-17.

Bernard, M. (2002). Criteria for optimal web design (designing for usability). Retrieved March 23, 2002 from the

World Wide Web:
http://psychology.wichita.edu/optimalweb/print.htm

Bird, B. (1998). Application of FrontPage 98 to the development of web sites for the Science Division and the Center for the Advancement of Learning and Teaching (CALT) at Anne Arundel Community College. In Association of Small Computer Users in Education: Proceeds of the ASCUE Summer Conference (31st, North Myrtle Beach, SC, June 7-11, 1998). (ERIC Document Reproduction Service No. ED 425 714)

Boettcher, S. & Schwartz, R. (1997). Team-building through technology: Using a newsletter or a web site to energize your department. In *Walking the Tightrope: The Balance between Innovations in Leadership. Proceedings of the Annual International Conference of the Chair Academy (6th, Reno, NV, February 12-15, 1997.* (ERIC Document Reproduction Service No. ED 107 026)

Brahler, C. J., Peterson, N. S., & Johnson, E. C. (1999). Developing on-line learning materials for higher education: An overview of current issues. *Educational Technology and Society 2* (2). Retrieved February 10, 2002 from the World Wide Web:
http://ifets.ieee.org/periodical/vol_2_99/jayne_brahler.html

Burge, E. J. (1994). Learning in computer conferenced contexts: The learner's perspective. *Journal of Distance Education/Revue de l'enseignement à distance*. 9 (1). Retrieved February 15, 2002 from the World Wide Web: http://cade.athabascau.ca/vol9.1/burge.html

Chandler, B. & Maddux, C. D. (1998). Student use of instructors' web sites. In *SITE 98: Society for Information Technology & Teacher Education International Conference (9th, Washington, DC, March 10-14, 1998). Proceedings*. (ERIC Document Reproduction Service No. ED 421 152)

Clark, R. E. & Sugrue, B. M. (1995). Research on instructional media, 1978-1988. In Anglin, G. (Ed.), *Instructional Technology: Past, Present, and Future* (pp 348-362). Libraries Unlimited.

Conklin, J. (1987). Hypertext: An introduction and survey. *IEEE Computer. 20* (9) (Sept. 1987), 17-40.

Csir, F. J. (1996). Evaluation and criteria of the world wide web: reference web sites. Unpublished master's research paper, Kent State University, Ohio. (ERIC Document Reproduction Service No. ED 413 919)

Davis, M. & Boyer, J. (1998). Restructuring web site design: An alternative to webteams. (ERIC Document Reproduction Service No. ED 425 753)

DiNucci, D., Giudice, M., & Stiles, L. (1998). *Elements of Web Design: The Designer's Guide to a New Medium.* (2nd Ed.). Berkeley, Peachpit Press.

Ebersole, S. (1997). Cognitive issues in the design and deployment of interactive hypermedia: Implications for authoring WWW sites. *Interpersonal Computing and Technology, 5,* 1-2 (April 1997), 19-36. Retrieved January 6, 2002 from the World Wide Web: http://jan.ucc.nau.edu/~ipct-j/1997/n2/ebersole.html

Eklund, J. (1995). Cognitive models for structuring hypermedia and implications for learning from the world-wide web. Retrieved January 13, 2002 from the World Wide Web: http://ausweb.scu.edu.au/aw95/hypertext/eklund/

Estes, T., Bronack, S., & Schoeny, Z. (1999). Creating optimized learning environments: A course using interactive web elements. In *SITE 99: Society for Information Technology & Teacher Education International Conference (10th, San Antonio, TX, February 28-March 4, 1999).* (ERIC Document Reproduction Service No. ED 432 256)

Formosa, J. (1998). Are you sure you want to train faculty to develop web-based instruction? Presented at the Mid-South Instructional Technology Conference (3rd, Murfreesboro, TN, April 5-7, 1998). (ERIC Document Reproduction Service No. ED 431 387)

Georgiadou, E. (1998). The design of web-based hypermedia courseware in higher education. Presented at the The 8th International Conference on Computer Graphics and Visualization (GraphiCon'98), Moscow, September 7-11, 1998. Retrieved January 13, 2002 from the World Wide Web: http://inet.keldysh.ru/gc98/cd/edu_prog/eli_geo.pdf

Gosselin, M. (2000). Physics 2K2. Retrieved February 8, 2002 from the World Wide Web: http://wshs.wtvl.k12.me.us/~physics361/intro/table.html

Hess, B. (1999). Graduate student cognition during information retrieval using the World Wide Web: A pilot study. Presented at the Annual Conference of the American Educational Research Association (Montreal, Canada, April 14-23, 1999). (ERIC Document Reproduction Service No. ED 429 118)

Hoffman, J. L., Kupperman, J., & Wallace, R. (1997). On-line learning materials for the science classroom: Design

methodology and implementation. Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 26, 1997). (ERIC Document Reproduction Service No. ED 407 263)

Johnston, J. (1997). Weaving a syllaweb: Consideration before constructing an on-line syllabus. (ERIC Document Reproduction Service No. ED 412 937)

Jonassen, D. H. & Hannum, W. H. (1987). Research-based principles for designing computer software. Educational Technology,December 1987, pp 7-14.

Kayany, J. M. (1998). Instructional uses and effects of World Wide Web course pages: A Review of instructor experiences. *American Communications Journal 1* (3). Retrieved January 7, 2002 from the World Wide Web: http://acjournal.org/holdings/vol1/iss3/articles/kayanay/kayanay.htm

Liao, Y. (1998). Effects of hypermedia versus traditional instruction on students' achievement: A meta-analysis. Journal of Research on Computing in Education, 30 (4), 341-359.

Liu, Y. P. (1999). Web page development and management. SPEC Kit 246 and SPEC Flyer 246. (ERIC Document Reproduction Service No. ED 433 847)

Livengood, S. P. (1997.) An evaluation instrument for Internet web sites. Master's Research Paper, Kent State University. (ERIC Document Reproduction Service No. ED 413 899)

Lynch, P. J. (1994a). The Evolving interface of multimedia. *Syllabus Magazine, 8* (3):48-50. Retrieved February 2, 2002 from the World Wide Web: http://info.med.yale.edu/caim/manual/papers/gui_and_mm.html

Lynch, P. J. (1994b). Visual design for the user interface, Part 2: Design fundamentals. *Journal of Biocommunications, 21* (2): 6-15. Retrieved February 2, 2002 from the World Wide Web: http://info.med.yale.edu/caim/manual/papers/gui2.html

Lynch, P. J. (1994c). Visual design for the user interface, Part 1: Design fundamentals. *Journal of Biocommunications, 21* (1): 22-30. Retrieved February 2, 2002 from the World Wide Web: http://info.med.yale.edu/caim/manual/papers/gui1.html

Maddux, C. D. (1999). A university class in web design for teachers: Content and rationale. In *SITE 99: Society for Information Technology & Teacher Education International Conference (10th, San Antonio, TX, February 28 - March 4, 1999)*. (ERIC Document Reproduction Service No. ED 432 251)

McCabe, M. F. (1998). Lessons from the field: Computer conferencing in higher education. *Journal of Information Technology for Teacher Education,* 7 (1), 71-87. Retrieved January 2, 2002 from the World Wide Web: http://www.triangle.co.uk/jit/07-01/mccabe.pdf

McKnight, C., Dillon, A., & Richardson, J. (1996). User-centered design of hypertext/hypermedia for education. In D. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology,* (pp. 622-633). New York: Simon & Schuster Macmillan.

Merrill, P. F, & Bunderson, C. V. (1981). Preliminary guidelines for employing graphics in instruction. *Journal of Instructional Development, 4* (4).

Miller, S. M. & Miller, K. L. (1999). Using instructional theory to facilitate communication in Web-based courses. *Educational Technology & Society 2* (3). Retrieved

January 2, 2002 from the World Wide Web: http://ifets.ieee.org/periodical/vol_3_9/miller.html

Morkes, J. & Nielsen, J. (1997). Concise, SCANNABLE, and Objective: How to write for the web. Available online at http://www.useit.com/papers/webwriting/writing.html

New Zealand Educational Software. (2002). "Audiograph Software" available online at: http://www.nzedsoft.com/audiographhomepa.html"

Nielsen, J. (2002). Field studies done right: Fast and observational. Retrieved January 20, 2002 from the World Wide Web: http://www.useit.com/alertbox/20020120.html

Nielsen, J. (2000). *Designing web usability.* Indiana: New Riders Publishing.

Nielsen, J. & Sano, D. (1994). SunWeb: User interface design for Sun microsystem's internal web. Retrieved January 7, 2002 from the World Wide Web: http://archive.ncsa.uiuc.edud/SDG/IT94/Proceedings/HCI/nielsen/sunweb.html.

Parmley, J. D., Hutchinson, A. & Parmley, S. C. (1998). Lessons learned from National Park Service electronic visitors: Implications for K-12 classrooms and teachers. In *SITE 98: Society for Information Technology and Teacher*

Education International Conference (9th, Washington DC, March 10-14, 1998). Proceedings. (ERIC Document Reproduction Service No. ED 421 167)

Quinton, C. (1999). Quinton Web. Retrieved January 7, 2002 from the World Wide Web: http://www.physicsteacher.com/

Ravaglia, R., de Barros, J. A. & Suppes, P. (1999). Computer-based Advanced Placement physics for gifted students. Unpublished paper, Stanford University, Stanford.

Reeves, T. C. & Dehoney, J. (1998). Cognitive and Social Functions of Course Web Sites. In *Webnet 98 World Converence of the WWW, Internet and Intranet Proceedins (3rd, Orlando, FL, November 7-12, 1998)*. (ERIC Document Reproduction Service No. ED 427 730)

Rossman, M. H. (1999). Successful online teaching using an asynchronous learner discussion forum. Journal of Asynchronous Learning Networks 3 (2).

Smith, D. R. (1997). Survey and evaluation of hospital websites. Master's research paper, Kent State University. (ERIC Document Reproduction Service No. ED 413 932)

Thüring, M., Hannemann, J. & Haake, J. (1995). Hypermedia and cognition: Designing for comprehension. *Communications of the ACM, 38* (8), 57-66.

Tittel, E. & James, S. N. (1997). *HTML For Dummies.* Boston: IDG Books.

Tullis, T. S., Boynton, J. L, & Hersh, H. (1995). Readability of Fonts in the Windows Environment. *CHI Conference on Human Factors and Computing Systems, '95 Proceedings.* Retrieved March 22, 2002 from the World Wide Web: http://www.acm.org/sigchi/chi95/proceedings/intpost/tst_bdy.htm