Web-Based Portfolios for Technology Education: A Personal Case Study

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A portfolio is a collection of work designed to communicate in various ways about its creator. Art and design professionals have long used portfolios to display their best work for a variety of purposes: to show off their work to prospective employers when seeking admission to colleges and universities; in preparing grant proposals to funding agencies; or seeking approval from a prospective gallery. In addition, art and design educators have long made use of student portfolios for assessment purposes.

The current educational reform movement has generated a frenzy of interest in authentic assessment. As a result, the portfolio has emerged as one of the primary experiments in alternative assessment at every educational level (see, for example, Collins and Dana, 1993; Gordon, 1994; Paulson, Paulson, & Meyer, 1991; Wiggins, 1989; Wolf, 1989). These education portfolios have generally been conventional in nature-containers such as notebooks and folders filled with student work, intended primarily for assessment purposes. In more recent years, portfolios have "gone digital," such as floppy disks on which students store their assignments (Milone, 1995; Moersch & Fisher, 1995; & Niguidula, 1997).

Portfolios do, in fact, provide an excellent tool for assessment. This alone would be reason for more widespread use of portfolios in technology education. But the benefits of portfolios in technology education go well beyond assessment, particularly if the portfolio is conceived of and executed as a Web-based portfolio. Web-based portfolios provide an excellent avenue for "Webworking" (Web page/site development), an area that is not yet, but should be, prevalent in the technology education curriculum.

In the spring of 1995, I began experimenting in my Graphic Communication II class with Web-based portfolios.That semester, I required my communication technology students to represent their course work in a portfolio displayed on the Web. I provided basic instruction in Web page design and development fundamentals and technical specifications, but consistent with Gordon (1994), I intentionally left the details of the execution to the students, rather than provide them with a rigid format. This enabled them to construct and reconstruct their concept of a portfolio as they saw fit-an approach in step with contemporary learning theory. I discovered that the process of designing and producing Web-based portfolios is an exceptional learning experience for students in a variety of ways. This article details the context and findings from this personal case study and offers recommendations and a rationale for the use of Web-based portfolios throughout technology education.

Portfolios in Technology Education

Portfolios and documentation are not really new to technology education. Graphic communication/ communication technology teachers have historically required portfolios to display photographs and printing samples, and more recently computer graphics, storyboards for multimedia, and so forth. Students in materials and processing and manufacturing courses have routinely documented their work with such items. Moreover, technology teachers have often required students to document their procedures and final products for assessment purposes.

Over the past decade, instructional method in technology education has shifted from the project method to the technological problem-solving method. The latter, often referred to as design and technology, involves substantially more of the design process and a corresponding increase in the amount of documentation required throughout all stages of designing, constructing, and evaluating solutions to

technological problems posed. As a result, conventional portfolios have increasingly been used as a way of documenting and displaying student work in the field. Hutchinson, Davis, Clarke, and Jewett (1989) provided a detailed overview of the conventional design portfolio and discussed its purpose, structure, and potential in technology education.

A Web-based portfolio is a transformation of the conventional portfolio to a format that may be displayed on any computer or accessed via the World Wide Web. The development of a Web-based portfolio offers such an array of learning opportunities and benefits that it now makes sense for nearly every student in technology education to develop a Web-based portfolio and continue to add to it in all subsequent technology education classes.

Why Web-Based Portfolios?

The information age is not just a cliché-we're living it! Global networked information systems such as the World Wide Web are changing nearly every aspect of our lives. These technologies should be prominent within our curriculum. Often, they are not. Web-based portfolios offer a meaningful way for technology students to gain a thorough understanding of these critical new technologies beyond mere Web research.

Web-based portfolios provide benefits that can never be realized with conventional portfolios. One vitally important benefit to the future of our profession is the Web and its potential to illustrate the outcomes of technology education programs-especially to those beyond our profession. While the Web is indeed a global medium, the most important audiences are much closer to home: parents, fellow teachers, administrators, and local educational decision makers. We want them to know what technology education is, and there is no better way than to share with them "authentic" evidence of what students are learning and doing in technology education classes.

The Web offers new ways of displaying our work. Conventional portfolios are fine for conventional materials-sketches, drafting, printed materials, and photographs. But the Web allows us new options such as animation, navigation, digital audio/video, virtual reality, and interactivity. In comparison, conventional portfolio techniques limit what's possible.

Everything we create in technology education may be displayed on the World Wide Web, whether it originates in the communication, production, or the energy/power/transportation component of the curriculum. Digital graphics can go straight to the Web. Three-dimensional prototypes may be recorded with a digital camera and displayed on the Web within minutes. Projects/solutions with moving parts may be videotaped, digitized, and converted to Web-viewable formats-such as animated GIFs or digital video. Digital video (DV) camcorders now make it remarkably simple to create digital video, and technologies such as Apple's QuickTime and RealNetwork's streaming software make video display on the Web an increasingly viable option.

There are no compelling reasons why technology education should not be taking full advantage of the opportunities that Web-based portfolios provide. Technology education should be leading this effort in our schools.

Findings

Teaching and Learning

In the spring 1995 semester, I provided students in my Graphic Communication II course (the second in a three-course sequence) with the option of developing a Web-based portfolio. Two students accepted the challenge and created handsome displays of their course work. I was impressed with how much they learned in the process and how well these portfolios communicated about what they had studied in the course. I had provided the basic fundamentals through conventional instruction, and they learned some "tricks" on their own from resources on the Web, as there were relatively few other sources of information at that time.

That fall, with the assistance of one of my undergraduate students, I established a Web site for the technology education program at Virginia Tech. Initially, it fit on a single floppy disk, though it now consumes several gigabytes of server space. Over the winter break, I set up a Web server to house our new Web site and the student portfolios that I now required (Sanders, 1996). The server proved to be relatively easy to set up, providing both my students and me with a host of new learning experiences. Among other things, students learned to upload data to the server with the FTP (file transfer protocol), basic server set-up, and a good bit about cross-platform compatibility. In short, they began to learn how networked information systems work (Sanders, 1999).

Given these initial successes with Web-based portfolios, I began to require them in my

Communication Technology class the following fall (1995) semester. The experiment continued to go very well. About 20% of the students seemed to get "hooked" on the possibilities the Web provided. That very first year, one student created a virtual reality (VRML) component for his "frames" formatted portfolio and included such things as midi audio segments and Java scripts. These were state-of-the-art capabilities at the time, supported only by the latest browser version. I did not teach those tools; he discovered and perfected them on his own. Students immediately began to create Web-based presentations for their in-class presentations in lieu of the more conventional PowerPoint presentations I had been requiring in class. Some students also began making Web-based presentations in other classes when called on to make presentations.

During the semester, students present their Web-based portfolios in class and their classmates and I provide both written and verbal feedback. These reviews cause students to reflect upon their work and upon the structure/aesthetics of their portfolio. Gordon (1994) and Porter and Cleland (1995) have discussed the value of peer feedback and reflection in the development of conventional portfolios. Students have an opportunity to rework their portfolios following these peer reviews, and the results can be dramatic. Moreover, the portfolio presentations often provide students a teaching opportunity, as they explain to their classmates the concepts and technical processes used to accomplish specific aspects of their portfolio.

The Web-based portfolio assignment was rich with problem-solving challenges. Some of the work (e.g., electronic color separations) was difficult to display effectively. Students began to experiment with screen captures, animations, and portable document files (PDF file format) to solve these technical challenges. I began to see the Web as a very powerful environment for the teaching/learning process-better, in some ways, than any I had previously experienced. The Web is the ultimate "facilitative" environment. I discovered, as did my students, that every technological "trick" a student might wish to execute on the Web is documented and often supported (with free tools) on the Web. Thus, motivated students access the information they need to develop innovative portfolios. Some did so voraciously, in a way that I had not previously witnessed in more than two decades of teaching.

In the fall of 1996, I extended the Web-based portfolio requirement "down" to the first course in the Graphic Communication sequence. This allowed students to develop their Web-based portfolios over the three-course sequence, adding to it during each subsequent course. My Web page/site development instruction expanded to include such things as technical and aesthetic design issues, creating and editing PDF files, animations, image maps, frames, copyright, and "fair use" of multimedia. A substantial percentage–perhaps half or more–of my students continue to experiment extensively with Webworking tools beyond those I demonstrate, putting in long hours after class on the assignment.

I continue to extend the offer of free server space (global dissemination) to students whose portfolios meet my expectations for this mode of "publication." People from all over the world regularly access these electronic portfolios from our technology education server (http://teched.vt.edu/).

In April 1999, for example, visitors browsed 15,449 electronic portfolio pages from our technology education server over the course of the month. These Web-based portfolio page "hits" resulted in 61,616 total "requests." Since each graphic on the page represents a "hit," there was an average of 3.99 images/page. This is worth noting, as it gives you some idea of just how "graphically rich" these pages are. Visitors literally get a rich picture of the work our students are doing by browsing these Web-based portfolios. In the process of browsing these portfolios, visitors learn a good deal about technology education and our program. In effect, these Web-based portfolios are the "industrial arts fairs" of the information age.

Elements of a Web-Based Portfolio

A Web-based portfolio is not a "home page"! Home pages that are often required of students in public schools are usually very simple Web pages with links to other "cool" Web pages, illustrated with a variety of "free" graphics copied from the far corners of the Web. Despite the zillions of home pages that have been created in classrooms across America and throughout the world, this exercise is relatively limited in the learning opportunity it provides. There are three fatal flaws to this home page strategy. First, almost no one other than the home page developer is likely to find the linked information to be the least bit interesting or useful. Second, few graphics found

on the Web are copyright free, which means the act of copying them to a home page is a violation of copyright law. Finally, there is very little to be learned from creating a list of Web-links and copying/pasting graphics.

Fortunately, there is a very simple solution to all three problems: students should create every component of their Web-based portfolios. By handling the assignment this way, every aspect of the Web-based portfolio-not just the images of class projects-is a demonstration of the student's potential/capability. This simple strategy solves all copyright issues. If students want a nifty animation for their return mail, or a flashy graphic for their main page, or attractive navigation buttons, they simply create these images. That's where most of the learning takes place. With this in mind, the Web-based portfolio might be viewed and characterized more as a learning activity than as an assessment tool.

Web-based portfolios should begin with an original design. In developing their designs, students should review other Web-based portfolios, making note of techniques and design solutions they like. They should also consult some of the many excellent Web sites that discuss and illustrate good Web design as well as conventional literature along these same lines (see, for example, Siegel, 1996; Weinman, 1997; Williams & Tollett, 1997; or any of the more than 25 links found at http://teched.vt.edu/gcc/html/Webtools/WebDesign.html). They should then develop rough layout sketches for each section of their portfolio and a "site map" for the overall layout. A house or a gallery offers a useful metaphor for conceptualizing the structure of the Web-based portfolio; both should have a welcoming entrance/main page that provides convenient access to the other rooms/sections of the building/portfolio.

Web-based portfolios should include a resume or, for younger students, a personal statement. But putting the resume alone online does not constitute a Web-based portfolio. One-line listings on resumes offer a concise way of communicating basic information, but they do not begin to portray the range of accomplishment afforded by the rest of the Web-based portfolio. Listing a class taken or software applications used means little compared to a well documented presentation of a project/solution created in a technology education course.

From the onset, my intent with the Web-based portfolio was to provide a venue so that students might display work from all of their technology education classes. While not a particularly difficult task, this takes considerable time and careful planning. Images and documentation must be created/saved as students progress through their various courses. All work, both digital and conventional, must be converted to Web-viewable file formats. Regrettably, many students do not find enough time outside of class to prepare work from all of their technology education courses for display on the Web. This will change as we increasingly use networked information systems (i.e., the Web and whatever supplants it) throughout the entire technology education curriculum. One day in the not-too-distant future, documenting course work on a network will be as commonplace as storing work in a notebook is today.

The following are some of the critical insights I have gathered since my first web-based portfolio class. Navigation tools (buttons and menus that allow "browsers" to go forward, back, return to the main page, etc.) are very important in portfolios. It is best to design a simple layout for these buttons and links. They should appear consistently in the same place on each page, so the user may find them easily. This simple rule of interface design made the Macintosh remarkably more "user friendly" than the DOS environment of the PC for a decade.

Each piece of work displayed in the portfolio should be accompanied by a brief narrative description of the process involved in the creation of the work. This is very important because, philosophically, technology education is more concerned with understanding technological concepts and processes than it is with the actual appearance of the final product. In contrast to artists' portfolios, which focus almost entirely on the appearance of the work of art, technology education portfolios should communicate the concepts and processes learned in the process of creating the work being displayed. Technology education is for all students, not just for those gifted in graphic design. Narrative descriptions of process accompanying each work displayed helps to underscore the point to those who view these portfolios on the Web that technology education is about technological understanding. Moreover, writing about the concepts, processes, and techniques employed reinforces the conceptual component of technology education for the students creating the portfolios. This documentation of process is often more telling than

the final compressed images of the work completed, since students gain an understanding of technological concepts and processes through the hands-on work, even if the final picture of the work does not make an award-winning design.

Finally, portfolios should include an "About this Portfolio" section. This is a good place for students to explain that the portfolio was developed as part of a technology education course/curriculum. In doing so, they should name the teacher, school, and the semester year in which the Web-based portfolio was initiated, keeping in mind that the Web-based portfolio may well continue to develop throughout the students' lifetimes. In addition, students might identify tools used and the unique technologies employed to produce this section of their portfolio.

Copyright protects the creator of any work from improper use by others. Technology educators and students need to be aware that most text, graphics, and so forth found on the Web may not be freely used elsewhere on the Web by all who encounter them! Since the creator has the rights to the work until those rights are formally released-which is generally handled by a written contract-most information encountered on the Web requires permission for fair use.

When students display their own work, they will own the rights, and they will begin to appreciate that copyright laws are written to protect their rights as the creator, rather than as a means to punish copyright violators. If all of the work contained in the portfolio is the student's work, there is not any danger of copyright infringement. For those who feel they must use clip-media, there are a relatively small number of Web sites that offer copyright free images and media. Typically, these sites clearly state that the media is "copyright free," and they provide written permission to use this media right there on the site. For a modest investment, technology teachers may purchase copyright-free graphics, audio, and video, and provide these for student use, thereby solving the copyright dilemma for those students who do not have the time or wherewithal to create their own from scratch.

Invariably, students will find copyrighted material on the Web that they would like to use. The "Fair Use Guidelines for Educational Multimedia" (Subcommittee on Courts and Intellectual Property, 1996) were established to assist educators in making decisions about the use of multimedia for educational purposes. In short, while 10% or less of most multimedia text/images/clips may generally be used in educational presentations, putting these same "clips" on the Web for worldwide dissemination is not considered "fair use." Technology teachers and students should become familiar with these guidelines and share them with their students to avoid unnecessary copyright infringement. The complete set of guidelines is posted on a number of Web sites (see, for example,http://www.libraries.psu.edu/ mtss/fairuse/).

Benefits of Web-Based Portfolios for Technology Teachers and Students

One of the most compelling reasons for employing Web-based portfolios in technology education is the outstanding learning opportunities they provide. Just as woodworking projects engaged students in the tools, materials, and processes of the industrial age, "Webworking" involves students with the tools, materials, and processes of the information age. Developing effective Web pages requires an understanding of a wide range of information age tools-design fundamentals, HTML and VRML (both scripting languages used to construct web pages) Java scripts, digital graphics, digital audio, digital video, animation techniques, and so forth. There are Web-development tools aimed at all levels of expertise so elementary technology education students may begin creating Web pages and continue to learn new and more sophisticated tools throughout their middle and high school years.

The Web-based portfolio assignment begins impacting students in significant ways even before they begin to assemble the final portfolio. Just as writing for publication requires more diligence and considerable revision than does writing in one's diary, the possibility of publishing their work on the Web provides students with additional motivation to do quality work in class. Selecting work for the portfolio involves self-assessment. Planning the portfolio requires students to reflect on their work, evaluate it, and revise it for "publication."

Web-based portfolios offer a good opportunity for teaching/learning design fundamentals. Conventional portfolios cause students to ask and answer such questions as: What is the best way to show off the work? How should the work be ordered and arranged? How might color enhance or detract from the work?

Web-based portfolios require answers to similar

questions, but they also provide design challenges that are tempered by the technical specifications and demands of the Web. The opportunities for technical challenges and creative alternatives when developing or converting material for display on the Web are much greater than for conventional portfolios. While basic display of text and graphics on the Web is a relatively simple task, students wishing to go beyond basic Web-portfolio assembly will discover technical challenges as far up the ladder as they wish to climb. Other than the obvious learning opportunities, self-promotion is the primary benefit students will realize from the development of Web-based portfolios. Students may use their portfolios to communicate specific talents and expertise to university admissions officers, scholarship selection committees, and prospective employers. Although providing a marketable skill is not an objective of the Web-based portfolio assignment, significant numbers of students who have created one in my classes have found both part-time and full-time employment as Web site developers.

Goerss (1993) asked middle school students what they liked about creating conventional portfolios. Among other things, students said portfolios helped keep them organized, allowed them to see personal improvement, provided a glimpse of their best work and past accomplishments, and gave them responsibility and choice.

Web-based portfolios benefit technology teachers in many ways as well. Student-developed Web-based portfolios can and should be used to promote what is happening in the technology education program. This can be accomplished by publishing all or some on the technology education program's Web site. Selected images may be compiled into a "gallery" of best work, in much the same way teachers collect and display work at technology festivals.

Technology teachers are increasingly using the technological problem-solving approach, requiring students to design multiple solutions to problems. The Web-based portfolio provides a means of documenting all of the steps along the way in the design process. Portfolios can be a very student-centered activity, particularly for older students who see it as a means of communicating their expertise to others, such as a prospective employer or college admissions officers.

The Web-based portfolio requirement also benefits technology teachers by bringing them "up to speed" with current information technologies. Technology teachers will increasingly face a credibility problem if they do not have basic competence with Webworking tools.

Benefits of Web-Based Portfolios for the Profession

As school systems continue to ramp up to the Internet, it is critical to the future of technology education that our laboratories be included in the school network. Because our facilities are often remotely located within, or even beyond, the walls of the main school building, leaving our facilities out of the network will be an easy way to shave dollars from the networking budget. When and where that occurs-and there is considerable anecdotal evidence that this trend is occurring-technology education will take a giant leap backward with respect to its role and status in education. It is critical that we request/demand network access in our laboratories-and required Webworking is perhaps the best way for us to make the case.

Webworking is becoming a requirement in education. Virginia's Standards of Learning, for example, require all students to be able to create Web pages by the end of eighth grade. This presents an opportunity for our profession. If all middle school technology education students were required to build Web-based portfolios, students could simply enroll in technology education to learn the basics of Webworking. Imagine what this would do for the status/image of the field. On the other hand, if we fail to seize this opportunity, others certainly will.

Since the Web is accessible to nearly everyone in the school and community, and to many across the planet, Web-based portfolios offer unprecedented public relations potential for technology education. Through the Web we can inform/educate parents of our students, potential new students, fellow teachers, administrators, and curious "surfers" about technology education. Given the multitude of ways in which technology education is misunderstood by the public, it is critical that we develop a presence on the World Wide Web, which would help to educate the public about our field (Sanders, 1995). Student portfolios displayed on technology education program Web sites would go a long way toward educating the public and developing such a presence. The resulting influence is global.

Our field has historically used student projects for public relations purposes. The public's image of

industrial arts was linked to the tangible reminders of the "take-home" project and public displays of student work that were so common in our field. The public did not learn of industrial arts by attending our national conference or reading our publications. They learned about us when their children built something tangible and brought it home. By seeing the work of our students in Web-based portfolios, parents and the broader public can begin to understand the content, method, curriculum, and purpose of technology education.

Our field needs the exposure Web-based portfolios provide. We need to share our good work with the public-fellow teachers, administrators, parents, and education decision makers. Without their knowledge and support of our work, we will not achieve what we hope to achieve in education.

Webworking Tools

While the intricacies of hypertext markup language (HTML) once limited Web page development to computer programmers, inexpensive what-you-see-is-what-you get editors now make the process more like word processing than programming. These tools make it easy to display and link graphics and text-the essential skill required for creating a Web-based portfolio. An endless array of freeware and shareware on the Web provides inquisitive and motivated students with the tools they need to create almost any effect that's "do-able" on the Web (see, for example, the Web Tools section of GRAPHIC COMM CENTRAL, http://teched.vt.edu/gcc/). So the tools are readily accessible and cost effective.

Though not absolutely essential, it is desirable for technology teachers to operate or have access to a Web server on which they may post student portfolios. Fortunately, most school systems now operate a Web server. But Web-based portfolios are developed off-line and may be saved on any storage medium (e.g., floppy disk, removable cartridge, CD-ROM, etc.) and displayed/read on any computer, whether connected to the Web or not.

In those cases where technology education teachers/students do not have local server support, there is the possibility of mounting Web-based portfolios on a nonprofit server in the community, on a commercial Web server supported completely by advertising (e.g., www.geocities.com), or on a remote server supported by the profession. The Virginia Technology Education Electronic Publishing Project (Sanders, 1997) for example, hosts Web sites for technology education programs in the state. State departments of education or professional associations can and should provide this service for those who do not have local options in this regard.

Closing Thoughts

Webworking is not yet commonly taught in technology education. My sense is that teacher education programs are not generally teaching or requiring Web-based portfolios of their students, and teachers in the field are likewise shying away from this opportunity. A national study of middle and high school technology education programs (Sanders, 1997a) found that about 40% of the programs had no access to the Internet whatsoever, which would help to explain why Webworking has not yet become a widespread practice in the field.

While many modular laboratories incorporate digital communication activities, most that I have visited were ill-equipped with respect to Webworking–or even Web access-perhaps since Web infrastructure/access cannot be sold/shipped with the other modular laboratory components. My work with the ITEA Section for Communication Technology, GRAPHIC COMM CENTRAL (http://teched.vt.edu/gcc/), and in the field leads me to conclude that relatively little is happening with networked information systems and, more generally, with digital communication technologies of all types in more conventional technology education laboratories/programs.

We do live in the information age. Thus, failure to engage our students in meaningful activities related to networked information systems will have negative ramifications for our profession in the future. The Web-based portfolio is an effective way for technology education teachers, programs, and students to become active and savvy participants in the networked information systems that are transforming our society. Technology teacher educators, public school technology teachers, and curriculum developers should therefore move quickly and decisively to incorporate Web-based portfolios into the technology education curriculum. Doing so would benefit the student, the local technology education program and teacher, and the profession at large. It is an opportunity we should not let pass us by.

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