Visual Design Model (VDM) to Develop Web-Based Instructional Problem-Solving: Teacher's Dilemma

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ABSTRACT

In this paper the design and development of an interactive case, *Teacher's Dilemma*, is described. The underlying concepts and design principles used in developing the Web-based cases are discussed as well as the characteristics of the case. Users of the case were able to access information that pertained to a difficult student, analyze the situation, and provide feedback to the teacher.

We integrated two design methods to achieve our goals: 1) storyboarding and 2) rapid prototyping. Overall, student teachers asked to analyze the situation performed well and were appreciative of the opportunity to use the Web in this manner.
INTRODUCTION

There is widespread interest in the use of the Internet and the World Wide Web (WWW) in learning environments. This interest has become the focus of considerable research about WEB technologies resulting in extensive recognition of the value of hypermedia for educational purposes. Despite this recognition, little appears about the methods employed to design, develop and implement Web-based applications.

Multimedia is the use of text, graphics, animation, pictures, video, and sound to present information (Najjar, 1996). Add to this definition the use of navigation and it is expanded to the term hypermedia.

Development of a hypermedia system is non-trivial and multi-talents are necessary. As stated by Bergeron and Bailin (1996) in an article relative to Web publishing, to lead a multi-authored hypermedia development means to create a common vision by defining 1) the pedagogical objectives, 2) the responsibilities of participants, 3) guidelines, 4) quality control, and 5) the role of supporting technologies. Relative to the project described in this paper, acquiring content is necessarily the first step and one in which a common vision may be defined. To implement the content, however, the design of the instruction is critical to the achievement of pedagogy. We add the need for visual talent or an artistic flare to produce user-friendly screens. Similarly, good technical skills as well as the supporting technologies are necessary to bring a project to fruition.

One of the basic components of the course, Higher Order Thinking for Educators (required of all students majoring in Elementary Education at our university) is a series of case studies. The cases introduce the students to issues encountered by teachers in public schools today and especially challenge their problem-solving skills.

Until recently, these cases had been presented in text format. To take advantage of multimedia, and provide convenience and even greater challenge to students, an online case was designed and developed by a cross-discipline team. The students, dispersed in various locations within Central Pennsylvania, were able to take advantage of the flexibility of the Web relative to time and place of access.

The rationale for the development process is described below as well as the characteristics of the Teacher's Dilemma, the aforementioned case. The development efforts of two students and four faculty members are detailed. In total, the expertise of instructional designers, a content specialist, and technology experts were integrated to design and develop a unique Web-based learning experience.

MEDIA IN EDUCATION

Value of Media to Learning

Numerous researchers have cited instructional technology (IT) as being effective in supporting learning. Cummins (1996) supports IT as being effective due to its ability to attract students by
longer, stronger attention and concentration. Furthermore, Berger (1992) believes that technology is a motivator and tends to create an environment whereby students spend more time on tasks, resulting in better retention. Schank (1993) advocates doing rather than watching and sees multimedia as offering serious improvement within learning environments. Likewise, Yaverbaum, Kulkarni, and Wood (1997) find that, as more and more media are added to content, students become more interested in course material. It is the dynamic, interactive and visual capabilities, according to Crosby and Stelovsky (1995), that enhance instruction.

The former chairman and chief executive officer of Apple Computer Inc., John Sculley, states that multimedia facilitates individualized learning, making students active participants in the learning process (1993). Finally, multimedia combinations appear to support the way people understand, organize, and access information (Najjar, 1996).

In spite of the strong positive effects, Lee and Johnson (1998) suggest that faculty are resisting technological integration. Reasons come from various researchers and include lack of access to resources, lack of rewards, and lack of awareness (Cummins, 1995; Williams and Peters, 1997). Also cited are time constraints, technology anxiety, lack of knowledge about the integration of technology, and lack of support by the administration (Ennis and Ennis 1995-96). Yaverbaum, Kulkarni, and Wood (1997) caution those who integrate media that it must be accomplished within a framework that includes pedagogical objectives and good design principles.

**Web Applications**

World Wide Web (WWW) functions offer flexibility and powerful tools to enrich and change pedagogical profiles of a course (Collis 1997). Collins introduces the concepts of "pedagogical enrichment" and "pedagogical re-engineering" to define the paths one might take to enrich and/or change a course.

*User friendly* is a term bantered by both developers and users of systems. The term refers to the manner in which a user is facilitated by software programs. Nevertheless, what might be friendly for one could not be friendly for another (Nielsen, 1994). Hence, the term *user-centered design* has become more important to the design and development of information systems (Corry, 1997). In sum, Corry supports the principle that user-centered design places attention on the development of products that are usable and useful and that this is accomplished by focusing on the user within the design process.

In this report, we focus on a course both enriched and changed due to the integration of media. Central to its development is not the technology itself but educational objectives, philosophy of the instructor, and software design.

**DEVELOPMENT METHODOLOGY**

Given the advantages of multimedia, the challenges to implementation and development within an academic environment, as well as the need to concentrate on a useful and usable product; four faculty collaborated to come up with a way to develop and implement the Teacher's Dilemma.
The two instructional designers involved in this effort had experience in conceptualizing computer-based instruction and Web applications. Additionally, each had expertise applying pedagogical theory to educational objectives. The course instructor provided case content. On the technology side of the team, both student programmers and the advising faculty member were experienced in developing programs, especially utilizing Web-based languages.

Most systems development projects and subsequent maintenance activities are organized into phases, commonly known in the field as the systems development life cycle (Amadio and Amadio, 1990). The tasks of analysis, design, implementation, and maintenance are each iterative in nature but the phases are distinct and deliverables defined. However, World Wide Web (WWW) development involves working with various media within a visual framework. Experimentation, prompt feedback, and exhaustive iteration are needed. These needs do not blend well with the constraints imposed by traditional development methods, which are sequential in nature and feedback mechanisms are often long.

A traditional design methodology also relies on the completion of requirements prior to programming. Prototyping utilizes modern software development tools to create working models of a system and allows for regular feedback and opportunity for modification (Amadio and Amadio, 1990). Bergeron and Bailin (1996) point out that the necessity of defining an optimum process to realize the maximum benefits from enabling technologies such as the WWW, hypermedia and multimedia content systems. They describe a hypermedia publication development process and outline several critical steps that include defining pedagogical objectives and defining roles of project participants. Prototyping facilitates change, visualization, and evolutionary development. Therefore, we perceived this methodology to be better suited to Web applications.

To work in the most productive manner, the team adopted an approach to development that integrated a methodology borrowed from the entertainment industry, called storyboarding with prototyping. Storyboarding has traditionally been used in two ways to brainstorm and organize thoughts in order to communicate an informational sequence. Storyboarding was first used in the 20s by the Disney staff in designing the sequence of animation gels. They pinned drawings to the wall to keep track of the stages of project completion and, according to Higgins (1995), in the 60s, they realized that "storyboarding was a natural for generating creative solutions to problems" (p.13).

Storyboards for animations, films, or video are usually arranged in columns with headers such as "Video" and "Audio," under which appear drawings describing the visual aspects of that scene and technical directions or dialogue (Bunch, 1991). In addition to flowcharting, storyboarding was included in the design process of computer programming to improve screen design and to reduce computer navigation errors for end users. The headers used can include "Screen" and "Action" (or similar words) where "Action" describes the user inputs required and the consequences of that input.

The storyboarding process has also been adapted as a technique in creative problem solving, where rather than pictures and dialogue, the headers embody ideas and strategies. Headers that stimulate brainstorming might include topics from strategic planning sessions or the main points
from mission statements. After headers are established, ideas are generated and these ideas are subsequently assigned as subtopics under the headers. Relationships between topics become evident as the discussion evolves. In this particular project, the two processes came together. Figure 1 shows the Visual Process Model (VPM), illustrating the process adapted for this project.

**Brainstorming:** Although brainstorming was a regular occurrence, the initial information-gathering involved the identification of parts of the case. The case was reviewed to make certain that all participants understood its content. We used the written text, information gathered in interviews with the instructor, and then simply permitted our imaginations to whirl.

Every member of the team was included in all brainstorming sessions. Ideas related to design were discussed. For instance, it was agreed that the online version must be creative, engaging, interactive, and apply several media. The content specialist was especially important at this stage. Her vast experience with problem-based learning added greatly to the combined team effort.

One particularly critical need during this time was assisting the content specialist visualize the potential of the technology. While she had experience with case-based problem solving, she had little experience with the Web and associated technologies. In this particular situation, the subject matter expert was also the client. Thus, it was imperative that we educate her about the capabilities of Web-based training. Specifically, it was critical that she comprehend the nonlinear nature of the Web and its interactivity capabilities. At this time, no attempt was made to determine exactly how concepts would be presented. Rather the team concentrated on comprehending the case and its various aspects.

**Storyboard:** The storyboard in effect became a funnel to the prototype. Capturing the essence of these sessions, we developed a board, a portion of which is shown in Figure 2. We adapted a typical storyboarding situation, as described above, to capture the transformation of the written case to a proposed screen design and related actions. The left side of the storyboard frame is a textual excerpt from the actual case. The middle portion of the board represents the proposed screen design that encompasses both graphics and text. On the final and right board are actions to be integrated into the design.

**Rapid Prototyping:** To prototype means to develop an executable version of a product which integrates key elements of a final version but is incomplete in many respects with the primary purpose being to conceptualize the final product (Jones, Li, and Merrill, 1992). By rapid prototyping we envision a process where one quickly builds and evaluates a series of prototypes (IEEE, 1989).

This phase of the process involved an actual working model of a portion(s) of the storyboard. The subgroup of student programmers with the faculty advisor worked to produce the prototypes for subsequent review sessions. Various tools used for this project were Asymetrix® ToolBook, Hypertext Markup Language (HTML), JAvaScript™, and JAVA™ applets. The first prototypes were primarily developed in ToolBook and exported to the Web. As animation and interactive segments were integrated into the product, language constructs were included.
Team Review and Feedback: Prior to development, we discussed the need for forthright feedback and were particularly concerned that our student developers would be offended by faculty critiques. However, this concern was unfounded and the students soon felt comfortable debating design and programming issues during these sessions.

Prototypes were reviewed biweekly and this rapid feedback provided our student programmers with information to develop the next prototype. The total project development lasted more than a year.

PRODUCT

The Teacher's Dilemma is an interactive learning environment designed to improve problem-solving skills, specifically for student teachers. The system is constructed such that students will learn to evaluate alternatives and make decisions. The first screen, or Home, pictured in Figure 3, facilitates linking between key sections that include the main part of the case itself, online instructions, and a credit section. Each section is turn is founded upon a similar concept, i.e. the linking of information sources. Students are able to approach information in whatever manner is most comfortable for them.

The screen display in Figure 4 shows how instructions are provided related to case navigation. Figure 5 is a still display of an animated screen and depicts the thoughts of the teacher involved in the dilemma. Two additional screens are shown in Figures 6 and 7. The former shows the problem student's report card, one of many records embedded within the case, while the latter screen is one in which students, after analyzing the situation, return comments to the course instructor.

INITIAL FEEDBACK

Attitudinal assessments were administered to the forty-nine student teachers, the first group to test the case. A Likert-type scale, ranging from 1 - 5, was employed with "1" being Very Poor and "5" being Very Good. Anonymity was assured, no identifying marks were placed on the surveys, and participation in no way influenced course grade. Table 1 shows these scores.

The feedback supplied by student teachers was overall positive. The highest student rankings were in the categories of "realistic," "pictures added meaning," and "informative." "User-friendly instructions" received the lowest rankings, albeit the overall result was still quite positive. In the next iteration, we will concentrate on making our instructions clearer.
DISCUSSION

We consider this project to be a successful development effort. The Visual Process Model (VPM) provided a powerful means of communication among team members. Perhaps one of the most important contributions is proof that a successful application, well-designed and incorporating strong pedagogy, was possible with minimal cost in money and time. Contributing to the success of project was 1) the careful of people for the development team, 2) regular review of prototypes and 3) the cross-discipline approach.

The University supported the purchase of peripheral hardware and support for a student intern. By sharing responsibilities, time constraints were minimal for each faculty member and this made participation by talented, non-tenured faculty possible. Student developers were given credit for their work, a small stipend, and each felt that the experience was one in which they gained substantial experience.

In the future, we plan to integrate computer conferencing to provide a collaborative environment. The current case utilizes feedback mechanisms between student and teacher but this addition will create the opportunity for discussions to expand to include student to student collaboration.


Figure 1
Visual Process Model (VPM)
For WEB Development
Figure 2
Story Board

Teacher’s Dilemma Storyboard

<table>
<thead>
<tr>
<th>Case</th>
<th>Screen</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Teacher's Dilemma" /></td>
<td>Title screen with running marquee. Left frame - menu links. &quot;Credits&quot; link goes to Development Team, &quot;Instructions&quot; goes to instructions, and &quot;Case Study&quot; goes to Background.</td>
</tr>
</tbody>
</table>

**Background**
There are several characters appearing in this case, so perhaps we should learn a little about them before we begin. Click on a picture below to review background information.

**Jefferson Elementary School is** in Riverston, a medium-sized city in the Northeast with a diverse population of about 65,000. The school district serves about 6,000 students.

Lower left menu bar allows user to access any part of the case non-linearly. Scrolls down to allow 11 selections. Background screen in main frame provides links from each name or picture to document about that character. When a picture is clicked, goes to that character's background information.

A header describes the subject, followed by the image, and then the information which may or may not be relevant to the case. An arrow at the bottom of the
Figure 3: Main Page

Figure 4: Instructions
Figure 5: Animated Teacher Thoughts

Driving Home
Driving home that afternoon, Melissa was thinking about her class, Jimmy, and the conversations with her fellow teachers.

Figure 6: Report Card
### Table 1: Student Rankings of Key Variables

<table>
<thead>
<tr>
<th></th>
<th>Student Average Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content of Study:</strong></td>
<td></td>
</tr>
<tr>
<td>Memorable</td>
<td>4.24</td>
</tr>
<tr>
<td>Realistic</td>
<td>4.47</td>
</tr>
<tr>
<td>Thought Provoking</td>
<td>4.41</td>
</tr>
<tr>
<td><strong>Computer as a Medium:</strong></td>
<td></td>
</tr>
<tr>
<td>Pictures Added Meaning</td>
<td>4.59</td>
</tr>
<tr>
<td>User Friendly Instructions</td>
<td>4.12</td>
</tr>
<tr>
<td>Ease of Navigation</td>
<td>4.22</td>
</tr>
<tr>
<td><strong>Comparing Paper to Computer</strong></td>
<td></td>
</tr>
<tr>
<td>Interesting</td>
<td>4.22</td>
</tr>
<tr>
<td>Enjoyable</td>
<td>4.37</td>
</tr>
<tr>
<td>Informative</td>
<td>4.63</td>
</tr>
</tbody>
</table>