A Model for Integrating Technology and Learning in Public Health Education

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Abstract

As computer interfaces emerge as an instructional medium, instructors transitioning from the classroom continue to bear the burden of designing effective instruction. The medium of the computer interface, and the kinds of learning and interactive possibilities it affords, presumably changes the delivery of learner-centered instruction. Strategically, teachers not only need instructional design ability, but they also need competence with human-computer interaction design. In addition, instructors and instructional designers need to be able to bring these two domains together, if they are to create truly learner-centered instruction using new media. This article focuses on how a team comprising an instructor and multimedia instructional developers collaborated to create a distance learning environment for a graduate course in public health. The authors will describe the workflow that the team used, focusing specifically on the integration between instructional design and human-computer interaction design frameworks as well as how the team approached design issues by incorporating various HCI theories. The authors will also show what insights the team had after a year and some of the strategic changes it made in light of them for the next.

Keywords

E-Learning, distance learning, instructional development, design, production, multimedia, video, technology integration strategies, instructional design, scenario-based learning, interactive systems, new media, direct manipulation, interaction design, interface design, contextual design, user profile and modeling, user experience, usability, participatory design, HCI.

Background

In 2001, the Department of Applied Health Science in the School of Health Physical Education and Recreation [HPER] at Indiana University began utilizing information technology in all of its graduate level courses, as a part of its eventual goal to implement a Public Health certificate in a distributed education format. The initiative combines a mandate from the department, faculty financial support from School administration (in the form of a competitive stipend award), and instructional consultation and development support from the School's pedagogy and instructional technology support office. The combination of human and financial resources into a shared vision has been critical to the initiative's success.

"Program Planning," a 500-level course, was the first to be implemented in a distance learning format, which the department believed would allow students to spend more time engaged in public health practice and service learning activities. Also, by delivering the course via distance learning, the course would be more attractive to public health professionals and other non-degree students throughout Indiana. In other words, the choice to use the distance learning format stemmed from two sources, one educational (emphasis on professional practice over classroom work) and the other merely pragmatic (ability to meet the needs of a geographically diverse group).

The ADDIE Model for Graduate Public Health Education: An Iterative Approach

The course development team used the ADDIE (Analyze, Design, Develop, Implement, and Evaluate) model of instructional design to manage the course development process. This process included student/user profiling, the formulation of teaching and learning objectives, constructing a blueprint for targeted instructional tasks, designing an attractive user interface, development of interaction designs, production of identified learning activities using various multimedia development tools and appropriate programming languages, learning application

testing and usability studies, and finally the evaluation of the quality and effectiveness of both the instructional design and the learning applications.

Analyze: Learner Analysis and User Modeling

Effective learning application design begins with learner/user research. For our team, this occurred on two levels: the instructional design level and the HCI level. For the former, we were concerned with what the students would already know, what they were there to learn, and so on. For the latter, we were concerned with their level of comfort with technology and their overall experience engaging with high-level work in a computer environment.

Mike Kuniavsky, an HCI specialist, defines "user research" as a process that consists of "a consistent, rapid, controlled, and thorough method of examining the users' perspective" (Kuniavsky, 2003). The practice of a successful user-centered design, which enables designers to take into account the users' perspectives and ethnographical research during the design process, results in user experiences that are engaging, effective, efficient, and positive for users (Garrett, 2003). In addition to understanding basic information about the students (i.e., graduate students between the age of 25 and 40 in public health program) and what they need to learn (i.e., the process of developing public health interventions in order to positively affect the health-related behaviors of individuals, groups, and communities), the team devoted special attention to identifying the users' computing inclinations as well as their perception of the use of distance learning as a learning format.

The course design team implemented a Web-based survey on potential users at this stage to obtain a more accurate computing user profile for the learning application.

	Sample Questions
Technology Inclination	Hours per day spent using computers
	Hours per day spent using the Internet
	Personally own a computer
	Preference of location using computer
Distance Learning	Prior experience with distance learning
	Perception of using distance learning format for this course
	Motivation of finishing different distance learning course components
	Most comfortable format for course assignment

Table 1: *Sample Questions for User Profile Survey*

Through the study of behaviors and motivations of real people, the user profile survey provided us with a descriptive model of the users (i.e., their social and physical environments, their relationships with one another, etc.) and what they hope to accomplish in class. The survey indicated that the majority of the prospective learners had prior experience with distance learning format, over the Internet or via CD-ROM; more than 50% of the participants indicated the highest level of excitement about the prospect of taking the course in a distance learning format, and only 15% expressed concern. Most of the users owned a personal computer and felt comfortable using it for communication, learning, and other aspects of their lives. The ethnographic nature of the survey made it possible for the course development team to develop user models, or "composite archetypes" (Cooper, 2003), and create a context for potential learners (Beyer & Holtzblatt, 1998), which guided the course design team's decision in translating learner profiles into an overarching design framework for the course, especially in areas such as course components, learning tasks, and interaction design.

Design: A Two-Way Approach to Transcoding Learning Content to Bytes

Scholars of media studies from McLuhan (1964) to Manovich (2001) have challenged the notion that we can separate the message (in this case, instructional content) from the medium (in this case, from the classroom or from a multimedia CD-ROM). Instead, they argue that the medium itself profoundly shapes and even constitutes the message. Others posit that the "embodiment" of information in a medium affects cognition as well: "embodiment makes clear that thought is a much broader cognitive function depending for its specificities on the embodied form enacting it" (Hayles, 1999, p.xiv). Manovich calls the mutual interactions that occur when content is expressed in digital media "transcoding," which is the encounter between the "culture" and "computer" layers. If these critics are right, then it follows that simply translating instructional design intended for the classroom to instructional design

intended for Web- or CD-ROM-based learning is unlikely to succeed. The team's goal, therefore, was to integrate HCI and media theory into the systematic instructional design process (as described by Gagné, Briggs, & Wager [1992] and Smith and Regan [1993]) from the beginning. Instructional design entailed media design.

The "Program Planning" course for public health was in part based on competencies outlined by the Council of Education for Public Health. One of the primary instructional goals of the course was to ensure that students developed these competencies. Two course components were identified to fulfill this goal: unit lectures that explain key concepts and principles of program planning, and interactive, skills-based application exercises. Where the lectures were to introduce concepts, the exercises would enable students to apply those concepts in scenarios based on real-world situations, providing students with the opportunity to practice problem-solving techniques (Gagné, Briggs, & Wager, 1992). The performance-based scenarios supported the practical orientation of the course, bringing about immediate and successful applications of the course content (Kindley, 2002). While it has been suggested that instructor-centered presentation of materials should be used sparingly (e.g., Crowl et al., 1997), given the nature of the course and the delivery format, the instructor opted for initiating each learning unit with a topic-based, content-intensive lecture that guided students through the learning process. Nonetheless, these lectures were but a part of a much larger, and more diverse whole, which included interactive exercises, practice questions, and a learning community.

The instructor was active in building a dynamic learning community that engaged a diverse range of students throughout the course in order to foster critical thinking skills through the weekly peer-discussion of current public health issues. The instructor was careful in reinforcing the targeted learning objectives of the week through online discussion forums that not only provided the appropriate context for the discussions, but which also encouraged in-depth dialogue on current topics of public health challenges. Scheduled events and regular office hours were conducted in the format of real-time chat to provide students with more opportunities for instructor-learner and learner-learner interactions as well as a sense of immediacy and presence (Kim, 2000).

With the broad parameters of the instructional and interaction design established, the team next turned its attention to translating these general plans into a concrete learning application. At this stage, the findings of the user studies were particularly helpful, as the team engaged in several pre-production design preparations prior to coding: paper prototypes (Boling & Frick, 1997; Beyer & Holtzblatt, 1998; Snyder, 2003), information architecture (Wodtke, 2003), and storyboards, all with an aim to obtain cost-effective (both in terms of time and effort) user feedback to inform the directions of both interface and interaction designs. These activities enabled the course development team to render visually what the users would see and do and articulate what the users would experience. Prototyping carries many benefits: it engages different stakeholders (both the designers as well as the users) in the active participation throughout the design process; it enables an effective iterative design process until the design concept is stabilized so as to minimize the squandering of resources. All told, the empirical emphasis placed upon pre-production activities such as paper prototypes, storyboards, or information architecture provided more reliable guidelines for the course development team for interaction design (Dillon & Zhu, 1997).

Assessing the effectiveness of the prototypes again required the team to gather evidence concerning the prototypes as learning applications and also the prototypes as software applications. The team looked for a combination of both usability goals (effectiveness, efficiency, safety, utility, learnability, and memorability) and user experience goals (satisfaction, enjoyment, fun, entertainment, helpfulness, motivation, aesthetics, reward, etc.) (Reece, et al., 2002). In particular, the course development team followed four interaction design imperatives as suggested by Reimann, Dubberly, Goodwin, Fore, & Korkan (cited in Cooper & Reimann, 2003):

Design Imperatives	Definition	Goals
Ethical Design	Considerate, helpful	▪ Do no harm ▪ Improve human situations
Purposeful Design	Useful, usable	▪ Help users achieve their goals and aspirations ▪ Accommodate user contexts and capacities
Pragmatic Design	Viable, feasible	▪ Help commissioning organizations achieve their goals ▪ Accommodate business and technical requirements
Elegant Design	Efficient, artful, affective	▪ Represent the simplest complete solution

		▪ Possess internal (self-revealing, understandable) coherence ▪ Appropriately accommodate and stimulate cognition and emotion

Table 2: *Interaction Design Imperatives*

As with many user interface and interaction designs, the learning application for the "Program Planning" course is based on the principle of *direct manipulation* of graphic objects (e.g., buttons, icons, function controls, etc.) on the screen (Cooper & Reimann 2003). The incorporation of direct manipulation in design enables the visual representation of manipulatable objects, replacing the user's reading of text with the user's own physical actions in that dataspace, and above all, the immediate demonstration of the result of the manipulation (Shneiderman cited in Cooper & Reimann, 2003). Direct manipulation helps move the student out of the comparatively passive role of reader and into the more performative role of doer. Abundant feedback was also important: given the intrinsic learner-directedness of the CD-ROM as a delivery format, the course development team felt a sense of urgency to design a learning application that frequently provides immediate and adequate visual feedback (so as to minimize the feelings of frustration, confusion, or being overwhelmed). Interactive graphical interfaces change the user experience from computer as tool or prosthesis to computer as space or environment (Johnson 1997). The team felt that the spatial metaphor was consistent with the instructional design emphasis on practice and performance.

Development

To ensure the timely delivery of the learning application and allow ample time for evaluation and redesign, it is important to construct a realistic project schedule that clearly identifies a list of milestones and concrete deliverables such as content, graphics, audio, video, programming snippets, and so on (Lee & Owens, 2000). To facilitate the managing and tracking of development progress and enhance the communication and collaboration among team members, in addition to regular project meetings, the course development team also used a Web-based project management tool, PHPCollab, to facilitate the development process. Because it was Web-based, the tool could be accessed via any browser connected to the Internet, which was convenient, because our team was often spread across different locations and operating systems. The project management tool enabled the team to monitor development activities and make necessary adjustments to development efforts in general and development tasks in particular. Image 1 and 2 illustrate the interface of this Web-based project management tool.

Implementation

One major challenge the course development team faced was to find a balanced, robust distance learning environment to meet the diverse learning objectives of the course. Knowing that many early efforts at distance learning were less than successful, in part because people tried to replicate the classroom experience too literally (Stevens-Long & Crowell [2002]), we tried, in the words of Siegel & Kirkley (1997), to be "computer imaginative"; that is, we strived to create learning designs that uniquely took advantage of the computing medium. Specifically, the team took advantage of its multimedia and asynchronous communication capabilities.

After two versions of design and refinement, the finished integrated learning application included the following components:

Multimedia Course CD. Blending video, audio, and user interaction, the course CD, authored in Macromedia Flash, served as the primary learning tool for this course. The Program Planning course was, compared to other courses, content-centered and skills-based. We felt that a multimedia CD provided diverse means of enabling students to engage and interact with, rather than simply read, course content.

The course CD was divided into 10 learning units. Each unit consisted of the following four components: 1) Lecture: An introductory video clip of the instructor providing an overview of the unit objectives, followed by unit content, in the form of audio-narrated slides with text, graphs, figures, and animations to facilitate learning. 2) Application exercises: Various interactive tasks that students perform to apply what they learned in the lecture. Completed exercises are captured and stored in the learning system for the duration of the session, making it possible for students to compare their work with solutions recommended by the instructor. 3) Self-test: An ungraded quiz that enables students to assess how well they accomplished the stated learning objectives. Upon completion, the correct answers and explanations are displayed side-by-side with the students' answers. 4) Resources: The instructor provided additional resources, including articles, Web sites, and research findings relevant to the unit. Images 3-7 show the course CD in its first generation, and images 8-13 show it in its second iteration.

The Internet Component. The course CD is strong at learner-to-content interaction, but working through a CD on a computer is an intrinsically solitary experience. Yet much of public health education is collaborative. To embed meaningful human collaboration into the course, we also integrated Oncourse, a Blackboard-like course management system as a shared learning space to foster collaborative learning. Students used its synchronous and asynchronous, formal and informal communication features to collaborate with their peers.

In addition, Oncourse was used for web-based surveys and exams throughout the semester to assess student learning.

Face-to-Face Interaction. Based on student feedback and a series of assessments conducted in 2002, in the second year of offering the course, the instructor built in bi-weekly and monthly face-to-face learning activities in 2003 to increase students' access to instructor and fellow students. The instructor-guided activities consisted of site visits to community health centers, mock program planning and promotion development, debates on public health program-planning issues, public health participant/provider matching games and so on. As the course has evolved, the instructor's role has gone from traditional office hours and email availability to guiding/modeling real-world health program planning problem-solving, blurring the distinction between instructor and students.

Finally, to ensure long-term improvement of the project, the instructor and development team actively involve students to in the development and revision of the learning tool itself. This embedded recursiveness ensures that the team had opportunity to learn from the course and improve it in future iterations. The embedded evaluation process for the tool is two-fold:

Ongoing Conversation about Technology and Health Promotion. Students are encouraged to engage in the ongoing discussion about their impressions of the potential benefits and limitations of information technology in the field of public health program planning and promotion. Special attention is devoted to the implications for different cultural groups and/or those with limited access to and/or experience with technology. The discourse not only raises the issue to the attention of all who participated, it also shapes the future offerings of the course. For example, some students noticed the lack of diversity in the images we used, and we were able to make appropriate changes based on their feedback.

Learning and Technology Component Suggestions and Development. In an effort to involve users in the ongoing refinement and (re)designing effort of the course, the course development team adopted the "participatory design" approach (Beyer & Holtzblatt, 1998; Shneiderman, 1998) to bring about more accurate information about user inclination and needs, and above all, to increase user acceptance of the learning application. Students are required to critique all aspects of the learning application individually and provide suggestions on how best to improve the tool in both the pedagogy and technology areas. As part of the course requirement, students need to design at least one application exercise for a particular learning unit and develop 5 questions to contribute to the self-test question bank. In addition, the students are paired in groups to envision a relevant multimedia piece or interactive learning activities that target a particular aspect of public health program planning. Throughout the process, the course development team works with students closely to provide consultations, training, and necessary resources. At the end of the semester, not only do the students improve technically and know what it takes to integrate technology in the field, these efforts also result in a library of student-centered learning applications that the instructor and the development team can use in the ongoing revision of the learning tool, with a diversity that supports a broader range of learning styles.

Evaluation

Evaluation of instruction is important in any instructional setting, but it was especially important for this project, because this was the first offering of this class in a distance learning format; it was the first time the instructor had designed for a distance learning format; and we brought together an interdisciplinary collection of theories (instructional design, HCI, and media studies) and experts (the instructor, instructional designers, multimedia authors, and programmers). To ensure adequate evaluation, the course development team introduced evaluation at every stage of the process, from early prototypes through end-of-course evaluations. These evaluations reflected our interdisciplinary approach, seeking to learn not only about how the participants learned, but also how their attitudes toward technology changed.

Using various evaluation methodologies such as "Quick and Dirty" evaluation and usability testing (Reece et al., 2002), the course development team focused on several key issues in particular during the evaluation stage: learners' ability to comprehend and apply knowledge, comparison of learners' attitudes towards distance learning before and after the course, the time needed for the learners to prepare for and complete each learning unit (vs. that

for the same class offered in the traditional setting), learners' perception of instructor availability, learners (users) and learning tasks; learners'/users' interaction with the learning application, etc.

For example, the course development team learned from the first year of the offering that students felt disappointed about the lack of interaction with each other and with the instructor, and we used a blended learning approach and introduced regular meetings (once or twice per month) with the instructor as well as many mini group projects. While most students felt comfortable using course CD and the Internet, at the beginning of each offering, we designed a technology orientation session to introduce all the components to ensure technology does not become a hindrance in students' learning process.

Adaptation

In spring 2004, the instructor and the development team began to repurpose this learning application for all public health providers in Indiana. The content that is suitable mainly for higher education, as opposed to the more generalized needs of all public health providers in the state, was removed and the interface was modified for the different user group. The final result represents how an integrated learning tool designed for higher education can also be used to meet the needs of practitioners. In spring 2004, hundreds of this modified version of the learning application were distributed across the state. Images 14 to 18 show the pubic health providers' version of the learning application.

Summary

The "Program Planning" project demonstrates it is essential to integrate sound pedagogy practices (i.e., appropriate instructional design principles, learning strategies, etc.) as well as HCI practices (i.e., user modeling, usability, prototyping, evaluation, etc.) and media theory to ensure a successful learning experience in the domain of distance learning. The multidisciplinary, team-based methodology in approaching both instructional and system design challenges results in a more holistic final product that reflects the theories and practices of a number of relevant domains.

References

Beyer, H., & Holtzblatt, K. (1998). *Contextual Design: Defining Customer-Centered Systems.* San Francisco: Morgan Kaufmann Publishers.

Boling, E. & Frick T. (1997). Holistic Rapid Prototyping for Web Design: early Usability Testing is Essential. In Badrul H. Khan (Ed.), *Web-based instruction* (pp. 221-224). Englewood Cliffs, New Jersey: Educational Technology Publications.

Cooper, A., & Reimann, R. (2003). *About face 2.0: the essentials of interaction design*. Indianapolis, Indiana: Wiley Publishing, Inc.

Crowl, T.K., Kaminsky, S., & Podell, D. M. (1997). *Educational psychology: Windows on teaching.* Madison, WI: Brown and Benchmark.

Dillon, A. & Zhu, E. (1997). Designing Web-based instruction: a human-computer interaction perspective. In Badrul H. Khan (Ed.), *Web-based instruction* (pp. 221-224). Englewood Cliffs, New Jersey: Educational Technology Publications.

Garrett, J. (2003). *The elements of user experience: user-centered design for the Web.* Indianapolis: New Riders.

Gagné. R. M.. Briggs, L. J., and Wager, W. W. (1992). *Principles of instructional design*, fourth edition. Fort Worth, TX: Harcourt, Brace Jovanovich College Publishers.

Hayles, N. Katherine. (1999). *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago: University of Chicago Press.

Johnson, S. (1997). *Interface culture: how new technology transforms the way we create & communicate*. San Francisco: Basic Books.

Kindley, R. W. *Scenario-based e-learning: a step beyond traditional e-learning*. http://www.learningcircuits.org/2002/may2002/kindley.html

Kim, A. J. (2000). *Community building on the web*. Berkeley, California: PeachPit Press.

Kuniavsky, M. (2003). *Observing the User Experience: A practitioner's guide to user research.* San Francisco: Morgan Kaufmann Publishers.

Lee, W. W. & Owens, D. (2000). *Multimedia-based instructional design: computer-based training, web-based training, distance broadcast training.* San Francisco: Jossey-Bass.

Manovich, L. (2001). *The language of new media*. Cambridge, Massachusetts, The MIT Press.

McLuhan, Marshall. *Understanding Media: The Extensions of Man*. Critical Edition (2003). Corte Madera, CA: Ginko Press.

Reece, J., Rogers, Y., & Sharp, H. (2002). *Interaction design: beyond human-computer interaction*. New York: John Wiley & Sons, Inc.

Shneiderman, B. (1998). *Designing the user interface: strategies for effective human-computer interaction*. Reading, Massachusetts: Addison Wesley Longman, Inc.

Siegel, M., & Kirkley, S. (1997). Moving Toward the Digital Learning Environment: The Future of Web-based Instruction. In B. H. Khan (ed.), *Web-based instruction* (pp. 263-270). Englewood Cliffs, New Jersey: Educational Technology Publications.

Snyder, C. *Paper prototyping: the fast and easy way to design and refine user interfaces*. (2003). San Francisco: Morgan Kaufmann Publishers.

Smith, P. & Ragan, T. (1993). *Instructional design*. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Stevens-Long, J., & Crowell, C (2002). The Design and Delivery of Interactive Online Graduate Education. In K. E. Dudestam & J. Schoenholtz-Read (Eds.), *Handbook of Online Learning*. Thousand Oaks, California: Sage Publications, Inc.

Wodtke, Christina. (2003). *Information architecture: blueprints for the Web*. Indianapolis: New Riders.