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Heuristic task analysis on e-learning course development: a formative research study

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Abstract Utilizing heuristic task analysis (HTA), a method developed for eliciting, analyzing, and representing expertise in complex cognitive tasks, a formative research study was conducted on the task of e-learning course development to further improve the HTA process. Three instructional designers from three different post-secondary institutions in the U.S. were selected for interviews. The interviews focused on three e-learning course development cases (one from each institution), and the participants were asked to articulate their underlying thoughts and principles for designing e-learning courses. Overall, the HTA process worked well in the sense that the study could elicit procedural steps and sub-steps involved in e-learning course development and heuristic knowledge with which the instructional designers performed each step. On the surface, the e-learning course development processes that the instructional designers used looked more alike than different, entailing major steps such as meeting with faculty, developing content, monitoring courses in progress, and debriefing the instructor and students. The underlying principles and knowledge that guided each instructional designer through the processes, however, were unique in that each instructional designer constructed her own heuristics to accommodate the myriad contextual factors that arose in her work setting. The study also discussed the challenge of identifying the simplest yet most representative e-learning course development case with multiple experts and suggestions for further improving the HTA process were also presented.

Keywords Heuristic task analysis (HTA) · Formative research · e-Learning course development · Instructional design · Higher education

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Introduction

As the information age evolves, distance education in general and e-learning in particular becomes more and more important in our educational landscape. The interest in e-learning is widespread from K-12 schools to corporations worldwide, but as indicated in the 2003 survey by the National Center for Education Statistics, the higher education sector is probably the most rapidly growing market for e-learning industry. Thus, the development of e-learning courses that is pedagogically sound and cost-effective is of special concern for many researchers and practitioners in post-secondary institutions.

On the surface, because e-learning has become so prevalent in higher education and the advantages of e-learning seem so powerful, proponents of e-learning assume that we know how to develop successful e-learning courses and that we have an accurate understanding of the processes we seek to support and enhance. As the history of instructional media shows us, however, technological potentials do not easily transfer into direct educational benefits (Cuban 1988, 2003; Zhao and Parks 1995). Indeed, developing e-learning courses that lives up to the standards of traditional face-to-face instruction is certainly more complex and much less hopeful than a surface view would reveal (Carr-Chellman and Duchastel 2000).

There is a flourishing body of literature on both the pros and cons of e-learning. Still, many researchers have criticized the fact that the vast majority of the pros and cons are recollections and opinions about how to develop e-learning courses rather than systematically gathered research data to help us make informed decisions in this overheated debate (Bannan-Ritland et al. 1998; Khan 1998; Ritchie and Hoffman 1997; The Institute for Higher Education Policy 2000). These recollections and opinions can be helpful to the extent that they can provide useful insights, but what would be even more helpful is to find experienced instructional designers who have successfully developed quality e-learning courses and identify the underlying knowledge and skills that guided their performance. What would be helpful above all else is to capture the "heuristics" of these instructional designers and make it broadly available to interested instructional designers and faculty in higher education (Lee 2004).

Thus, the purpose of this study is to explicate the heuristic knowledge underlying the performance of experienced instructional designers by addressing the following research questions: (a) what heuristic knowledge underlies expert e-learning course designers' performance when they develop e-learning courses in post-secondary settings? and (b) how does the heuristic knowledge of one instructional designer differ from that of other instructional designers?

This study has three important implications for the field of instructional design and technology. First, as a result of analyzing experienced instructional designers' performance and underlying heuristics, we will gain a better understanding of e-learning course development as a task domain. Second, the study outcome provides practical guidelines to help less experienced practitioners to develop e-learning courses more effectively and efficiently. Last, the study utilizes the HTA process and formatively evaluate its effectiveness in uncovering experienced instructional designers' heuristics, which will help further improve the HTA methodology to elicit, analyze, and represent heuristic knowledge across disciplines.

Theoretical framework

Formative research is a kind of developmental or design-based research that is intended to improve instructional design theory (Lee and Reigeluth 2003). By intentionally instantiating a case in which the HTA process was applied, this study attempts to collect formative data and examine the strengths and weakness of HTA in uncovering heuristic knowledge of experienced instructional designers when developing e-learning courses. Therefore, our focus is not to confirm the HTA process but to improve it by providing a rich description of a case.

Research on expertise in instructional design

In a thorough discussion of modern decision theories, Zachary and Ryder (1997) note: "…human experts do not make decisions in an analytical manner, indeed or even in a conscious manner, but rather apply their accumulated experience and knowledge (collectively called their expertise) to identify and effect the most appropriate action" (p. 75). Hence, expertise refers to all the various kinds of knowledge that an expert draws upon, explicitly or implicitly, in performing a task.

Such expertise typically goes far beyond procedural knowledge to include heuristics, principles, mental models, and guidelines, especially for complex cognitive tasks such as e-learning course development. The tacit and heuristic nature of this kind of expertise makes it particularly difficult to analyze and transmit to others, and indeed, the experiences and insights of instructional designers have not been fully utilized to guide the practice, and there is a need for research studies that systematically attempt to identify, analyze, and formalize the tacit knowledge underlying the e-learning course development process.

Analyses of expert performance across a variety of domains have demonstrated the following commonalities (Le Maistre 1998): (a) experts can process information faster than novices due to their rich, well-organized knowledge bases in the domain, (b) experts tend to focus on the deeper level of a problem and its underlying structure during their problem-solving process, and (c) experts recognize meaningful patterns in a problem more easily than novices since they have a larger repertoire of trouble shooting strategies from previous experiences.

These commonalities are also found in studies of expert performance in the instructional design field, and according to Perez and his colleagues (Perez et al. 1995), expert instructional designers approach the task somewhat differently than novices in terms of problem-solving patterns, speed, and memory capacities. They have also revealed that expert instructional designers rely on case-specific strategies in guiding the design process. Still, researchers such as Atchison (1996) and Rowland (1992a, b) have raised concerns about the lack of systematic investigation of the gap between the actual instructional design process practiced by experts and so-called instructional design models, urging the need for further developing understanding and methods of capturing the quintessence of expert practice. They have argued that a significant portion of the instructional design process varies from the commonly held, "rational" (or procedural) view of instructional design and represents a reflective and creative process based on observations of the iterative, cyclical, and ad hoc design processes used in practice.

Previous studies of the broader instructional design process present ample opportunities for replication in the field of e-learning course development. However, few research studies have focused on the performance of expert instructional designers and identification of what constitutes expert practice in e-learning course development, leaving significant need for additional research.

Heuristic task analysis

Heuristic task analysis (HTA) is a method developed for eliciting, analyzing, and representing expertise in complex cognitive (or "heuristic") tasks (Reigeluth 1999). *Heuristics*, mostly known as rules of thumb, educated guesses, or intuitive judgments, stand for strategies and criteria for deciding the most effective courses of action among several alternatives in problem-solving situations (Pearl 1984). Thus, *heuristic tasks* are "tasks for which experts use causal models—interrelated sets of principles and/or guidelines—to decide what to do when, such as a high school course on thinking skills or a corporate training program on management skills" (Reigeluth 1999, p. 435). As our society in general and the workplace in particular become more complex, our abilities to deal with heuristic tasks become more critical than ever before. Thus, powerful methods for analyzing knowledge underlying complex, heuristic tasks are in great need.

Traditional task analysis methods typically result in a list of tasks and sub-tasks stated in behavioral terms and framed in a procedural format (Gordon and Gill 1997; Ryder and Redding 1993). In contrast, the HTA method primarily focuses on analyzing relatively complicated, ill-structured tasks for which experts use such heuristic knowledge as principles, causal models, and guidelines to decide what to do when, instead of being aware of and deliberately following a set of steps.

The HTA is conducted by asking the question "What is the simplest version of the task that an expert has ever performed?" and "What is the next simplest version?" and so on. Identifying the boundary of the simplest yet still representative task dramatically reduces the amount of knowledge and number of contextual factors that are necessary for expert performance. More importantly, starting with the simplest version allows analysts to study the phenomenon of expert performance under controlled conditions and to do so in a reliable fashion (Ericsson and Charness 1997). Once the simplest version is analyzed, then progressively more complex versions of the task can be determined and analyzed in order to identify the additional knowledge that an expert uses to perform them. (For more detail, see Appendix 1.)

To summarize, a review of the literature on e-learning course development indicates a gap between the need for advancing our knowledge about developing quality e-learning courses and the methodologies that enable us to do so. The HTA process shows promise for generating more useful knowledge about how to develop e-learning courses.

Methods

The task selected for analysis in this study is the development of e-learning courses in university settings. e-Learning course development has some procedural but mostly heuristic elements, and this study identifies both, with particular focus on the latter because they have been found to be more pervasive in this complicated process that involves numerous variables and design considerations (Julian et al. 1999; Lohr 1998).

Selection of participants

Previous studies addressing the issue of amassing sufficient numbers of experts for knowledge acquisition advise that the scope and depth of interviews eventually depends on the purpose and practicality of any given study (Shadbolt et al. 1999). Since the purpose of this study is to identify in-depth heuristics of experienced instructional designers in developing e-learning courses, rather than to generalize the heuristics, we interviewed fewer instructional designers, just enough to avoid idiosyncrasy, and interviewed each participant in more depth until the saturation point was reached.

For conducting the HTA (see Appendix 1), we identified three instructional designers. Table 1 summarizes the qualifications of each participant.

Table 1 Participating instructional designer profiles

Name	Title	Institution	Highest degree earned	Years of experience
Catherine	Instructional designer	Purdue University	M.Ed. (Instructional Technology)	6
Michelle	Instructional designer	University of Northern Iowa	M.Ed. (Instructional Design)	7
Anita	Instructional designer	University of South Florida	M.Ed. (Instructional Design)	6

Note: Pseudonyms were used for all participating instructional designers

Data collection methods

Interviews

Like most knowledge elicitation studies involving human experts as data sources (Hoffman et al. 1995), in this study, semi-structured, in-person interviews were used as the primary data collection method. Each participant was interviewed a minimum of three and maximum of five times, for about 60–90 min each time. It was estimated that a total of 30 h would be necessary to elicit the in-depth heuristics of all participants. This was a tentative, approximate number of hours that was based on an estimate of expected reasonable depth of coverage of the expertise given the purpose of the study. The number of interviews for each participant was adjusted in the course of the investigation (Merriam 1998). In other words, the interviews were continued until a point of saturation or redundancy was reached.

The interviews with each participant centered on eliciting information about the simplest version of the task that she had designed and delivered. This allowed us to understand the case-based reasoning that was used by the participant to identify and represent her expertise (Schank 1982, 1989). In previous case studies, we found that using a specific case as a basis of discussion was instrumental to explicating tacit knowledge through using a well orchestrated array of observations, descriptions, and probing questions (Lee and Reigeluth 2003). The HTA offers a set of interview questions for probing the participant's heuristic knowledge for performing the task of e-learning course development. We were not restricted to the predefined questions, and the overall interview process was flexible, emergent, and reflective in nature. In other words, depending on the strengths and problems of the initial interviews in identifying task expertise, we revised the HTA method for each subsequent interview. The HTA method is an iterative process, which means that finishing the first round of HTA is not the end of the study but the beginning of the second round of HTA; and the end of the second round is, again, the beginning of the third round; and so on.

Data analysis and interpretation

Triangulation

For more thorough data and greater breadth, this study involved multiple experienced instructional designers as data sources. The task of e-learning course development is often perceived as collaborative teamwork requiring more than one person (i.e., instructional designer) for completion. When comparing findings from the interviews with each participant, we encountered situations in which different participants approached the same problem with totally different solutions that were equally effective. In those cases, rather than trying to seek a single best solution, we tried to identify the different conditions under which each solution worked well.

Member checks

After each interview with a participant, the first author transcribed the interview and brought a summary of the interview and tentative interpretations to the next interview for review prior to the next interview. Through this process, the participants corrected her errors and misconceptions about their expertise, and she had a chance to ask additional questions to clarify the data already collected.

Three e-learning course development cases

This section reports findings from three e-learning course development cases. Each case begins with a description of background information (i.e., program/course setting and expert biography); next, it explores procedural and heuristic knowledge identified by the participant; and it concludes with a discussion of case-specific findings.

Case 1: e-MBA program at Purdue University

The e-MBA program at the Krannert School of Business, Purdue University, was a 6-year-old, fully accredited, e-learning executive MBA program in Food and Agricultural Business. As an alternative to traditional part-time executive MBA programs, the e-MBA program heavily utilized e-learning technology allowing full-time working professionals to pursue degrees. The program consisted of four semester modules, 22-weeks each, and students progressed in a cohort of 25 by taking three courses per semester. Although the majority of faculty–student and student–student interactions occurred online, the program did have residency components. Students were required to be on campus for 9 weeks during their program, including 1 week, on-site orientation and 2 weeks every semester.

Catherine was an instructional designer at Purdue. Since she had accepted the position of Distance Education Specialist for the e-MBA program in early 2000, she had guided faculty through the process of transforming face-to-face courses into Web-based courses, managed course delivery for two ongoing student cohorts, and provided technical training. She was in charge of every course in the program and had designed and revised 26 e-learning courses.

Catherine held a BS degree from Purdue's Hospitality and Tourism Management program and a master's degree in instructional technology. Her corporate background and strong interpersonal skills suited her well for working with faculty, understanding her unique student clientele (who were full-time working business managers), and meeting their collective needs.

The course Catherine identified as the simplest yet most representative of her e-learning course development work was "Applied Quantitative Analysis." This course explored the application of contemporary concepts and quantitative techniques for decision making in the context of food and agricultural business management. Applied Quantitative Analysis had been taught for 2 years by the same instructor with students of 16 and 27, respectively, and was initially developed by another instructional designer. There were numerous student complaints about the original course, mainly due to its complex, unorganized interface and unrealistic student workload. Thus, Catherine worked with the faculty to restructure the existing e-learning course with a more intuitive interface and redesigned student assignments.

The e-MBA Program at Purdue seemed to be organized primarily around a business model of marketing and command-and-control management, which had a huge impact on how Catherine approached the task of e-learning course development. Her e-learning course development process was built on corporate ideas about customer (i.e., student) focus, course standardization, tight personnel control and cost effectiveness (maximizing student outcomes while minimizing the "inputs" of faculty and development time), rather than on particular learning theories or pedagogical beliefs.

Compared to less standardized processes where individual designers create e-learning courses in ways that may not be easily understood by other designers, this business-like model sets clear standards and thus seems to be more reliable in case of high turnover among instructional designers.

When designing an e-learning course, Catherine's first priority was customizing design and delivery to meet the needs of students who worked full-time in addition to taking three courses per semester. She designed courses based on a course template that allowed consistency across courses. This minimized student time and effort to learn about new course structures and navigation schemes as well as the course development time and effort for her. Faculty members also seemed to like this standardized process as they perceived e-learning courses as a part of the e-MBA program "package." Catherine seemed to have more control over the design of courses than she admitted when working with faculty.

Since the profitable e-MBA program was self-sustained and Catherine was the only instructional designer in the program, she could afford whatever she wanted or needed to do when it came to incorporating the newest technologies. She was rather minimalistic, however, and did not see the need to always adopt the newest technologies.

Case 2: Continuing Education and Special Programs at the University of Northern Iowa

Since 1996, the University of Northern Iowa offered e-learning courses through the Continuing Education and Special Programs (CESP) to expand access to educational offerings for students who lived beyond commuting distance and wished to pursue degrees or update their knowledge in specific content areas. Students who took e-learning courses through the CESP were mostly in-service teachers working on their master's degrees. As a cohort, they usually registered for one course per semester, and it took them up to 3 years to complete the program.

As this study was completed, more than 20 departments from four schools offered credit and non-credit e-learning courses at both undergraduate and graduate levels. The CESP provided each course with technical, instructional, and administrative support. Problems related to hardware/server access were handled through the WebCT support unit; a full-time instructional designer and a graphic designer assisted faculty with converting course materials to Web format and uploading to WebCT. The program office took care of course logistics such as advertising, student registration, management of course records, and fee collection.

Michelle was an instructional developer with the CESP at the UNI. She had developed numerous e-learning courses since 1997: she began as a graduate student, assisting faculty with e-learning course development, and later accepted a staff position and became a full-time instructional designer. She found her educational technology background helpful in terms of providing theoretical understanding; her most valuable asset as an instructional designer, however, was her experience as a distance student; she considered herself "self-taught" in e-learning course development to take something good out of her experience in poorly designed e-learning courses. Michelle held a master's degree in educational technology from UNI. Prior to her current position, she worked at a community college, developing face-to-face courses and conducting technology application workshops.

The course Michelle identified as the simplest yet most representative of her e-learning course development work was "Communication Theory in Media." Exploring contemporary theories of mass communication, learning, perception, and propaganda as they apply to message design utilizing communication media, this course was an elective in the master's program in Educational Technology and a required course in the Master's program in Communication and Training Technologies. There were approximately 20 students enrolled in the course at the time of this study. About half of the students were teachers at various locations in the state of Iowa working on their master's degrees e-learning, and the other half were residential graduate students.

In previous semesters, this course had been only taught face-to-face and always by the same instructor. Like most WBI courses she designed, Michelle was given 2 months to work with the instructor and coordinate its design and delivery. The graphic designer who recently had joined the CESP provided assistance with graphics (i.e., course banner and customized icons for the course website), but Michelle did most of the work, including consulting with the faculty member, converting existing course materials, designing the course website, and training the faculty.

"Efficacy" and "student-centeredness" seem to be the words to best describe Michelle's strategy for developing e-learning courses. Having developed more than 120 courses for the CESP during the previous 4 years, she had constructed a system that enabled her to produce quality e-learning courses while coping with a large volume of work and tight timelines. Her strategy was to differentiate parts of work that needed to be customized from those that could be standardized. Consultation meetings with faculty and tracking students' previous coursework are examples of "customization," which was time-consuming and thus labor-intensive but crucial for quality assurance. Time-savers like the course development protocols (i.e., formatting and editing guidelines) or step-by-step tutorials represent the standardized aspect of her e-learning course development process and were geared toward extreme efficacy and error-proof communication with her clients (i.e., faculty and students).

As a student taking up to two courses every semester, Michelle had a realistic understanding of how much work students could handle in a single course, the challenges they encountered, and the types of support needed to thrive in e-learning learning environments. Combined with her 'bird's-eye-view' of the program, her authentic experience as a distance student seemed to increase the credibility of her advice to faculty members when suggesting ways to accommodate student needs and urging adjustment of weekly readings/assignments.

Case 3: The Educational Outreach division at the University of South Florida

The vast majority of distance learning initiatives at the University of South Florida grew rapidly in terms of both student enrollments and technology integration since 1998, and most e-learning courses were coordinated through the division of Educational Outreach. Anita joined Educational Outreach as a graduate assistant in 2000. Since then, she had provided course support for faculty teaching e-learning courses and guided the design and delivery of numerous e-learning courses at USF. As professional instructional designer, her major responsibilities included meeting with faculty to discuss design issues and e-learning options for their courses, acting as liaison between faculty and the USF library to secure copyright permission for content, helping faculty prepare and upload materials to course websites, and maintaining/updating/trouble-shooting websites.

Anita earned her degrees (B.A. in Mathematics and M.Ed. in Instructional Technology) from USF. She was also a licensed vocational nurse and dialysis technician, and had served the United States Air Force at Travis, CA, as a medical service specialist until she went to college for her post-secondary education.

The course Anita identified as the simplest yet the most representative of her e-learning course development work was "General Chemistry (I)." This course explored principles and applications of chemistry such as properties of substances and reactions, thermo-chemistry, atomic-molecular structure and bonding, and periodic properties of elements/compounds, and it was a multiple-section course taught by six different instructors. Since it was a required course for every first-year student in the chemistry department, more than 1,000 students (200 students for each section) were enrolled at the time of this study.

General Chemistry (I) was problematic to convert e-learning because of its volume; there has been some improvement in terms of WebCT server capability, but at the time Anita was working with the instructors, the server could not handle 1,000 students accessing a course shell at the same time. Thus, the course was structured utilizing a main course shell which served as an umbrella website for the entire class and was linked to separate course shells for each section.

As indicated by the bold university-wide policy about supporting two major learning management systems (LMS) (i.e., WebCT and Blackboard), the USF was keen about being on top of the latest learning technologies, and Anita had ample opportunities to experiment with various tools and examine the strengths and weaknesses of each tool. She took an eclectic approach when selecting development tools for e-learning courses, and throughout interviews, she emphasized that instructional designers should consider LMS as versatile and useful tools to choose from their open toolbox when developing e-learning courses.

It was also evident from interviews that Anita underscored the collaborative nature of e-learning course development. According to her, e-learning course development requires a wide range of knowledge and skills, including instructional and curriculum design, multimedia production, consulting and counseling skills, and project management. The CITI provided her an ideal work setting in this regard because she could collaborate with her peer instructional designers and support staff members at various stages of course development.

Comparison of findings across the three design cases

This section highlights commonalities and differences in findings from the three e-learning course development cases.

Influencing factors

When asked to identify major factors that affect task difficulty in developing e-learning courses, all three participants responded that faculty, students, and content (i.e., types and amount of course materials) were the most important considerations.

Faculty

The participants were unanimous in confirming that faculty was probably the most crucial factor to consider when developing e-learning courses. The underlying reasons why each participant considered faculty important in e-learning course development, however, differed depending on her context. Catherine was concerned about the mindset of individual faculty. She put considerable effort in creating a consistent design across the curriculum and disseminating best practices of e-learning pedagogy. Thus, individual faculty members' openness to take suggestions and adopt previously established program standards was important for her role as the program instructional designer. For Michelle, given the large volume of courses assigned to her each semester, the timeliness and cooperation of faculty to provide course materials and feedback became a critical factor. Anita took a role as consultant when working with faculty. Her priorities were meeting individual faculty members' needs and desires as well as those of students, so she considered faculty members' ability to conceptualize their courses and communicate their needs most important.

Students

It is not surprising that all three experts identified students as another crucial factor in determining their approaches to e-learning course development. Whether face-to-face or online, every decision instructional designers make is informed by who their audience is, and the three cases studied were no exceptions. Besides student prerequisites and individual learning styles that are usually considered important in the learner analysis literature, student experience with the particular programs that they were enrolled in and with other e-learning courses as well as their technical proficiency and access to equipment/bandwidth became factors for e-learning course development. Especially when students were taking courses as a cohort, as in the cases of Catherine and Michelle, designing courses for second- or third-year cohorts became much easier because they could assume the level of student knowledge based on courses students had (or had not) taken.

Course contents

For Catherine and Anita, content was considered an important factor because, depending on the types or amount of materials to be converted or created for e-learning, the production time and effort could vary from a matter of 1–2 day(s) to up to 2–3 months. Michelle was more concerned with how much time she needed to develop a new course; but considering that the types and amount of materials (e.g., video or audio components) ultimately affected how much time she could spend on the design, it was evident that content was an important consideration for all three participants.

Program settings

The participants selected for this study came from mid-sized to large state universities offering e-learning courses. Anita worked with peer instructional designers, but both Catherine and Michelle were solely responsible for developing every e-learning course in their programs. Still, the programs where Catherine and Michelle worked were contrastive in many ways: the e-MBA program was much smaller, cohort-based, and customized for business managers with high mobility, while the CESP handled a large volume of students and courses for cohorts of teachers pursuing their master's degrees in various education majors. Educational Outreach, where Anita worked, offered credit courses at both graduate and undergraduate levels, as well as non-credit courses. These differences affected the priorities with which each expert approached e-learning course development.

Procedural knowledge in e-learning course development

The steps or sub-steps in e-learning course development identified by the participants remained consistent across all three cases, except for some minor details intended to accommodate case-specific requirements such as on-site orientations or 2-week residency. When designing a new e-learning course from scratch, all participants went through similar processes: (a) some sort of preparation to gather course information prior to meeting with faculty, (b) initial consultation meetings with faculty to learn about the course and the instructor and discuss course objectives, readings and assignments, student activities, and grading, (c) course development, where course materials were converted to digital formats, chunked and paced into weekly modules, and course logistics were determined, and (d) ongoing monitoring for course delivery and faculty training where they updated and maintained the course website and assisted with technical trouble shooting for the course throughout the semester.

Overall, Catherine and Michelle perceived the e-learning course development process as more standardized and reiterative than Anita did. This might be explained by the way each program was set up. Both Catherine and Michelle supported faculty at departmental or program levels, which increased the likelihood of repeatedly working with the same faculty members. Since all faculty members were from the same department or program and worked with the same cohorts of students, it was easier for both experts to recycle the e-learning course development process once they found a system that worked for their context.

Dissimilarly, Anita supported faculty at the university level, which means her clients might be faculty members from any discipline, and the courses assigned could be at the graduate or undergraduate level, and for credit or non-credit. Thus, she seemed to be more sensitive and accommodating to individual faculty member's needs and to have embraced more "unknowns" than the other two participants.

Heuristic knowledge in e-learning course design

Relationships with faculty

In all three cases, the participants underscored the importance of building a trusting relationship with faculty to succeed, and the methods or heuristics each participant used to establish rapport with them varied. Catherine took instructors to lunch as a way of building interpersonal relationship with faculty and presented herself more as a coach, rather than a disciplinarian, to make constructive suggestions. Michelle used frequent and direct communication as a means of building mutual trust. Anita discretely utilized her networking with other instructional designers and support staff members to learn about particular faculty members and get advice on working with "problem faculty."

The fact that all three participants identified faculty as the most influential factor when developing e-learning courses and that a significant portion of heuristic knowledge elicited during the interviews was about establishing successful relationships with faculty indicates that the task of e-learning course development is about interpersonal relationships between the instructional designer and faculty as much as it is about instructional design and technology.

Student workload

As Carnevale (2001) reported, students taking e-learning courses tend to be easily overwhelmed, dealing with new technology and course interface, higher expectations/demands from the instructor, job and other commitments in addition to taking e-learning courses, and isolation from their peers and the instructor. It was evident from interviews with all three experts that they were cognizant of this issue and developed their own heuristics to moderate student workload throughout the semester. For example, Catherine came up with faculty guidelines which suggested that students could not spend more than 20 h a week for all three courses combined. She also advised faculty to be aware of the "flow of the semester" and consider reducing student readings and assignments before and after the intensive 2-week residency period. Similarly, Michelle shared her experience as a distance student and helped faculty establish a more realistic understanding of how much work students could reasonably handle in a single course.

Design of course interface

"Less is more" was a common theme across all three cases when the participants designed the interface for e-learning courses. This minimalist (or functional) approach to interface design is nothing new, and Web design gurus like Nielsen (1999) and Shneiderman (1998) have long advised that the first principle of good design is to understand users' needs and try to eliminate difficulties they might encounter while navigating.

Whether the LMS participants used were developed in-house or commercially purchased, the experts streamlined the course interface, deleting or inactivating all extra tools to minimize student confusion, and used only four or five basic features that were crucial to navigating the course website. For example, Catherine applied the same course design template ("course outline"–"lectures"–"discussion forum"–"assignments/grades") to every course she designed, and so did Michelle with her own selection ("content modules"–"communication tools"–"grades"–"tutorials").

Role of instructional designer

According to the *Chronicle of Higher Education*, many universities and colleges venturing into e-learning have created instructional support units to help faculty transform their face-to-face courses into online versions, and some administrators believe that instructional designers should have some expertise in a given discipline, as well as skills and experience in project management and instructional design (Carnevale 2000).

Given the large volume and variety of courses they handle in practice, however, it is unrealistic to expect instructional designers to be knowledgeable in every e-learning course content area they design. Among the three experts, Catherine's Hospitality and Tourism Management background was the closest match for the courses in her program (Food and Agricultural Business Management), but overall, the instructional designer's subject matter knowledge was not considered crucial to developing e-learning courses.

The role of instructional designer varied from one case to another, which seems to reflect how each program was set up. On one end, Michelle worked with faculty members who taught courses through the CESP, and her assistance was largely limited to creating course materials and setting up courses in WebCT. This was primarily a consequence of the sheer number of courses she handled every semester. Although she initially provided each faculty member with individual consulting, delivering a course was ultimately considered the instructor's responsibility, and once the semester began, she did not get involved with the course except for mechanical/technical trouble-shooting.

Conversely, Catherine was hands-on with faculty throughout the course development process, from advance planning to actual delivery. The e-MBA program consisted of four semester modules, and each course was an integral part of those modules. The program also had some program-specific requirements such as a 2-week residency during each semester and grading stipulations. Catherine's job was not only developing e-learning courses, but also assuring that every course in the program met all program requirements and maintained consistency as a part of the whole e-MBA program package.

For Anita, course involvement fell somewhere between the other two. The CITI was loosely structured in the sense that it was not associated with a particular department or program but provided assistance to any faculty member on request. She treated each faculty member as a client and focused on his or her needs when designing courses. Technological infrastructures and staffing in each institution also seem to be a factor in determining the role the instructional designer played. The resources of the CITI team, which consisted of multimedia specialists, graphic designers, and computer programmers, as well as her peer instructional designers, enabled Anita to act as an instructional design consultant, directing her clients to various delivery options to best suit their instructional needs.

Regardless of differences, when developing e-learning courses, all participants demonstrated the ability to use heuristics to achieve the following goals: (a) to recognize and flexibly cope with contextual constraints to meet the needs of faculty, students, and the program/unit, (b) to best utilize available resources (e.g., technology infrastructures and campus-wide support structures), (c) to draw from their unique backgrounds (e.g., corporate backgrounds and experience as a distance student) as well as their training as instructional designers, (d) to maintain integrity and rigor in their courses by assuring interactivity and quality control, and (e) to plot and pace content and activities according to the "flow" of courses.

Reflections on findings

The HTA applied to this study yielded both procedural and heuristic knowledge that guided the three participants' performance in e-learning course development. When we further analyzed and categorized the elicited knowledge by topic areas, however, we found relatively few heuristics related to instructional design compared to other areas such as interpersonal relationships, project management, and program/curriculum design. There may be several explanations for this lack of instructional design principles and guidelines emphasized by the participating instructional designers, and this section approaches this issue from three different angles (a) selection of participants, (b) implications of using LMS in e-learning course development, and (c) contextual factors that constrained the e-learning course development process in each case.

Selection of participants

The type and significance of knowledge that can be elicited from the HTA may vary depending on the areas and depth of expertise of participating experts. Thus, the selection of qualified experts is crucial to ensure the integrity and usefulness of elicited heuristics as outcomes. The HTA does not address this issue in enough detail, however, and the biggest challenge for conducting the HTA in this study was related to selecting "experienced" instructional designers, and more specifically, what selection criteria to use and how to recruit the participants.

Although there have been several research studies attempting to systematically investigate expert performance in instructional design (Rowland 1992a, b; Atchison 1996; Le Maistre 1998), few of them provided details and guidance concerning the selection of experts.

The participants for this study were selected based on their relevant knowledge and experience and they can be described as experienced instructional designers representing current best practice in e-learning course development. Still, there is no evidence to systematically verify the quality of their e-learning courses in terms of pedagogical value, which may explain the lack of their emphasis on instructional design guidelines during the interviews. It is our hope that this study will encourage others to conduct additional research to improve the available guidance for expert selection in the HTA process.

Implications of learning management systems

As LMS become an indispensable part of the academic-computing infrastructure on most campuses, it is presumed that commercial LMS such as WebCT or Blackboard are used for the development and delivery of more than one-fifth of all college courses (Olsen 2001). The three e-learning course development cases studied were no exception to this trend, and either in-house or commercial LMS were used to develop e-learning courses by all participants.

The built-in tools and templates available in LMS spared the experts' time and effort for creating e-learning syllabi/outlines, assignments, discussions, quizzes, and grade books from scratch. However, the findings indicate that the instructional decisions that the experts made during the design process were colored by such systems, and we further argue that the pre-defined course interface and existence (or non-existence) of features to support specific activities compromise the flexibility and creativity of the e-learning course development process used by each participant.

Case-specific constraints

Through the three cases studied, it was clear that the work settings where the participants practiced e-learning course development had an impact on how the participants approached the e-learning course development, and more specifically, each case had context-specific constraints that pulled the participants from practicing more creative and reflective development processes. For example, the limited time and the large volume of courses assigned to Michelle each semester forced her to spend most of her time and effort on the production and management side of the e-learning course development process, leaving her little room for focusing on pedagogical decisions. Compared to Michelle, both Catherine and Anita had more flexibility and resources to work on individual courses. However, the tightly laid-out curriculum and the demand from the program to satisfy a particular clientele (i.e., full-time working professionals taking three courses per semester) kept Catherine from exploring diverse instructional means for creating unique and customized learning experiences in each course and reinforced her to follow a rather standardized process. Similarly, the types and depth of instructional activities that Anita could incorporate when she designed self-directed, non-credit e-learning courses were somewhat limited because of the program's emphasis on content/information, rather than on activity/learning.

Implications for e-learning course development

The use of e-learning technologies in distance education is burgeoning, and the practice of professional instructional designers assisting faculty in converting their classroom teaching into e-learning courses is an important part of this development. Still, there are few studies that closely examine the everyday practices of instructional designers and identify their heuristic knowledge to benefit a broader interested audience (e.g., less experienced instructional support staff, faculty members who want to develop e-learning courses on their own) (Carnevale 2000; Julian et al. 1999; Le Maistre 1998). The findings of this study contribute to the body of knowledge in e-learning course development and untangle some of the myths and misunderstandings about the practice of instructional designers in higher education.

In earlier development of the e-learning course development field, researchers and practitioners raised their concerns that the new trends and practices in e-learning course development might inhibit, rather than promote, good education by interfering with faculty independence in developing and teaching courses, unbundling the faculty role into different (and often less qualified) personnel in developing the curriculum, teaching the course, and assessing student outcomes (Carr 2000; Feenberg 1999; Schifter 2000).

However, the findings from these three cases indicate that working with a professional instructional designer improved the integrity and quality of e-learning courses in at least three ways: first, faculty members went through timely, rigorous course planning to re-examine their course preparation and delivery for teaching online; second, they often benefited from having someone with more experience with distance students and the program and thus were able to build their course activities on students' previous knowledge and experience; and last, the instructional designer provided them with ongoing technical support and often worked as an arbitrator between faculty and students, enabling faculty to concentrate on their teaching rather than course maintenance and technical trouble shooting.

Implications for the HTA

Overall, the HTA interview protocols worked well in the sense that we could elicit steps and sub-steps involved in e-learning course development and heuristic knowledge with which the experts performed each step. At the same time, we also faced challenges when trying to identify the simplest and most representative e-learning course development case.

As Chipman and his colleagues argue (Chipman et al. 2000), most tasks involve both observable (or "procedural") and tacit ("heuristic") knowledge. Arbitrarily separating one type of knowledge from the other is unlikely to enhance our understanding to improve task performance. Thus, during the interviews, we addressed both procedural and heuristic elements of e-learning course development and found that a significant portion of heuristic knowledge was triggered when associated with procedural elements.

All three experts seemed to have difficulties identifying the simplest yet representative case in e-learning course development. They found it difficult to cover enough depth and breadth of heuristic knowledge based on a single case. Thus, it was useful to ask them to think about ways the specific case fell short of how it should have been done (an ideal case for this version of the task) and to have them offer guidelines for how this specific case should have been done.

The HTA suggests that the task analyst interview multiple experts and identify the simplest version of the task based on consensus among the experts (Lee and Reigeluth 2003). However, it was difficult to have the three experts all think of the same case because their realms of knowledge did not overlap one another due to the differences in their program settings (e.g., student base, content areas, and resources). Thus, each expert was asked to identify the simplest version of an e-learning course development case that represented her work regardless of the versions that the other experts identified, and we treated each case as a separate version. It was also beneficial to periodically ask each expert questions about the chosen case, to keep the analysis focused on the flow of that version of the task.

Previous studies on the HTA (Reigeluth et al. 2000) suggested the use of supporting materials to help experts recall details about the task performance for use as points of reference. However, all e-learning courses developed by the three experts were housed within LMS and were password-protected. To preserve the instructor's intellectual property and anonymity, we had limited access to course websites and were able to see the materials only when the experts were present to provide a password for their courses. Since we could not take anything away (e.g., capturing screen shots), asking content-specific questions or referring to a certain section of the course outside of in-person interviews was a challenge. Free access to the course websites would have been helpful to save interview time and effort as well as to increase accuracy in communicating with the experts over the phone or e-mails.

Furthermore, given the collaborative nature of e-learning course development, selecting faculty members who worked with experts and including interviews with them might have been helpful in eliciting more detailed, authentic heuristic knowledge. Also, additional guidance for interviewing experts while they interact with faculty might be beneficial.

Most task analysis methods were developed for and tested with procedural tasks and the HTA method is one of the relatively new alternatives to analyze more complex cognitive tasks. We believe the most helpful research issue at this early stage of HTA is not to prove the methodology but to *improve* it. It should be noted that the applicability of HTA beyond the three development cases described in this study remains to be investigated. We hope others will join our efforts to improve HTA and provide further guidance for analyzing heuristic knowledge across domains.

Appendix 1: Summary of the HTA method[1]

Phase I. Prepare for analysis and design

1. Decide on a task to analyze and be clear about your reasons for analyzing it.
2. [Make sure you (the analyst)] have enough task knowledge to have a good command of terminology and key ideas.
3. (Make sure you) have enough knowledge about the intended uses of the task description.
4. Arrange to interview multiple experts.
5. Establish rapport with, and introduce the HTA process to, the first (and each additional) task experts.
6. Prepare for the interviews.

Phase II. Identify the simplest version of the task

7. Identify the simplest version. Hold a focus group interview with multiple task experts, and help them to reach consensus about the simplest version of the task that is fairly representative of the task as a whole. Also help them to describe the conditions that distinguish that version from all other versions.
8. Analyze the heuristic knowledge. With the least experienced expert that you have not yet interviewed, analyze the heuristic knowledge (mostly principles,

[1] For more detail, see Lee and Reigeluth (2003).

causal models, and guidelines) for this version of the task.

With the task expert, review a record (or any other visual aid) of this version of the task.
Ask the task expert to think of and describe one specific performance of this version of the task to focus on for your analysis, or ask if a videotaped performance would be a good case for you to focus on with the expert during the analysis as a form of case-based reasoning.
Decide whether to use a top-down or bottom-up approach to analyzing the knowledge upon which the expert's performance is based). If top-down, use Step 8.4 and skip Step 8.5. If bottom-up, skip Step 8.4 and use Step 8.5.
If top-down approach, start by identifying the general categories of knowledge that the expert uses, then proceed to analyze each.
If bottom-up approach, ask the expert to describe each decision that s/he made and the process through which s/he went to make each decision.
Ask the task expert to think of similar performances of the task that are within the realm of the version of the task you are currently analyzing. Use each such performance (case) to broaden the steps, guidelines, explanatory models, descriptive models, and metacognitive/decision rules so that they represent the knowledge bases the expert uses to deal with all performances for that version of the task.

9. Repeat this entire process (Steps 5–8.6) with the next least experienced task expert to identify any alternative views of the task and the knowledge that underlies its performance.

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