This Issue:

Tools of the Trade: The Role of Perceptions and Context in Designing and Developing Instructional Learning Aids
   by Sherry Kollman and Patricia L. Hardré

A Case of Wikis and Contradictions: Activity Systems, Classroom Community, and Instructional Design for Collaborative Online Learning
   by Lisa Marie Johnson and Roderick Sims

Virtual World Problem-centered Challenge Evaluation
   by Jennifer A. Maddrell, Ginger S. Watson, and Gary R. Morrison

Integrating Student Analysis of Error into the Design of Customized Online Modules for Teaching a Topic in Business Statistics
   by Jayson Kunzler and D. Sammons

Teaching Online and Blended Courses: Perceptions of Faculty
   Joseph Madaus

Training for Impact on Sexual Harassment: A Case Study in Applied Learning Theory
   by William Swann
Contents:

Guest Editorial
by Wilhelmina C. Savenye, Associate Editor

Tools of the Trade: The Role of Perceptions and Context in Designing and Developing Instructional Learning Aids
by Sherry Kollman and Patricia L. Hardré

A Case of Wikis and Contradictions: Activity Systems, Classroom Community, and Instructional Design for Collaborative Online Learning
by Lisa Marie Johnson and Roderick Sims

Virtual World Problem-centered Challenge Evaluation
by Jennifer A. Maddrell, Ginger S. Watson, and Gary R. Morrison

Integrating Student Analysis of Error into the Design of Customized Online Modules for Teaching a Topic in Business Statistics
by Jayson Kunzler and D. Sammons

Teaching Online and Blended Courses: Perceptions of Faculty
by Joseph Madaus

Training for Impact on Sexual Harassment: A Case Study in Applied Learning Theory
by William Swann
About
The Journal for Applied Instructional Design
ISSN: 2160-5289

JAID STAFF
Senior Editor: Leslie Moller, Ph.D.
Associate Editor: Wilhelmina Savanye, Ph.D.
Associate Editor: Douglas Harvey, Ph.D.
Assistant Editor: Benjamin Erlandson, Ph.D.
Production Editor: Don Robison

EDITORIAL BOARD
Andy Gibbons, Ph.D., Brigham Young University
David Richard Moore, Researcher and Author
Wilhelmina Savanye, Ph.D., Arizona State University
MJ (Mary Jean) Bishop, Ph.D., Lehigh University
Rob Foshay, Ph.D., Walden University and The Foshay Group
James Ellsworth, Ph.D., U.S. Naval War College
David Wiley, Ph.D., Brigham Young University
Ellen Wagner, Ph.D., Sage Road Solutions, LLC

REVIEW BOARD
Chris Dede, Ph.D., Harvard University
Gary Morrison, Ed.D., Old Dominion University
Brent Wilson, Ph.D., University of Colorado Denver
Mike Simonson, Ph.D., Nova Southeastern University
MaryFriend Shepard, Ph.D., Walden University
David Wiley, Ph.D., Brigham Young University
Robert Bernard, Ph.D., Concordia University
Douglas Harvey, Ph.D., Stockton University
Nan Thornton, Ph.D., Capella University
Amy Adcock, Ph.D., Old Dominion University

The purpose of this journal is to bridge the gap between theory and practice by providing reflective scholar-practitioners a means for publishing articles related the field of Instructional Design.

JAID’s goals are to encourage and nurture the development of the reflective practitioner as well as collaborations between academics and practitioners as a means of disseminating and developing new ideas in instructional design. The resulting articles should inform both the study and practice of instructional design.

JAID is an online open-access journal and is offered without cost to users.

View this journal at: http://www.jaidpub.org

For questions contact Don Robison at drobi036@odu.edu
Guest Editorial

Wilhelmina C. Savenye, Ph.D.
Arizona State University
Associate Editor

We are so pleased to welcome you, on behalf of all of the staff of the Journal of Applied Instructional Design, to our newest issue of the journal. We are grateful once again to all of the individuals who have contributed to this issue, including, of course, the authors, but also editorial board members, guest reviewers and you all, our readers.

In this issue, we present the recent work of a set of emerging scholars, fresh voices that reflect not only the vibrancy of our field, but new directions and evolving strategies for instructional design. The authors’ instructional design research, theory and practice represent varied technologies and delivery systems, and provide for us a deep view of several components of the instructional design process.

The authors present views and research on designing learning materials across the gamut of technologies, from instructional learning aids that are presented in both print and digital form, to wikis for student collaboration and group projects, to virtual worlds for learning. We are invited to learn more about many aspects of instructional design for online learning systems, with an emphasis in some papers on improving e-learning delivery aspects and efficiency, in addition to learning.

The research presented includes, too, work across the spectrum of activities we call instructional design. There is needs assessment data collected to enhance the decisions made by designers both early in the development process and in later stages of design, when learning systems are being considered for improvement. Many of the papers included in this issue commendably include considerable, and rich, evaluation data, to not only improve their specific learning projects, but to provide all of us in the field with data that may enhance our own work. For example, designers who read this issue may find they, too, would like to utilize error analysis more fully in their own work.

Perspectives which form the foundation of instructional design and development also vary greatly, and are well represented in this issue.

The research and design projects presented here also meet the needs of many types of audiences, from learners in business settings who must navigate the sometimes tricky world of human personnel issues, to college and university students in undergraduate and graduate courses, to K-12 students and their teachers using an innovative virtual world in a problem-based engineering challenge. Represented in this issue as well is a focus on the needs of experienced technology-using online faculty.

We hope you enjoy this issue, and welcome your comments and contributions to the ongoing dialogue this journal represents.

Please join us in thanking those who helped make this issue possible. First, we appreciate all of our authors and those of you who are preparing or submitting instructional design research and development manuscripts for the journal. We recognize that YOU all ARE our field, and are the foundation of our future. We also thank our editor, Les Moller, for providing the chance to guest-edit this issue of JAID. As always, we thank our staff, Don Robison, Production Editor; Ben Erlandson, Assistant Editor; and Douglas Harvey, Associate Editor.
2013 AECT International Convention

Innovate! Integrate! Communicate!
AECT's Annual International Convention
October 29—November 2, 2013
Anaheim, California

This year’s convention theme is Innovate! Integrate! Communicate!. Over the last year there has been a renewed interest among the general public in using technology for training and education. Fueled by high profile projects such as the Stanford AI class, MITx, and the Khan Academy, many organizations have been rushing to implement technology enhanced learning and instructional systems. Not surprisingly, just as has happened several times before when the pendulum of popular opinion has swung toward greater use of technology for learning, more than a few of these organizations are rushing to embrace ill-conceived and poorly researched strategies and techniques that have consistently failed in the past. We know better! The membership of AECT is in a unique position to shape the future of learning and instruction. We are a nexus for research and communication about educational technology.
Tools of the Trade: The Role of Perceptions and Context in Designing and Developing Instructional Learning Aids

Sherry Kollman, University of Oklahoma
Patricia L. Hardré, University of Oklahoma

Abstract: Design principles, theories and artifacts from instruction in many fields have been analyzed from various perspectives. Instructional learning aids (ILAs) such as workbooks and job aids are components of instructional packages that are often utilized, but not often considered in terms of their role in learners’ experience of instruction. We used a mixed methods approach to examine the effects of two types of ILAs for the design skill development of 11 graduate students over two sequential semesters. As designers, we depend on general principles, and may draw on principles from various frameworks to address particular design demands. But how do the unique aspects of content, context and learners’ perceptions influence the use and effectiveness of those tools we create? In this nine-month study we examined learners’ perceived utility and actual utilization of two distinct types of instructional aids designed for the sequenced instructional design courses. Learners’ utilization of these tools varied depending on the tools’ specific design elements, features of the contexts, and the match of intended use with learners’ perceptions—demonstrating that perception (not intent) drives use. These findings inform strategic reasoning and practice in the design of ILAs for both the academic and practitioner.

Keywords: instructional design, instructional aids, learner workbooks, performance aids, perception and utilization

Designers in primarily academic educational settings and those who generally work in training and development settings tend to utilize different types of design strategies and solutions, often more out of comfort and ease of use than from systematic design reasoning. In this project, we took two types of instructional aids frequently used in business training and tested them in a graduate instructional design class. With the development of new technologies, teachers and trainers rush to test the effects of digital aids, but rarely step back to examine the value of more conventional learning aids in unconventional contexts. Despite the burgeoning of digital tools, there are myriad situations and contexts in which paper-based versions are still used. In this study we assessed the effects of tool type and design features of two traditional types of
instructional aids, both electronic and paper based (a workbook and a flipbook-type job aid), including their interactions with learner perceptions and context.

**Background**

The nature of expertise in ID is complex, and it has been classified across types of skills, from straightforward procedure (in its simpler applications) to complex and ill-defined problem-solving or innovation design (in its more unique applications) (Brown & Green, 2006; Goel & Pirolli, 1992; Owen, 2007). Efforts to clarify and define the field include sets of core processes or skill competencies and codified professional standards, both general and field-specific (e.g., Cross, 1990; Goel & Pirolli, 1992; Richey, Fields & Foxon, 2001). Expert and competent practice in ID encompasses elements of systematic application of principles from learning and instructional theory (Cox, 2003; Dick, Carey & Carey, 2009). It also includes elements of flexibly-adaptive subjective judgment, refined by depth of knowledge and range of practice (Christensen & Ogusthorpe, 2004). Some ID roles involve repetition of the same rote skills, while others require innovative applications of principles for every project (Cennamo & Kalk, 2004).

An important aspect of ID is that skill and practice are deeply situated in contexts-of-use (Goel & Pirolli, 1992). While basic concepts and principles generalize across outcomes and domains of learning, selection and application of strategies are often constrained by contexts of instruction and performance (Cennamo & Kalk, 2004). Similarly, the development of competence in ID is situated in the learning experience (Quinn, 1994), and in the range of opportunities found to build schema for later recall and transfer of those skills (Fadde, 2009; Gagné & Medsker, 1996). Beyond basic knowledge and process skill, more elusive elements of ID are expert and difficult to define, alternately termed “design thinking”, “design judgment”, “design character” or “design expertise” (Boling, Easterling, Hardré, Howard & Roman, 2011; Brown & Green, 2006; Molenda & Boling, 2008).

**Instructional Learning Aids**

The design features of primary presentation material and instructional learning aids (ILAs) can influence learners’ ability to engage, apply and recall information that is presented in classroom or training settings (Smith & Ragan, 2005). If designed with consideration of the learners, learning environment, and facilitator, an ILA can be a tool to maintain engagement and guide learners to build usable schemas in the skill set (Rossett & Schafer, 2007; Lizzio & Wilson, 2007). If designed with consideration of the performance task and future application, the ILA can also serve as a reference and job aid (Smith & Ragan, 2005; Rossett & Schafer, 2007) that learners utilize to support use of knowledge and skills.

If there is a need to create active learning environments to accommodate and assimilate information, there is a need to identify and research design of supporting tools that provide the opportunity to work with, personalize, and reflect on, information within the context of learning environments. The overarching question guiding this work was: What are the decisions that instructional designers need to consider when developing instructional aids, with particular attention to learners’ perceptions and application of presented material?

Very few examples of data-driven research studies can be found on this topic (as we discovered from searching a broad set of terms such as learner workbooks, learning aids, participant guides and user guides). The term “workbook” did reveal studies that examined online workbooks, elementary school workbook practice (Block, Collins, Parris, Reed, Whitely & Cleveland, 2009), and a reflection workbook (Lizzio & Wilson, 2009), but these studies only examined one of the characteristics in which we were interested. Our search of existing literature yielded little scholarly work and even less applied design research. There were studies of technology-based learning systems and aids, but these tend to focus on the digital tooling and system features, rather than on the more basic design features of the aids themselves. Most ILAs can be delivered in various media and systems, and our interest was not in the media, but in the effects of basic design strategies that could be flexibly implemented.
One only needs to attend training and development in any educational setting, company or organization, or an industry job site, to recognize that traditional ILAs (such as workbooks and handheld job aids) are still widely utilized. Some have been converted, or imported without significant redesign, into digital formats (just as much of e-learning is essentially the importation of existing materials into digital delivery systems). The premise of developing an ILA or supporting performance tool is to enhance engagement, learning and job performance. However, we need design strategies grounded in theoretical foundations of education and demonstrated as effective, to know that our instructional aids actually will support learning and skill development. In this project, we stepped back from technology to examine learners’ response to, and use of, traditional ILAs for learning a complex, highly cognitive, applied skill set such as designing instruction.

Design Principles for Learning Aids

Before beginning the project, we also reviewed the existing literature relevant to designing ILAs and distilled principles to use in our design and development. The design principles for instructional learning aids and performance job aids present implications for thinking and learning, through the paths of human cognitive processing as reflected in research-based principles of design. Decisions on these characteristics are informed by learner, content and contexts characteristics that we generate in the design analyses. Principles grounded in basic design features are captured in Table 1.

Research-based Implications for Design of ILAs

Learners can only handle small amounts of information in working memory (Ormrod, 2008; Paas, Renkl, Sweller, 2003). During the brief time of initial cognitive processing, learners attempt to make connections by accessing stored information from long-term memory. To increase cognitive understanding, learners need the opportunity to interact richly with information, which stimulates cognitive review and practice (Makany, Kemp & Dror, 2009), and maintaining learners’ attention is key (Dudukovic, Dubrow & Wagner, 2009). If connections are not made, learners are likely to lose key pieces of information (Ormrod, 2008). Material should be organized and structured in design so that learners are encouraged and supported in using learning aids as appropriate, and then challenged to use skills more independently as they develop competence (Smith & Ragan, 2005). Information should also be ordered and grouped so that learners can use it to develop accurate but personally meaningful schemas (Dick, Carey & Carey, 2005). These strategies all influence cognitive processing, initial understanding and eventual recall and transfer of skills. In designing instruction it is important that learners have relevant tools available to apply and practice target knowledge and skills.

As ILAs move from training to transfer, as job aids, their design features need to support learners to actually use them as reminders, checklists or reference guides (as appropriate to the tasks and tool). As job aids, ILAs need to promote speed of reference and efficient cueing for learners to accurately recall the necessary and relevant information that enables them to effectively perform tasks. These outcomes depend on design features like organization that concisely captures key content and makes it accessible as needed, and on visuals and graphics that can be quickly understood and linked to task components (Dirksen, 2012). Issues like legibility of typographic elements (e.g., fonts) have been the subject of decades of research and debate, leading to the conclusion that not one single factor but the fusion of the whole presentation drives clarity and use (Bix, 2002).

Analyses Informing Design Decisions

Building on the research-based findings and principles, designers take into account specifics of a given learning dynamic, based on analysis of the learners, task, content and contexts. Some key characteristics of our learning dynamic are identified in the following sections.

**Learner characteristics.** In general, adult learners need and want information to take back and apply (Knowles, Holton & Swanson, 1998; Kenner & Weinerman, 2011), so instructional aids need to be designed to provide task-relevance at some level to
Table 1: Design Principles and Features of Learning Aids

<table>
<thead>
<tr>
<th>Feature I: Layout</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep layout consistent throughout.</td>
<td><strong>Margins</strong>: Margins need to allow for final packaging (e.g., binding, 3-hole punching, stapling, two-sided printing).</td>
</tr>
<tr>
<td>Design layout for learner needs and intended use.</td>
<td><strong>Columns</strong>: Columns need to consider embedded elements (e.g., charts, space for writing) and aesthetics (e.g., grouping, discriminating between items).</td>
</tr>
<tr>
<td><strong>White Space</strong>: Include room needed to interact, take notes, create, capture ideas, provide resources needed for reference.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature II: Graphics</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and place visual and graphic elements to enhance meaning and understanding.</td>
<td><strong>Placing Graphics</strong>: Graphics must be clearly related to content and placed proximate to relevant content.</td>
</tr>
<tr>
<td><strong>Design of Graphics</strong>: Illustrations and representations are selected and presented so that they best support learner understanding, illustrate complex concepts and processes, and minimize misconceptions.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature III: Typography</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrange typography to direct learner attention, support understanding.</td>
<td><strong>Type size</strong>: Balance space allowances and learners’ needs such as visibility. Most uses feature type sizes: 10, 12, 14, and 16. Use larger type sizes for headings as appropriate for materials.</td>
</tr>
<tr>
<td>Keep typography consistent throughout materials, so learners focus on content rather than on decoding.</td>
<td><strong>Fonts</strong>: studies disagree on how fonts effect learning, so they should be considered as a whole with other textual and typographic elements.</td>
</tr>
<tr>
<td><strong>Spacing</strong>: Consider the effects of vertical and horizontal spacing on learners’ eyes and attention.</td>
<td></td>
</tr>
<tr>
<td><strong>Ensure Consistency</strong>: Prepare style sheet for development.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature IV: Visual Aesthetics</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistent aesthetic enhancements, such as color and balance promote engagement and utilization.</td>
<td><strong>Color scheme</strong>: Embed a consistent color scheme throughout all material to create coherent, consistent professional look.</td>
</tr>
<tr>
<td><strong>Visual Balance</strong>: Overall balance of elements on a page effects learner attention and may support (or reduce) later location for reference.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature V: Content</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concisely capture key content to supplement training and cue later recall for task use.</td>
<td><strong>Balance content</strong>: Keep ILAs concise, but supplement key content ideas, cues for skill use, and effective memory cues, such as mnemonics, model elements, and rules-of-application.</td>
</tr>
<tr>
<td><strong>Scaffolding and Fading</strong>: Present more material and remove scaffold progressively.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature VI: Content &amp; Organization</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order and organize information to support learners creating accurate and accessible personal schema.</td>
<td><strong>Sequencing</strong>: Present foundational material at outset, to establish foundation. Balance cognitive load of new and complex information.</td>
</tr>
<tr>
<td><strong>Clustering</strong>: Group related information together to support understanding of relationships.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature VII: Media &amp; Access</th>
<th>Relevant Strategies for Instructional Learning Aids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrate media with information to maximize use.</td>
<td><strong>Integration</strong>: Integrate information with media features, to maximize access and support use and later application.</td>
</tr>
<tr>
<td><strong>Interacting</strong>: Provide space and access for interactivity that supports reflective learning and applied practice.</td>
<td></td>
</tr>
</tbody>
</table>
each learner. Our adult learners wanted a learning environment that provided usable tools and the opportunity to practice, so they would leave the classroom knowing they could utilize those skills (Knowles, Holton & Swanson, 1998). As graduate students and practitioners, our learners needed ILAs linked to their curricular requirements, to facilitate success on their instructional design requirements. As novice designers, they also needed tools that reflected authentic professional skill requisites and would help them transfer strategies to other applied design contexts beyond the classroom. Learners in these courses previously expressed perceptions of particular challenges (such as applying design adaptively to more effectively meet different needs), so the ILAs were explicitly designed to address those needs. As graduate students and competent professionals, equipped with successful study and task strategies, our learners wanted to be independent and autonomous in their work (e.g., Hardré & Burris, 2012; Hardré, Ferguson, Bratton & Johnson, 2008). However, as relative novices in design, they needed significant support in the specific knowledge and strategies of ID (e.g., Hardré & Chen, 2005; Hardré, Ge & Thomas, 2007).

**Content and task.** Given the adaptive nature of the task of design, ILAs for this skill set needed to allow for them to be used across a range of possible projects. However, they still needed to be consistent in supporting the application of the key information and principles of the field, and be tied to the professional standards of practice. Because they were being used in the introductory-level course sequence, having the information organized in ways linked back to the texts and other course materials supported coherence in learners’ understanding of the field.

**Context-of-learning.** In analyzing the utility and practicality of the design to create ILAs a designer must consider the different activities occurring in the learning environment, as well as how learners will interact with the tool. The two ILAs created for this project were different in their functions, aims and relations to the learning and performance environments. However, both were intended as tools for use both in and outside of the instructor-led class, to assist in content retention and to support their application to individual and collaborative design tasks.

**Context-of-use.** A well-designed ILA should serve as a reference tool after the lesson has been completed. Such a tool needs to provide cues and triggers that facilitate learners’ use of knowledge and skills, often done effectively with participation by learners themselves (Rossett & Shafer, 2007). Use of an ILA for unique task work (like ID) can continue to evolve as learners incorporate the aid into their own situations. Integrating an ILA into a lesson or training can help ensure consistency for content learning (Rossett & Shafer, 2007) and provide structure to promote transfer, balanced with flexibility as learners interact and customize their use.

**Research Purpose and Questions**

The overarching inquiry for this project focused on learners’ perceptions and utilization of two custom-designed learning aids. We sought to identify and discriminate among perceptions and degree of utilization that learning aids (learner workbook and design job aid) could generate. We wanted to better understand how the specific design elements of ILAs can support and engage learners, with attention to context elements of learning and performance environments.

**Methods**

We set out to identify learner perceptions and degree of utilization, along with attributions of developmental contributions from the ILAs (learner workbook and design job aid). The learners all volunteered (consistent with IRB requirements) to participate in a study of the course design elements, but the project materials did not specify the ILAs as a focus of the study, to avoid leading or biasing responses.

The researchers were also the materials designer (Researcher #1), and the course instructor (Researcher #2), and as such we were aware of the potential for bias toward positive findings. To control for bias (consistent with Marshall & Rossman, 2011), we: 1) acknowledged our dual identities and consciously divided duties to reduce implicit approval messages; 2) designed with the strategy of multiple, independent, confirmatory data sources requiring con-
vergence (triangulation); 3) adopted roles of systematic observation and transparency, including crosschecking for bias; and 4) in the data analysis utilized both analytic induction and constant comparative analysis, requiring continuous checking and confirmation.

**Learners**

Learners were 11 graduate students enrolled in two sequential design courses (ID I & II), who progressed together through the academic year. Age ranged from 23 to 50, and gender mix was 8 (73%) female, 3 (27%) male. Ethnicity of participants included: 9 Anglo/White, 1 Latino/Hispanic, and 1 Asian/Chinese/Korean. The participants’ majors and status ranged from first-year ID master’s students to doctoral students in fine arts and educational psychology. All were described (by themselves and by the researchers) as novice designers. About half of the students had not previously used a learner workbook and none had previously used a tool like the job aid.

**Learning Aids**

Two new learning and performance aids were introduced during the two-semester course sequence, as productivity tools for the students. The aids were systematically introduced in two sequential courses, one each semester, to supplement existing instruction. They were embedded in the normal instruction of the courses. Early in each semester, the instructor introduced the tool, explained its purpose, guided and coached its use, then progressively left learners to judge when and how to use it. Both ILAs were provided to the learners at no cost.

**Learner workbook.** The first-semester ILA was a learner workbook (i.e., participant guide, learner guide) (seminar-type, 8 ½ x 11”) that scaffolded learners in reflecting on and applying the text and class content in ID I. It was explicitly content-focused, because the ID information was seen as both complex and unfamiliar by previous learners in the first course. The workbook was designed, developed and presented complete to the learners with their other course materials the first week of class. The workbook design was categorized by class sessions and topics, to align with course content. Its key design elements included note spaces for each class session, and reflection areas encouraging learners to think through and apply what and how they were learning. By engaging in these sections, learners were able to capture “aha” moments for each class session and topic. It was accompanied by a cd containing a digital version (pdf) of the workbook, to allow users flexible access and provide portability of the content.

**Design job aid.** The second-semester ILA was a design job aid (pocket-sized, spiral-bound, flip-book type) that scaffolded learners in extracting ID principles and translating them to practice for the varying design tasks that they were challenged to complete in ID II. It was explicitly task-focused, because (from previous groups) the rapid production of ID deliverables was seen as the most challenging and daunting new component of the second course. In the interest of both exercising their design reasoning and gaining commitment to the ILA, the job aid was presented partially designed, and students were asked to contribute to the final design decisions as to its appearance and exact configuration for use. The content was outlined utilizing Gagné’s Nine Events of Instruction to leverage those structural tools they had learned in ID I and bridge to the types of design decisions they would make in ID II and in their later professional practice. Each aspect, from size to spiral binding to the colored cascading tabs, was reasoned based on learner needs and task demands. Additionally, keeping the content short and to the point, delivered in bullet list format, efficiently provided the cues needed to assist learners in recalling the key information for designing their instructional projects.

Both ILAs were designed and delivered in hard copy (paper), printed in color. After the job aid was implemented, some of the learners asked for a digital version, so we developed an interactive digital reproduction of the job aid (in Adobe Flash). We uploaded it into the course LMS where it was accessible to all learners. Using the tracking tools inside the LMS, we were able to determine who accessed the digital aid, as well as the frequency. Table 2 shows a comparison of the design features of the ILAs.
### Comparative Characteristics of the Instructional Learning Aids

<table>
<thead>
<tr>
<th>Design Features</th>
<th>Learner Workbook</th>
<th>Design Job Aid</th>
</tr>
</thead>
</table>
| **Layout**              | 8 ½ x 11 inches, 86 pages, spiral bound, heavy stock paper, printed on both sides, illustrated cover.  
  Textual content in outline form, space for writing applications and questions  
  Designed as self-contained, interactive tool for learners to document ideas, applications related to course content.  
  Provided white space for learners to document responses. | 7½ x 8½-inches, 23 pages, laminated card stock, illustrated cover.  
  Top spiral binding, cascading layers to distinguish sections of tool.  
  Designed with bullet points, concise terms for quick reference, no internal interactions, tool to apply on external projects.  
  Used white space to distinguish among types and levels of information. |
| **Graphics**            | Illustrated with charts and other graphics to illustrate key points of content.  
  Symbols throughout cued individual and group interactions and activities. | Global graphic framework guided user to reference and apply design strategies. |
| **Typography**          | Used font size and embellishments (bold, italics) to guide learners’ attention and promote understanding. | Used font size and embellishments (bold, italics) to guide learners’ attention and promote understanding. |
| **Visual Aesthetics**   | Incorporated color to guide attention, cue actions, and stimulate positive affect.  
  Visual balance achieved with columns and placement of tables and graphics. | Color scheme discriminated among eight types of learning outcomes.  
  Visual balance achieved with placement of graphic and text examples. |
| **Content & Organization** | Content aligned with class meeting topics and readings.  
  Organized around course schedule, sequentially.  
  Sections included information, course reflection & application activities (individual, group), professional examples. | Content aligned with Gagne’s Nine Events of Instruction.  
  Organized around eight learning outcomes, from sequential class assignments.  
  Sections included definitions, design strategies, examples. |
| **Media & Access**      | Paper-based, digital (pdf) version on cd | Paper-based, digital (Flash) version online |
Data Sources

Data sources included: questionnaires designed to assess perceptions of the aids, periodic independent observations of utilization by two researchers and metacognitive essays. In order to identify their role in students’ learning and skill development, assessments tracked students’ use of and responses to the ILAs, as aids-to-learning-and-practice. The ILAs were integrated into the authentic design course experience that included experiential learning and independent projects.

In addition to the measures listed below, we assessed learning and design performance as part of both semesters’ courses, through design products, both individual and collaborative. To determine how the learners used the ILAs and what they learned from them, we depended to a degree on the students’ independent attributions of influence of the ILAs, provided in their written essays. Table 3 shows a summary of the data sources and timing of data collection.

Questionnaires

Sets of questionnaire instruments were customized to assess students’ perceptions of the ILAs each semester. They also reported behavioral interaction with, and use of, the ILAs, such as how frequently

---

Table 3: Data Collection Activities/Sources

<table>
<thead>
<tr>
<th>Week in Study</th>
<th>Data Collection Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>ID I</strong></td>
</tr>
<tr>
<td>2</td>
<td>Distribute Productivity Tool #2 Learner Workbook (LWB)</td>
</tr>
<tr>
<td>3</td>
<td>Obs #1: Participation, Interaction &amp; LWB Utilization</td>
</tr>
<tr>
<td>4</td>
<td>LWB Questionnaire Time 1</td>
</tr>
<tr>
<td>5</td>
<td>Obs #2: Participation, Interaction &amp; LWB Utilization</td>
</tr>
<tr>
<td>7</td>
<td>Obs #3: Participation, Interaction &amp; LWB Utilization</td>
</tr>
<tr>
<td>8</td>
<td>LWB Questionnaire Time 2</td>
</tr>
<tr>
<td></td>
<td>Obs #4: Participation, Interaction &amp; LWB Utilization</td>
</tr>
<tr>
<td>10</td>
<td>Obs #5: Participation, Interaction &amp; LWB Utilization</td>
</tr>
<tr>
<td>13</td>
<td>Obs #6: Participation, Interaction &amp; LWB Utilization</td>
</tr>
<tr>
<td></td>
<td><strong>ID II</strong></td>
</tr>
<tr>
<td>20</td>
<td>Distribute Productivity Tool #1 Job Aid (JA)</td>
</tr>
<tr>
<td>23</td>
<td>Obs #1: Participation, Interaction &amp; JA Utilization</td>
</tr>
<tr>
<td>25</td>
<td>JA Questionnaire Time 1</td>
</tr>
<tr>
<td>27</td>
<td>Obs #2: Participation, Interaction &amp; JA Utilization</td>
</tr>
<tr>
<td>29</td>
<td>Obs #3: Participation, Interaction &amp; JA Utilization</td>
</tr>
<tr>
<td>30</td>
<td>JA Questionnaire Time 2</td>
</tr>
<tr>
<td>31</td>
<td>Obs #4: Participation, Interaction &amp; JA Utilization</td>
</tr>
<tr>
<td>32</td>
<td>Obs #5: Participation, Interaction &amp; JA Utilization</td>
</tr>
<tr>
<td>33</td>
<td>Obs #6: Participation, Interaction &amp; JA Utilization</td>
</tr>
</tbody>
</table>
they used them without prompting by others. These were given multiple times to document any measurable change. They were not parallel forms, so the comparisons of the differential responses to the two ILAs are not direct and deductive, but inductive and based on the multi-source data.

**Learner workbook.** Questionnaires assessed student perceptions of the ID I learner workbook, including: value, utility, usability, application, and satisfaction with the workbook as a tool to strengthen ID knowledge (administered weeks 4 & 8). The 12 (6-point) Likert-type items, were followed by prompts for additional descriptive detail to support those numeric responses. Sample items: “I understand the benefits of recording findings from the in-class activities in the learner workbook” (followed by) “Please identify those benefits”.

**Design job aid.** Perceptions of usability and application of the ID II design job aid were assessed with an original 12-item instrument. Items included Likert-type (e.g., “I am using the job aid to assist in recalling differences in each of the assigned instructional designs”); dichotomous (e.g., “The job aid anchored in Gagné’s nine events of instruction, assisted me to embed the strategies to my own instructional design”); checklist/selection type (e.g., “During the course of the class the events within the job aid that I referred to the most often were…[followed by list]”); and generative items (e.g., “What changes you would make to the job aid to better assist you in your process of designing instruction?”).

**Observations**

Two independent observers recorded observations of students, individually and in groups, across a range of behaviors and characteristics. Both observers produced data in quantitative and qualitative forms. Three times each semester, the instructor-designer recorded observations of students’ in-class design activities. Dates were set a priori based on the class schedule. Three times each semester, the external researcher-designer made random visits for systematic observations of learners’ design activities. The researchers used an observation protocol that ensured consistent application across users and instances.

**Metacognitive essays**

At the end of each semester course, students were assigned to write metacognitive essays reflecting on their ID learning and skill development. Relevant content in these essays reflects the role of the ILAs from students’ perspectives (for examples see Table 4).

**Findings**

Tools of the trade need to be designed with the same attentive analysis as a full instructional product. The study data reveal that design decisions need to consider the product as it will be used holistically, from the role of the instructor or facilitator to parallel content in other sources. The data also underscore that it is perception, not intent, that drives overall success of ILAs.

As part of the larger study and the course in which it was embedded, learning and performance were measured, but because this was not a controlled experimental study, we could not explicitly separate out the effects of the job aids on those outcomes. Two indicators suggest differential contributions of the ILAs to design learning, one indicates that the use (vs. non-use) of the ILAs promoted greater learning across students, and the other that students’ attributed more positive effect on their design development to the second ILA (the job aid) than to the first ILA (the workbook).

We saw a pattern of more improved understanding and higher final performance in those students that more actively used the ILAs. However, these were also consistent with their engagement and participation in other course activities, so we could not separate out the contributions of these design variables, and the possibly differential effects of tool-specific versus general motivation for learning. We did explicitly measure and below report the learners’ attributions of effects on learning and performance to the ILAs. Patterns of behavioral interactions with the ILAs (such as frequency of use) were treated as emergent differences based on the data. Detailed findings for each ILA are presented in the following sections.

**Learner Workbook**

**Perceptions.** For the learner workbook (ID I), in terms of perceptions, learners recognized its primar-
ily content focus, and saw it as linked to learning about ID, similar to the texts and class notes. They perceived some redundancy in having multiple sources of similar information and supports (though each resource contained unique information and supports in addition to the overlap). They perceived it as having only moderate value to their overall learning experience (5 of the 11 students rated its value a 3 out of 6, and 4 rated it a 2). Their qualitative comments reflected similar patterns of perceptions. They reported that it provided an additional source of what they viewed as very similar information, and due to the perceived redundancy found it only minimally helpful for their skill development and design work. Learners attributed little of their learning and skill development to the first ILA, though it was consistent with all of the design and learning principles from resources in scholarship and practice. The pragmatic application of referencing an 86-page workbook to assist in designing instruction was the primary rationale for the negative perception and lack of utilization. Table 4 shows the pattern of perceptions for both of the ILAs.

Table 4: Patterns in Perceptions of the Instructional Learning Aids

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean/Frequency Responses</th>
<th>Generative Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to use learner workbook participating in class activities and exercises</td>
<td>Mean = 3.41 (1-6 scale)</td>
<td>“I don’t feel the workbook assisted my learning. . . . lacked integration in actual practice.”</td>
</tr>
<tr>
<td>Attributes learning of new knowledge and information to learner workbook</td>
<td>Mean = 3.76 (1-10 scale)</td>
<td>“I don’t feel the learner workbook assisted in my overall learning of the content. . . . I did not utilize it. It seemed to be extraneous.”</td>
</tr>
<tr>
<td>Attributes learning of new applied skills and strategies to learner workbook</td>
<td>Mean = 3.76 (1-10 scale)</td>
<td></td>
</tr>
</tbody>
</table>

Design Job Aid (ID II)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean/Frequency Responses</th>
<th>Generative Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the job aid to assist in recalling key information for instructional design projects</td>
<td>In-Class: Mean = 3.09 (1-6 scale) Outside: Mean = 4.82 (1-6 scale)</td>
<td>“I liked that the job aid had all of the types of learning together in one spot. I could easily flip through the pages and compare/contrast for the different types of knowledge.”</td>
</tr>
<tr>
<td>Frequency referencing paper-based job aid.</td>
<td>6 at least weekly 5 less than weekly</td>
<td></td>
</tr>
<tr>
<td>Frequency of referencing online job aid.</td>
<td>1 once to view 10 never</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I used the job aid to design the overall strategy. It reminded me of all the things I needed to include, so I was more open to be creative with the ideas to map into the strategy.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I felt the cascading component of the aid was easy to use as well as the color coding.”</td>
</tr>
</tbody>
</table>
Utilization. Learners reported infrequent overall utilization outside of class (0-5 uses; average of 2 times-per-student), and only minimal additional use was observed in class by both researchers (0-4 uses; average of 2 times-per-student). More than half of the students tended to use it when cued by the instructor. Though they had been provided with a digital version of the workbook, these learners were not observed using it, and did not report doing so.

Design Job Aid

Perceptions. Learners recognized the task focus of the job aid, and saw it as a direct aid in producing their design assignments. They reported a high perceived value for this tool (all 11 learners said that they found it valuable, both inside and outside of the classroom). They perceived it as unique in content (though its core information was also replicated in the texts and class notes). Their feedback reflected similar patterns of perceptions. They reported that the job aid provided a unique source of helpful information, and found it extremely useful in promoting success in their skill development and design work. Learners reported gaining much in task efficiency and skill development from using the job aid. They said that using it caused them to recall and use the related design and learning principles from the course and texts.

Utilization. Learners reported frequent utilization outside of class (2-10 uses; average of 5 times-per-student), and additional frequent use was observed in class by both researchers (3-8 uses; average of 4 times-per-student). Nearly all (10 of 11) reported voluntarily using it weekly or semi-weekly, without cueing. Learners also inititated use of the job aid in their peer critiques, using it to recall the strategies recommended for various design outcomes. Utilization was also evident in the frequency with which learners carried the job aid to class.

Digital Job Aid

Students had requested a digital version of the job aid on the same day the paper-based version was released, as they believed having this tool readily available online would increase their usage. In order to evaluate the effectiveness of putting together a digital job aid, we checked on their utilization of the alternative tool, given that this was a requested addition to the original design. Surprisingly, there was little use (1 of 11) of the digital ILA, though the tool was readily accessible on the learning management system as requested. The compact size and portability of the paper-based job aid caused learners to keep it readily available, making it even more accessible than taking the extra steps necessary to access the digital version.

Principles of Design for ILAs from this Study

We synthesized our findings in this study with the principles from previous literature applicable to design of ILAs more generally. We developed a set of research-supported and emergent principles for designing tangible learning aids for face-to-face educational and training settings, and as post-training performance aids.

1. More complex content in ILAs may support interaction for learning, but also tends to reduce quickness of access and use for reference and transfer, so it presents tradeoffs for ILAs intended for both initial learning and later performance.
2. Portability of a tangible job aid promotes accessibility and may promote utilization.
3. Portability of a tangible job aid may present advantage over a similar digital tool for some users, tasks and contexts.
4. More complex factors than scaffolded use in training promote (or reduce) likelihood of learners’ utilization of ILAs in transfer to performance.
5. Participatory design of ILAs by users may promote ownership and adoption for task performance.

Future Research

In preparing to build upon this research, data that provides more specific connections between the design features and learners’ utilization could refine our understanding of the dynamic role of ILAs. In addition, a larger sample with even richer data would support more precise analysis for determining their role in learners’ engagement and competence development. To support comparison of types and formats of ILAs, future studies should include parallel measures.
References


A Case of Wikis and Contradictions: Activity Systems, Classroom Community, and Instructional Design for Collaborative Online Learning

Lisa Marie Johnson, Ashford University
Roderick Sims, University of Queensland

Abstract: An activity system, a combination of community, rules, outcomes division of labor, and context, is a means to analyze the interactions which take place within a bounded community, such as that found in online collaborative classrooms. Elements in an activity system which impede the use of a technology within that system are known as contradictions. With the current emphasis on online classroom community and collaboration, this study employed an ex-post facto qualitative exploratory design, where data from student engagement with a wiki (an online collaborative tool) was analyzed in conjunction with reflective comments to assess the interactions in terms of an activity system and component contradictions as well as course design factors. The Classroom Community Scale (CCS) was employed to analyze wiki usage and interactions, generating scores on two dimensions: Connectedness and Learning. Findings suggested that as the activity system developed, a combination of community, rules, outcomes, division of labor, and context gave rise to contradictions in the use of the wiki technology due to the inherent features of the wiki technology itself. The results extend the understanding of instructional designers of online learning with respect to the selection of wikis as a medium for collaborative instructional strategies to facilitate a strong sense of classroom community in collaborative online learning contexts.

Keywords: Activity Theory, Classroom Community, Collaboration, Instructional Design, Wikis

Introduction

One of the key affordances of the online environment for teaching and learning has been the potential for participants to develop, through the networks of communication and interaction, a sense of community. Inherent within these environments are the tools for communication, such as the threaded discussion, blog and wiki, although the extent to which they contribute to the formation of a community of learning remains unclear. Studies by Drouin (2008), Palloff and Pratt (2007) as well as Rovai and Whiting (2007) have shown that students benefit from increased retention and learning of course content in those online courses which develop strong classroom community, and therefore instructional designs for online learning that facilitate the development of classroom community are important.

For example, with respect to threaded discussions, Graff (2006), Rovai (2002a, b), and Rovai and Whiting (2005) reported classroom community to be essential for course designs in order to assist with attracting and retaining students. Similar findings, but with respect to the use of wikis, were reported by Coyle (2007) and Elgort, Smith, and Toland (2008), with their features considered as an appropriate choice for classroom community development. Nevertheless, as noted by Ruth and Houghton (2009, p. 135), wikis remain somewhat of an enigma in community develop-
ment, as “much is written on the 'how' of using wikis and yet little on the 'why'”.

Classroom Community
Within the context of online learning environments, the value of establishing community cannot be underestimated. Evidence for this is shown by a series of studies conducted by Rovai (2001a, b; 2002a, b; c) and Rovai and Whiting (2007) which focused on classroom community among undergraduate students, and which resulted in the development of the Classroom Community Scale. Results using this instrument indicated that a strong sense of classroom community benefits students by promoting retention and increased learning of course content (Drouin, 2008; Ouzts, 2003; 2006; Palloff & Pratt, 2007; Rovai & Whiting, 2007).

According to Rovai (2002a, p. 4), classroom community is characterized by the “mutual interdependence among members, sense of belonging, connectedness, spirit, trust, interactivity, common expectations, shared values and goals, and overlapping histories among members”.

Activity Systems
Given the importance of community and collaboration in the online learning environment, the concept of the activity system, which is a combination of interactions based on community, rules, outcomes, division of labor, context (Murphy & Rodriguez-Manzanares, 2008), presents a useful means by which to explore classroom community. With respect to this, by Engeström (1987; 1999), Barab, Evans, and Baek (2003), and Murphy and Rodriguez-Manzanares (2008) identified activity theory as an appropriate theoretical lens for investigating collaboration using wikis within the context of online learning courses. Drawing on research from Engstrom (1987), Murphy and Rodriguez-Manzanares (2008, pp. 443-446) depicted the five dimensions of an activity system, represented in Figure 1, as having the following characteristics:

- **community**: the organization or context in which the activity occurs;
- **rules**: the behavioral norms and conventions for the activity for the subjects;
- **outcomes**: the results of the activity, which may be intended or not;
- **division of labor**: the goal specific organizational processes used by the final dimension; and
- **context**: the contextual nature of the activity in relation to the rules and division of labor occurring in the activity.

![Figure 1: Dimensions of an activity system (adapted from Murphy and Rodriguez-Manzanares, 2008)](image)

Contradictions
Problems that arise in the use of technologies for learning are known as contradictions, and are caused by elements in an activity system that impedes the use of a technology for the desired ends (Barab, Evans, & Baek, 2003). As discussed by Murphy and Rodriguez-Manzanares (2008), these contradictions constitute “disturbances” which prevent efficient use of a technology in an instructional activity and are a key concern of an investigation of any activity system.

Wikis
Given the focus of activity systems and contradictions on the technology of online education, it therefore becomes important to examine how those technologies affect the systems in which they operate. One such learning technology is the wiki, a collaborative web-based authoring tool which enables rapid editing by multiple authors and the especially useful feature of version histories (Scardamalia & Bereiter, 2008). Elgort (2007) argued that, due to their inherent features, wikis have the potential to alter the very nature of community development in online learning environments because ownership of knowledge production and perceptions of interaction shift toward group rather than individual endeavors. Furthermore, Ruth and Houghton (2009) indicated that wikis challenge
traditional approaches to instructional design by centering designs on the process of constructing knowledge and by facilitating collaboration.

Wikis are considered a second generation or Web 2.0 technology, which enable affordances such as editing, contribution, versioning, and sharing. Dearstyn (2007) characterized Web 2.0 as any technology accessed via the Internet that embodies (a) new collaborative work styles leading to co-authored negotiated products of knowledge and understanding; (b) new applications supporting community interaction; and (c) new software connecting people and applications to capitalize on the benefits of distributed and collective intelligence (para. 3). And as a web-based technology, wikis facilitate rapid collaborative authoring and editing (Leuf & Cunningham, 2001) and therefore support social constructivist learning principles, which include “communication, collaboration, and knowledge building” (Robertson, 2008, p. 425).

While wikis have been shown to promote classroom community (Ruth & Houghton, 2009; Su & Beaumont, 2010), the use of wikis for collaboration in educational contexts has also revealed contradictions or tensions between learning and technology (Barab, Evans, & Baek, 2003; Murphy & Rodriguez-Manzanares, 2008). Considering that instructional design and the associated instructional strategies mediate these contradictions, it is paramount to understand the affordances of the wiki technology in terms of activity systems and contradictions on the context of collaborative learning designs.

Exploring the activity system of a technology to discover the nature of interaction and contradictions, or tensions, which arise with the technology, will expand understanding of the nature of collaboration in online learning. Given the evidence of the importance of classroom community for online learning and the associated impacts on activity systems and contradictions in those systems, the current study was established to investigate the influence of wiki technology in an online learning context on the development of classroom community. Consequently the research questions guiding this study were:

1. To what extent does classroom community develop in a learning environment in which a wiki is used as the method for participant collaboration?
2. When wikis act as a medium of student interaction in an online learning context, how does the activity system give rise to contradictions?
3. How does the instructional method used with a wiki activity influence the development of a sense of classroom community?

Method
Design and Instrumentation
This study employed an ex-post facto qualitative exploratory case study design, where data from student engagement with a wiki was analyzed using the Classroom Community Scale (CCS) developed by Rovai (2001a, b). The CCS consists of 20 questions scored by participants on a 5-point Likert-scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree); ten of the questions measure the subscale Sense of Connectedness and the remaining 10 questions measure the subscale Sense of Learning. The questions for each subscale are shown in Table 1.

Completion of the Classroom Scale (CCS) generates possible scores between 80 (twenty Strongly Agree responses scored at four points each and zero (twenty Strongly Disagree responses scored at zero). The corresponding maximum and minimum scores for the two subscales are 40 and zero respectively. The closer a score is to the maximum, the closer that respondent is indicating they achieved a sense of connection or learning.

The Sense of Connectedness subscale represents participant’s feelings about “cohesion, spirit, trust, and interdependence” with other participants in a course (Rovai, 2002b, p. 206). Rovai (2001b) explained that connectedness in a learning context is evidenced by a sense of benevolence and credibility toward peers. Rovai (2002a, p. 5) further explained credibility is an “expectation that the word of other students in the community can be relied on” and benevolence indicates the “extent to which students are genuinely interested in the welfare of other members of the community and are motivated to assist others in their learning”. The Sense of Learning subscale represents participant’s feelings about “interaction with each other as they pursue the construction of understanding and the degree to which members share values and beliefs concerning the extent to which their educational goals and expectations are being satisfied” (Rovai, 2002b, pp. 206-207).
Three open-ended questions were also included to elicit information to provide additional insights into classroom community

1. What problems do you recall experiencing with the wiki activity? For example, anything related to the activity that prevented you from performing the task you were required to complete. Please answer in as much detail as possible.
2. What else can you add about your use of the wiki and experience using the wiki in the cultural anthropology course?
3. Describe how the instructor’s involvement in the wiki activity aided or prevented your successful use of the wiki for completing your task(s) with the wiki.

Other data used in the analysis included course journal responses completed by participants and post-survey follow-up interviews. In addition, direct observation and post-context analysis of the instructional context served as additional research data. This study represents the research component of a doctoral dissertation and IRB/Human Subjects approval was received for all students who were enrolled in the class at the time the data was collected. The lead author was the researcher and class instructor; the second author was advisor during the research process.

Participants
The case was represented by students enrolled in an online freshman social science course with little prior domain knowledge in the subject or experience with wikis. Six students agreed to participate in the Classroom Community Scale, and two of these participated in a telephone interview to clarify responses and explore definitions of classroom community. Of the six participants who were interviewed following participating in the wiki experience, each indicated they had not used a wiki previously. To assess the reliability of their recalled experiences, participants' confidence level in recalling course experiences using the wiki were also assessed, with four participants very confident and two somewhat confident of their recollections.

Data Collection
The wiki used for this study was the default wiki format for the Moodle v1.9 learning management system, also known as the Erfurt wiki (Moodle, 2011)., all 22 participants worked in small groups to develop weekly reading summaries in a wiki page preformatted by the instructor. The instructional strategy was aligned to meet the seven factors known to positively correlate with classroom community development (Rovai, 2002, p. 7) as represented in Table 2.

<table>
<thead>
<tr>
<th>Sense of Connectedness</th>
<th>Sense of Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>I felt that students in the course cared about each other.</td>
<td>I felt that I was encouraged to ask questions.</td>
</tr>
<tr>
<td>I felt connected to others in this course.</td>
<td>I felt that it was hard to get help when I had a question.</td>
</tr>
<tr>
<td>I did not feel a spirit of community.</td>
<td>I felt that I received timely feedback.</td>
</tr>
<tr>
<td>I felt that the course was like a family.</td>
<td>I felt uneasy exposing gaps in my understanding.</td>
</tr>
<tr>
<td>I felt isolated in this course.</td>
<td>I felt reluctant to speak openly.</td>
</tr>
<tr>
<td>I trusted others in the course.</td>
<td>I felt that the course resulted in only modest learning.</td>
</tr>
<tr>
<td>I felt that I could rely on others in the course.</td>
<td>I felt that other students did not help me learn.</td>
</tr>
<tr>
<td>I felt that members of this course depended on me.</td>
<td>I felt that I was given ample opportunities to learn.</td>
</tr>
<tr>
<td>I felt uncertain about others in the course.</td>
<td>I felt that my educational needs were not being met.</td>
</tr>
<tr>
<td>I felt confident that others would support me.</td>
<td>I felt that the course did not promote a desire to learn.</td>
</tr>
</tbody>
</table>
Small groups of three-to-five learners were given a weekly essay to write collaboratively that focused on a series of questions related to the course content. Since each learner could contribute multiple times and edit other learner’s contributions, a degree of social equality was embedded within the instructional strategy design. The facilitation of the small group activity included use of the wiki technology to provide comments on page edits to guide groups toward quality in responses and consensus in their responses. Figure 2 provides an example of the main page of one weekly collaborative essay assignment demonstrating, in part, the organization of the group activity by the instructor.

Table 2: Alignment of Community Factors with Instructional Strategy

<table>
<thead>
<tr>
<th>Community Factor</th>
<th>Instructional Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transactional Distance</td>
<td>Frequent communications within wiki pages and via email to groups to minimize distance</td>
</tr>
<tr>
<td>Social Presence</td>
<td>Instructor presence encouraging group interactions</td>
</tr>
<tr>
<td>Social Equality</td>
<td>Equality of group members with emergent leadership within groups; unassigned roles; wiki affordance for editing shared product of writing; encouragement by instructor toward consensus in responses; viewing of other groups’ wiki responses</td>
</tr>
<tr>
<td>Small Group Activities</td>
<td>Consistent groups to answer weekly wiki questions with specific evaluation and collaboration instructions</td>
</tr>
<tr>
<td>Group Facilitation</td>
<td>Group assignments by instructor; preformatted wiki pages as group spaces</td>
</tr>
<tr>
<td>Teaching Style And Learning Stage</td>
<td>First year college learners; entry level course</td>
</tr>
<tr>
<td>Community Size</td>
<td>Class of 22 assigned to groups of 3-5 learners each</td>
</tr>
</tbody>
</table>

Figure 2: Wiki article page where groups would access the response pages
Participants were also able to view the wiki question pages other groups' questions, providing another dimension of interaction to the activity system that developed in the course through use of the wiki tool. Participants were able to recognize positive outcomes by other groups through instructor feedback throughout the week and apply those lessons to their group’s response. Instructor comments encouraging the viewing of positive examples from each group promoted cross-group interaction. Therefore, employing the seven factors known to positively correlate with the development of classroom community (see Table 2), the teaching style in this case was seen to foster a sense of community among groups as well as within groups.

By way of clarification, the total number of students enrolled in the course was 22, and the data from their interactions in the wiki, resulting in the contributions and journal entries, were used to inform the analysis of the instructional strategies employed for the use of the wiki. The ‘case’, represented by the six participants, provided the data for the analysis of the CSS and the open-ended survey questions.

Course journal responses were completed at the time the course was active; participant responses about use of the wiki were coded for tensions and instructional factors that influenced classroom community development. Tensions were defined as factors that impede completion of an instructional activity, while instructional factors influencing the level of classroom community were identified based on the parameters proposed by Rovai (2002b).

Classroom Community and Wikis

Results

The first research question examined the extent to which classroom community develops in a learning environment in which a wiki is used as the method for participant collaboration. The raw scores for the Classroom Community Scale and the associated Sense of Connectedness and Sense of Learning subscales are presented in Table 3 and graphically represented in Figures 3, 4, and 5 following.

Table 3: Overall and Subscale Raw Scores

<table>
<thead>
<tr>
<th>Participant</th>
<th>CCS Score</th>
<th>Connectedness Score</th>
<th>Learning Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>61</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td>Participant 2</td>
<td>75</td>
<td>38</td>
<td>37</td>
</tr>
<tr>
<td>Participant 3</td>
<td>35</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td>Participant 4</td>
<td>42</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>Participant 5</td>
<td>58</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Participant 6</td>
<td>64</td>
<td>34</td>
<td>30</td>
</tr>
<tr>
<td>Total (Mean/Possible)</td>
<td>55.83/80</td>
<td>27.00/40</td>
<td>28.83/40</td>
</tr>
</tbody>
</table>

Based on these results, a medium to high level of classroom community developed when a wiki was used for collaboration in an online learning context. The graphical representation shown in Figure 3 demonstrates that four of the six participants (P1, P2, P5, P6) indicated a strong sense of connectedness (scores of 30 and above) through the use of the wiki, while two (P3, P4) indicated a low sense of connectedness (scores of 16 or less). While this may not be causal in terms of wiki usage, the results point to classroom community developing in a learning environment in which a wiki is used as the method for participant collaboration.

Examples of participant responses illustrate the ways in which this connectedness was perceived: Participant 2 remarked, “It was overwhelming at first and required an enormous amount of team effort. The teamwork, communication, sharing of ideas, and the process of learning was an amazing ride for me” while Participant 6 commented “It [the wiki activity] made the course interesting and fun. I can't remember the last time or a time I really enjoyed participating in a class”.

24  www.jaidpub.org  ·  May 2013  ·  ISSN: 2160-528924
The connectedness data was complemented by that for the Sense of Learning sub-scale, represented in Figure 4, where all participants indicated at least a strong sense of learning, with all scores in excess of twenty. This again suggests that a wiki activity can influence the development of a sense of achievement and learning within the classroom environment.
Together, as presented in Figure 5, the scores show that only one participant (P3) did not develop a strong sense of community (a combined score less than 40) as measured through the combined subscales of connectedness and learning. In combination therefore, these three sets of data provide supportive evidence for the first research question, that classroom community can develop in a learning environment in which a wiki is used for participant collaboration.

Discussion

Given these results, further analysis of the data provides a context for their use within the online classroom. For example, embedded within the Sense of Learning subscale are participants’ shared expectations and goals for learning. According to Rovai (2002a), shared expectations and learning goals signal that students have a “commitment to a common educational purpose and epitomizes student attitudes concerning the quality of learning” (p. 6). Furthermore, existing research addressing wikis in online learning indicated that shared expectations and goals are a necessary characteristics for their successful classroom implementation (Elgort, Smith, et al., 2008; Johnson, Clarke, & Harrington, 2008; Peacock, Fellows, & Eustace, 2007).

Participants reported their commitment to the shared outcome of the weekly questions as a means for achieving the course outcomes, which suggested that, regardless of the technology used, the collaborative nature of the activity necessitated a common goal structure for group participants, which is reflected in the Sense of Learning sub-scale. Another element emerging from analysis of the CCS subscale scores is that the wiki activity collaboration experience developed a relatively consistent Sense of Learning among the participants while the Sense of Connectedness was more varied. What accounts for this difference may be the level of task-driven action by participants for completing the wiki activity: “task-driven interaction is directed toward the completion of assigned tasks while socio-emotionally-driven interaction is directed toward
relationships among students” (Rovai, 2002a, p. 5).

As interaction is characterized by task-driven and socio-emotional driven actions in a collaborative activity, the higher raw scores for the Sense of Learning subscale may be interpreted as having resulted from the task-driven actions of participants to completing the wiki activity. For example, as represented in Figures 3 and 4, Participant 4 indicated that success in achieving learning in the wiki activity resulted from the drive to complete the wiki tasks each week, even though they failed to achieve a Sense of Connectedness due to issues of cohesion and trust with group peers.

**Activity Systems and Contradictions**

**Results**

The second research question considered how an activity system might give rise to contradictions when wikis act as a medium of student interaction. To address this, the activity system that developed in the wiki-based collaborative learning instructional strategy was analyzed, using course journals and survey responses. The activity system that emerged from this study was characterized by small groups (community, division of labor) collaborating in a common wiki space to construct a substantial and coherent response to questions about course content (outcomes, context) following specific guidelines provided for interaction and criteria for evaluation of the collaboration (rules). Within this system, several contradictions were identified, which Murphy and Rodriguez-Manzanares (2008) stated arise when values about use of a technology are in conflict and may effect change in instructional practices. The contradictions emerging from the activity system associated with this study are detailed in the following exposition.

**Contradiction: Familiarity**

Based on participant responses, there were indications that a lack of familiarity with the wiki format caused contradictions in the use of the wiki technology, with some participants expressing concern that group members were able to replace their contributions to the wiki pages, even though the page history recorded every contribution, participants were concerned that the instructor would not be able to evaluate their work. This highlights the issues faced with using a technology – while the technology itself may have apparent or assumed benefits, such as collaboration, the very act of collaboration can create contradictions. For example, Participant 1 reported that more time to learn the technology would have benefited the group’s participation since some members experienced problems understanding how the wiki page revisions and histories were recorded.

**Contradiction: Choice of Wiki**

A contradiction that resulted from the activity system related to the wiki technology chosen for the activity. Based on participant feedback and analysis, the Erfurt wiki technology proved to be deficient in that it did not include talk or discussion pages, which can encourage discussion about page content. Consequently, participants struggled with finding the best way to communicate with group members about page content and proposed revisions. Although the wiki pages often included comments from group members, this led to anxiety by the final editor who would have to comb the pages before the due date to remove comments.

**Contradiction: Simultaneous Editing**

With respect to the issues associated with simultaneous editing being unavailable, Participant 3 reported that, “it was an inconvenience that the wiki was unavailable when other students were updating it”. While a page was open for editing, if another attempted to edit the page an error message would appear asking the individual to check back later because the page was open for editing. In course journal responses, participants remarked that peers would forget to close a page and it would delay editing. This delay in the ability to edit pages caused tensions among group members.

The contradiction caused by the inability to simultaneously edit pages may have reduced course learning because group members were unable to engage in collaboration when they so desired. Associated with this was the time period for participation, with allocation of one week per question. Consequently, if several group members attempted to contribute at the end of the week, there were delays and frustrations.

**Contradiction: Cohesion and Trust**

A final contradiction involved the level of cohesion and trust among group members. Anxiety about the unfamiliarity with the wiki technology and issues of
simultaneous editing and the division of labor in groups combined to cause a contradiction in the relationship between the participants (subjects) meeting their collaboration goals (object) and the use of the wiki (tool). Consequently, although the majority of participants felt the wiki activity was a success, a design using a wiki to develop strong classroom community would necessarily need to address these contradictions, which would involve revision of the instructional method and consideration of the limitations of the wiki technology selected for the collaborative learning activity.

Together these contradictions highlight the conundrum confronting designers of courses that integrate collaborative tools such as the wiki: how to generate benefit of the social aspects of learning when the technology to enable those social, collaborative interactions has inherent drawbacks (or contradictions). The following section considers this in terms of the design strategies that could be used to resolve these contradictions.

**Classroom Community and Design Strategy**

**Design and Contradictions**

The link between classroom community and design strategy was the focus of the third research question, which considered ways in which the instructional method used with a wiki activity influences the development of a sense of classroom community. This was assessed using responses to the Classroom Community Scale, the emergent contradictions from the activity system and responses to the survey.

For the contradiction “familiarity”, an initial strategy, common with new technologies, is to give participants the opportunity to use a sandbox (or practice) area in order to become familiar with the technology prior to the formal learning activities. While this option was provided to participants, few took advantage of the opportunity. Reasons for this were not clear from the data, but based on other data related to the wiki activity itself; it was apparent participants felt rushed in the brief 10-week course time frame. To address this, an instructional design focused on lessening the influence of the contradiction might consider using scaffolding, whereby participants are provided specific activities to practice with the wiki prior to the collaborative activities commencing.

With respect to the “choice of wiki” contradiction, more informed consideration of the wiki chosen for collaborative learning will impact on the contradictions arising in the activity system. This is a poignant reminder for designers: that the technology selected for an instructional strategy must match that strategy! In this study, the features of the “default” wiki available through the learning management system resulted in contradictions within the activity system – with a subsequent effect on connectedness and learning for some participants. Because a technology, such as wiki, offers collaborative options does not mean those options will align with the collaborative strategies a designer may wish to deploy.

The third contradiction emerging related to “simultaneous editing”, with participants frustrated at times because others were using the system at the same time. If the design is restricted by the technology available (in this study the Erfurt wiki) then designing for online collaborative learning requires consideration of the schedule of activities involving the wiki, the typical days of participation that will involve utilization of the wiki technology, and the editing capabilities of the chosen wiki technology. On reflection, the weekly timeline for question participation in the instructional method employed in this study proved a challenge for participants who were inclined toward participation on the weekend, or at the end of the weekly activity. To further facilitate the development of classroom community, a revision of the instructional method employed in this study would include weekday end dates for the collaborative activity and longer collaborative periods for questions. This aligns with Jeong and Frazier’s (2008) assertion that the type of collaboration and cognitive engagement is dependent on the timing of interactions.

Considering the final contradiction, “cohesion and trust”, and in association with the unfamiliarity with the technology, a strategy to use non-graded activities with a smaller group, dyad or triad would enable collaborators to develop a greater level of cohesion and trust before the larger group activity. Though Oufts (2006) and Rovai (2002a) that small groups of five to seven members is effective, the unique nature of editing and revisions, essentially a rewriting of existing content, may mean fewer collaborators leads to greater sense of shared goals, learning, interaction, and connectedness. Applying accepted instructional methods
for collaborative online learning to wiki technology implementation may not be effective, reminding designers that the strategy must align with the outcome and technology, as emphasized by Sims (2008).

Further Design Reflections
Although participants were asked to consider developing group roles, such as editor, to facilitate a smoother cooperative endeavor to construct the weekly responses, few groups actually achieved this level of role-organization. Although groups were encouraged to divide questions into parts to manage the response workload, and to review responses from other groups for ideas and guidance, no groups were observed as having implemented these actions. A proposed revision of the instructional strategy to require role assignments and division of workload in the collaborative activity is recommended. That is, a suggestion of role assignments and division of workload for small group collaborative activities is not as effective as a requirement of these for the success of the instructional strategy in facilitating a sense of classroom community. These adjustments to the instructional method would place more constraints on participants, but may increase the cognitive engagement and shared responsibility among group members by providing the structure necessary to complete the collaborative activity.

The instructional method employed followed Chen (2007) and Zorko (2009) who both proposed that collaborative online learning designs include shared goals for collaboration and clear benchmarks of goal achievement. Based on the findings from this study, a revision of the instructional method to include more granular evaluation criteria is warranted. The wiki employed for this study enabled participants to co-author a single response to a group assigned question. Evaluation of the participation in groups focused on the number and frequency of contributions, but not specifically on the quality of the contributions beyond accuracy of information. Because participants reported anxiety about group peers editing and revising their contributions, a more transparent evaluation structure that informed participants of the instructor's use of the history tracking (page revision) for contributions is recommended for increasing the sense of shared goal and benchmarks of goal achievement.

Conclusion
Using collaborative activities to enable classroom community has been a key goal for designers of online learning, and this study investigated a course which deployed a wiki for collaborative learning. Data from the Classroom Community Scale, course journals and participant responses revealed that a medium to high level of classroom community developed; however the activity system that emerged gave rise to, largely related to the inherent features of the wiki technology itself.

While the higher education community continues to embrace online technology, and learning management systems integrate a wider range of collaborative tools, the risk is that designers and teachers will assume that those tools will, de facto, align with the chosen instructional strategies. Based on the findings from this study, the technology itself may compromise, through the emergence of contradictions, the very learning environment it is supposed to enhance. The challenge for the designer therefore is to anticipate such contradictions and to ensure the technology is aligned to instructional strategy; this will only be achieved through rigorous testing, observation, and motivation to achieve the best learning environments for both teacher and student.

References


Virtual World Problem-centered Challenge Evaluation

Jennifer A. Maddrell, Old Dominion University
Ginger S. Watson, Old Dominion University
Gary R. Morrison, Old Dominion University

Abstract: This paper describes the two-year implementation evaluation of a problem-based engineering design challenge held in a virtual world. The team-based challenge was designed and facilitated by an aerospace research and education institute for middle and high school student competitors in both classrooms and after-school programs across the U.S. An independent evaluation team examined participant experiences to consider the strengths of the challenge, as well as recommendations to enhance the effectiveness and efficiency of future challenges. Overall, the evaluation team found that the problem-centered design challenge offered the student competitors a unique and valuable opportunity to engage in real-life science and engineering problems with the support of advanced science, technology, and engineering resources and college-level and professional experts. Recommendations centered on needed adjustments to achieve and prepare for growth, support for teams, assessment refinement, and collaboration and other technology enhancements.

Keywords: Problem-centered instruction, virtual worlds

Over the past decade, educators have explored the learning opportunities in online three-dimensional (3D) virtual worlds. Due in a large part to the advent of the popular virtual world Second Life, the 2007 edition of the Horizon Report predicted virtual worlds would have a prominent role in the technology used to support learning, (The New Media Consortium and EDU-CAUSE Learning Initiative, 2007). In that same year, others made bold predictions that 80% of active Internet users would participate in virtual worlds (Gartner, 2007). A recent search for the term virtual world(s) within the text of articles indexed in the ERIC database returned 262 results since 1994 from peer reviewed academic journals, suggesting a high level of interest from researchers, as well.

This paper summarizes a two year evaluation of the implementation of a team-based problem-centered design challenge in which small groups of middle and high-school students worked collaboratively as engineers and scientists to solve authentic engineering problems in both classroom and virtual world settings. The challenge was designed, developed, and implemented by an aerospace research and education institute. A stated objective of the challenge was to offer students the opportunity to engage in authentic problem-solving processes essential to careers in science, technology, engineering, and math (STEM).

The implementation evaluation, conducted by independent evaluators neither affiliated with the aerospace institute nor responsible for the design or implementation of the program, examined both the 2010-11
inaugural year of the engineering design challenge, as well as the subsequent 2011-12 implementation that incorporated the evaluators’ recommendations from the 2010-11 evaluation. Conducted in two phases that followed a standard academic calendar, Phase 1 of each challenge was implemented in the fall semester, while Phase 2 was conducted in the spring term. Phase 1 offered teachers and students in both traditional classrooms and after-school programs a free inquiry-based STEM education project in which students worked in teams to design and build a prototype solution to meet the design specifications of the challenge using a recommended eight-step design process. Students were given the opportunity to extend their participation in the challenge by submitting their design prototypes for possible selection to Phase 2 of the challenge that was set in an online virtual world based on the ActiveWorlds platform (http://www.activeworlds.com/). As part of a competitive selection process at the beginning of Phase 2, teams of students were chosen by college engineering students to continue their design development under the mentorship and guidance of the college student as the team’s leader. At the end of Phase 2, finalist teams with the best designs were selected to present their projects in a design assessment process that determined the winning team for each challenge.

This paper begins by examining research conducted to date on virtual worlds in education, as well as theory and research on both problem-centered and group-based instruction. This review of literature is followed by a summary of the implementation evaluation, starting with a description of the evaluation methods employed and concluding with the analysis, discussion, and conclusions of the evaluation.

**Virtual Worlds in Education**

Some suggest virtual worlds offer educators another option to support distance education (Wang & Lockee, 2010), including remote or simulation laboratories (Balamuralithara & Woods, 2009). However, many are not interested in merely replicating traditional classroom experiences, but also hope to improve the learning process by leveraging the media characteristics, or affordances, of the newest technologies to foster immersive online learning environments (Choi & Baek, 2011; Dalgarno & Lee, 2010; Dickey, 2005). As technology has evolved, educators have explored the potential of virtual worlds for the development of realistic environments for practice, the creation of 3D educational artifacts, and immersion into a virtual space that would not otherwise be accessible (Salmon, 2009). However, these same enhancements are a barrier to some learners who do not have the needed high-speed Internet or technology to support access (Kirriemuir, 2010; Twining, 2010).

Research reviews on the use of virtual worlds in education suggest a lack of empirical experimental research in favor of descriptive exploratory studies that have relied on qualitative data collection, such as participant questionnaires, interviews, and observations, to examine how the virtual worlds were used (Hew & Cheung, 2010; Jarmon, Traphagan, Mayrath, & Trivedi, 2009; Wang & Lockee, 2010). In addition, research reviews suggest the majority of research has been conducted in a college setting where educators are using the virtual worlds as not only online communication spaces, but also as venues that facilitate simulations of a 3D space allowing the perception of immersion in the virtual environment through the user’s avatar, as well as experiential spaces that encourage users to learn by doing (Hew & Cheung, 2010). However, while it is compelling to consider the learner interaction options afforded by the ever-expanding roster of virtual worlds with self-representations, or avatars, that allow participants to move and interact with each other and the environment (Dickey, 2005; Hew & Cheung, 2010; Wang & Lockee, 2010). The following highlights the theory and research associated with the use of virtual worlds in education, as well as relevant theory and research in problem-centered and group-based instruction.
of virtual reality technologies, research has long suggested no significant difference in learning outcomes based on the media used to facilitate instruction (Bernard, Abrami, Yiping Lou, & Borokhovski, 2004; Clark, 1983, 1994, 2001). These findings are supported by a recent review of research that offered little conclusive evidence of specific learning benefits from the 3D aspects of these virtual environments (Dalgarno & Lee, 2010).

**Problem-centered Instruction**

Following a review of instructional design theories to identify common prescriptive principles, Merrill (2002) identified the use of a problem-centered approach as a first principle of instruction. Problem-centered approaches are forwarded from both cognitive (Morrison & Lowther, 2010) and constructivist (Jonassen, 1999) perspectives, and are in contrast to topic-centered instruction in which task components are taught in isolation from a real-world problem. Problems represent the gap between a desired state and a current state, while problem solving is the process of bridging the gap that some argue is the only legitimate goal of education (Jonassen, 2011). Of the range of problem types, design problems often have no right or wrong answer (rather better or worse answers), and are considered to be of the most complex and ill-structured types to solve (Jonassen, 2000).

While reviews of problem-centered instruction offer various descriptions of methods, those described as problem-based approaches tend to (a) focus learning in small student groups, (b) a tutor is present as a facilitator, (c) authentic problems are presented before study of the topic, (d) the to-be-learned knowledge and skills are encountered within the problem, and (e) new information acquisition is self-directed (Gijbels, Dochy, Van den Bossche, & Segers, 2005).

Research findings on problem-based instructional methods are mixed with reviews of research suggesting limited or negative effects for recall of factual or conceptual knowledge, but significant positive effects on applications of skills and principles (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Hattie, 2009). However, meta-analyses of problem-based approaches also suggest the variation in effects between knowledge and skills acquisition are significantly influenced by the assessment methods, and that the better the assessment instrument evaluates the learners’ knowledge and skill application, the larger the positive effect of the problem-based approach (Dochy et al., 2003; Gijbels et al., 2005). Supporting a foundational assumption of instructional design that the conditions of learning should match the learning outcomes and the form of assessment, Jonassen (2011) argues that adequate assessment of a learner’s ability to solve problems must extend beyond the learner’s ability to recall information on a test, and suggests a four-pronged assessment approach that includes assessment of the learner’s (a) problem schemas, including classifying the characteristics of the problem and the problem-solving process, (b) problem-solving performance, including the learner’s constructed response or product compared to a rubric of desired performance, (c) cognitive skills required to solve the problem, including the learner’s evaluation of the causal relationships among problem elements, and (d) ability to construct arguments in support of their solution.

**Group-based Instruction**

Two meta-analyses of small group, whole class, and individual learning strategies suggested that under certain conditions, instructional strategies involving small groups (two to four students) resulted in a small, but significantly positive effect on individual achievement over either whole class (Lou, Abrami, & Spence, 2000) or individual learning approaches (Lou, Abrami, & d’Apollonia, 2001). Compared to whole class instruction, the achievement effects of small group instruction were significantly larger for students of all ability levels when (a) teachers were trained in small group instruction (b) grouping was based on ability and group cohesiveness, and (c) cooperative learning (which promotes both interdependence and individual accountability within carefully designed activities) was used as the method of instruction (Lou et al., 2000). Similarly, when learning with computer technology, the effects of small group learning over individual learning with regard to individual achievement are significantly enhanced when (a) students had group work experience, (b) cooperative learning strategies were employed, (c) group size was small (pairs of students), (d) the subject was in the social sciences (versus math, science, or language arts), and (e) students were either low or high ability who appeared to benefit from receiving and giving support (Lou et al., 2001). However, even when superior group products or
task outcomes were produced, no significant positive effects on individual achievement resulted when the group work (a) used no cooperative learning strategies, (b) groups were large, (c) group work used unstructured exploratory environments, or (d) the computer-based programs provided students with elaborate feedback (Lou et al., 2001).

While many forms of group-based learning exist, cooperative learning refers to an instructional approach in which learners work together in small groups and may be assessed based on the group’s performance (Slavin, 1980). Studies conducted on cooperative learning suggests it is effective approach (Hattie, 2009) and often results in superior achievement gains compared to traditional classroom conditions, particularly when group goals and individual accountability are included (Slavin, 1983, 1991). Importantly, research has found that cooperative group-based learning that does not include group rewards for individual learning is no more effective in terms of learner achievement than studying independently (Slavin, 1983). Overall, these finding suggested that when working in groups, not all students may learn equally well and group task performance was not positively related to individual learning achievement in large groups with no designed cooperative strategies (Lou et al., 2001).

**Evaluation Purpose and Questions**

As suggested by theory and research, while descriptive studies suggest instruction in virtual worlds encourages learning by doing, research has long suggested no significant difference in learning achievement based on the media used to facilitate instruction (Clark, 1983, 1994, 2001). Further, the results of both problem-centered and group-based instruction suggest the strategies employed affect the learning outcomes. Therefore, the purpose of this implementation evaluation was to provide decision makers with a description of what happened during the challenge, as well as an examination of the efficacy and efficiency of the challenge as a group-based and problem-centered experience. The evaluation attempted to answer the following questions. What were participation levels during the challenge implementations? Were sufficient resources and support offered to participants? What was the nature of the participants’ experiences within the challenge? What was the efficiency and efficacy of the learner assessment processes?

**Method**

This two-year evaluation examined the implementation of a small-group problem-centered design challenge that was designed, developed, and implemented by an aerospace research and education institute for teams of middle and high-school student competitors participating in both face-to-face and virtual world settings. Independent evaluators, whose experience centered on advanced and online learning environments for education and training, conducted the evaluation. The evaluation examined two complete implementations of the challenge occurring between September 2010 and April 2012 and included an expert review of instructional materials, participant perception surveys and interviews, direct observation, and a review of challenge outcome and activity data. The following describes the participant characteristics, the evaluation design, and the document collection and analysis procedures used in this evaluation.

**Participant Characteristics**

During Phase 1 of the 2010-11 implementation, 693 people registered on the challenge website. Registrant groups included college students \( n = 94 \), college professors \( n = 8 \), high-school teachers \( n = 123 \), high-school students \( n = 378 \), and others \( n = 90 \). By the end of Phase 1 of the 2010-11 design challenge, teams of four to five high-school students prepared 24 team-based submissions of potential solutions to an authentic engineering design problem under the guidance of their middle and high-school teachers or after-school coaches. During the 2011-12 implementation, the challenge also included middle-school student competitors and participation increased to over 57 teams submitting their proposed solutions in Phase 1. During each of the implementations, the potential solutions submitted from teams in Phase 1, only 20 teams were selected to progress to Phase 2 of the challenge that was held in the virtual world. In Phase 2 of the design challenge, the student teams were no longer guided by their teachers or coaches, but were instead supported virtually by (a) challenge facilitators employed by the aerospace institute, (b) 20 college student team leaders who volunteered to mentor one team of four or five students, (c) 15 challenge assessors,
including college engineering students and professors who volunteered to assess the work of the teams, and (d) five college student technology specialists who were paid to provide technology support to the teams.

**Evaluation Design**

The implementation evaluation was an iterative process of information gathering, sharing, analysis, and reporting, along with continuous discussion between the evaluation team and challenge implementers about what worked well and areas requiring revision. The reviewers evaluated the degree to which the instructional presentation, learner practice opportunities in the problem-centered scenario, and embedded guidance and support would affect student outcomes. In addition, the evaluators considered the overall efficiency of the instruction’s implementation, including the ease with which participants were able to interact within the instructional environment.

**Data Collection and Analysis**

The evaluation began with an expert review of the instructional materials prior to the 2010-11 challenge implementation. The challenge evaluations were also based on surveys and interviews with participants, as well as the evaluation team’s observations and document reviews from the challenge, including the design assessments of each competing team.

**Expert review of materials.** For the expert review, the evaluation team reviewed the instructional materials and resources embedded and linked from the challenge website. The virtual world was under development at the time of this pre-implementation review and was not included in the expert review of materials. The reviewers’ evaluation focused on the instructional merits (effectiveness and efficiency) of the instruction, as well as the usability of the instructional materials presented to participants. In evaluating the instructional merits of the instruction, the reviewers considered the degree to which the instructional presentation, learner practice opportunities, and embedded guidance (or feedback) may influence student learning. In addition, the evaluators considered the overall efficiency associated with the instruction’s implementation. With regard to usability, the evaluators considered the ease with which participants would be able to interact with the instructional environment, including issues of accessibility and user instructions and support.

**Surveys and interviews.** The purpose of the interviews and surveys was to capture participant perceptions of the challenge. At the conclusion of Phase 1 of each implementation, each school teacher or coach who participated during Phase 1 received a link to an online perception survey. A primary aim of this survey of the teachers and coaches was to understand the teachers’ motivations to participate. In addition, all college student team leaders and student competitors were asked to complete an online perception survey at the conclusion of Phase 2 in each challenge implementation. All surveys were developed by the evaluation team with input from the challenge facilitator and focused on the participants’ perceptions of the challenge.

At the conclusion of the 2010-11 challenge implementation, interviews were conducted with three challenge evaluators who performed team assessments. In addition, frequent informal conversations were held with the challenge facilitator throughout both implementations of the challenge.

**Observation and document review.** The evaluators had access to both the challenge website and the virtual world. They observed the challenge implementation from the initial orientation sessions prior to the 2010-11 implementation through the final team presentations at the conclusion of the 2011-12 implementation. Observation and document reviews provided information about overall participation and the teams’ outcome assessments. In addition, the evaluators reviewed correspondence between the challenge facilitator and the teams, including documents related to both challenge facilitation and team assessment. The challenge facilitator provided the evaluation team with documents related to the assessments, including the scores assigned to the challenge designs and summary comments from the challenge assessors.

**Challenge Materials**

As problem-centered instruction, the design challenge required the students to solve realistic science and engineering problems that were tied to national standards and focused on the students’ STEM skills and knowledge. The instructional content provided teachers and students with a short list of prior knowledge expectations, as well as a roster of standards addressed in the challenge based on the National Science Education Standards, and those of the National Council of Teachers of Mathematics, the International Society for Tech-
not actually participate in the challenge as designed. In contrast, during the 2011-12 implementation, over 110 teams registered for Phase 1 with 57 teams submitting their work for consideration in Phase 2.

**Resources and Support Adequacy**

**Website content.** Within the post-challenge surveys, 13 teachers and coaches responded in 2010-11 and 12 responded in 2011-12. Teachers and coaches noted the value in the provided content, including the video clips of engineers and information about the design process. Several teachers and coaches added written comments to the surveys indicating that they were able to integrate the project into curriculum and that the challenge aligned to course objectives and standards. Overall, the structure of the challenge offered teachers and coaches a high degree of flexibility to incorporate the design challenge into both classroom and after-school settings, while offering outreach and professional development to educators.

**Student competitor support.** Student challenge competitors participated in Phase 1 of the challenge under the direction of an adult educator (either their classroom teacher or another adult coach). In Phase 2, college-level participants were recruited to fulfill the roles of team leaders, challenge assessors, and technology specialists. In both the 2010-11 and 2011-12 post-challenge surveys, over 90% of the student competitors viewed the team leaders as responsive and supportive. In addition, when asked to consider the effectiveness of the college team leaders in the challenge to guide the student competitors, one challenge assessor noted that while it was unlikely that any team leader (or challenge assessor, for that matter) would be an expert in the design specifications for the challenge problem, it could be expected that a college-level engineering student would have the necessary research skills to seek out and find the relevant background subject matter. Ultimately, the challenge assessor saw the team leader role as mobilizing, scheduling, making themselves available, and helping the student competitors properly create their virtual world spaces during Phase 2.

**Challenge facilitation.** In conversations with the evaluation team, the challenge facilitator noted that participants needed information regarding both the subject matter of the design problems and the administration of the challenge, as well as gentle prodding and support once the challenge was under way. While

**Participation Levels**

For the 2010-11 implementation, only 24 teams completed Phase 1, below the desired 60 to 70 teams. In addition, one Phase 1 coach worked with 32 teams as part of an online after-school program. This coach had 14 teams complete Phase 1 and all were selected for Phase 2. Therefore, only 10 of the teams that completed Phase 1 advanced registration were not part of this online after-school program. As such, the majority of teachers and coaches who registered on the challenge website were considered tourists who arrived at the website to seek information about the challenge and to download available free resources, but who did not actively participate in the challenge as designed. In contrast, during the 2011-12 implementation, over 110 teams registered for Phase 1 with 57 teams submitting their work for consideration in Phase 2.

**Findings**

From an analysis of the data collected, the following describes the two challenge implementations. This description includes the participation levels, the resources and support adequacy, the participant experiences, and the learner assessment processes.
the teachers, coaches, and team leaders had the primary roles of mentoring the student competitors through either Phase 1 or Phase 2 of the challenge, the challenge facilitator acted as the overall challenge implementer during each phase. The challenge facilitator oversaw the teams’ progress, offered mentoring suggestions, coordinated with the challenge assessors, facilitated guest speaker presentations, and connected teams to technology specialists. In addition, the challenge utilized a range of new technologies to connect geographically dispersed groups of participants. As such, the challenge facilitation required considerable forethought in terms of participant needs and required support.

The challenge facilitator also noted the need to be “hands on” during the Phase 2 portion of the challenge in order to coordinate the roles of the team leaders, challenge assessors, and technology specialists. Based on observations of the evaluation team, the facilitator role was crucial to the overall success of the challenge. As noted by one of the professors involved in the challenge assessment, those involved in the challenge facilitation did a “killer job” in development and implementation.

Technology support. The five paid college technology specialists were each assigned to four teams during Phase 2 of each challenge. In terms of training, not all technology specialists agreed within the survey that training for this position prepared them for the tasks they performed. One noted, “We all seemed lost … we didn’t really know what we should be doing.” In other written comments, the specialists indicated that they learned as they went and that the “training process never really stopped.” One suggested spending time looking at the problems the students and technology had during this challenge and focusing future training on those types of problems.

In addition, survey responses from the technology specialists suggested that each team used their services used differently. While one specialist reported all that was required of a specialist was “familiarity with tech, free time, and a background with virtual worlds”, all specialists felt that handling more than five or six teams would diminish the quality of service provided. Most noted the best part of working with the design teams was seeing the realization of the competitors’ hard work. Yet, the specialists noted that a challenge for supporting the teams was the need to clarify periodically the specialist’s limited role with the team (for example, to clarify that specialists were unable to help with the design itself). In addition, several noted they spent a lot of time explaining the use of modeling software and various modeling terms to the competitors. One specialist suggested streamlining the model building process by offering or suggesting a set of tools that are easy to use and have the required capabilities for the challenge.

Participant Experiences

Teachers and coaches. A primary purpose of the teachers and coaches survey was to understand why more teachers did not progress further within the challenge. However, only 12 of the 123 teachers and coaches who registered on the website completed at least part of the 2010-11 survey. Not surprisingly, only six of registrants who did not complete Phase 1 completed the survey. Of those, four responded that they utilized the website materials with students, but did not complete Phase 1 challenge requirements, while the other two did not use the materials with students. Of those who did not complete advanced registration, 80% responded that lack of time to devote to the project and lack of student interest were contributing factors, while 60% felt unclear of their role in the challenge.

In both the 2010-11 and 2011-12 surveys, all teachers and coaches who completed the survey agreed that the instructional goals and objectives of the challenge were clearly stated, and agreed that they would recommend the challenge to other teachers. While half of the 2010-11 respondents felt more incentives were needed to proceed to Phase 2, only one respondent in the 2011-12 survey felt more incentives were needed. In both the 2010-11 and 2011-12 surveys, approximately half of the respondents felt that no changes were needed in terms of support, while the others wanted more guidance on how to run Phase 1 and saw a need for additional instructions on the website, tutorials or webinars on how to implement the challenge, and questions and answer sessions.

While nearly 90% of responding teachers and coaches in the 2010-11 survey saw value in the provided content, such as video clips of engineers or information about the design process, only 25% of respondents to the 2011-12 survey listed this content as one of the best components of the challenge. The difference could suggest teachers repeating their participation in the challenge relied less on the provided sub-
ject matter content. However, in written comments, one respondent to the 2010-11 survey noted a problem accessing the videos due to system IT lockout at the school. In addition, most survey respondents saw benefit in the opportunity for students to work with college engineering students and engineering professionals, as well as the opportunity to participate with teams in a virtual environment with other students. Several added written comments to the perception surveys indicating that they were able to integrate the project into curriculum and that the challenge aligned to course objectives and standards.

**College student team leaders.** Of the 16 college team leaders who responded to the 2010-11 end of challenge survey, 80% agreed that they enjoyed working on the challenge. Written comments within this survey of the college student team leaders suggested that virtual team coordination, communication, and technical difficulties caused delays for the teams. However, within the 2011-12 end of challenge survey, only five college team leaders responded, but all agreed that they enjoyed working on the challenge, suggesting implementation improvements in support of the team leaders. Approximately half of the college student team leaders in both the 2010-11 and 2011-12 surveys agreed that the team leader role and responsibilities were well defined within the challenge, while over 90% of the team leaders in both surveys agreed that their students learned a lot by participating in the challenge.

Regarding team communication, nearly all of the team leaders who responded to the 2010-11 and 2011-12 surveys reported communicating with the teams using email. Other commonly used communication tools were Google Docs and Skype. Further, email and Skype were frequently identified in the comments as the communication tools that the teams preferred to use. As a sign of the changing times, less than half of the teams in both years reported using phone voice calls.

**Student competitors.** In both the 2010-11 and 2011-12 post-challenge surveys of the student competitors, every respondent agreed that he or she enjoyed working on the challenge, except one student who expressed frustration working with the team’s leader. In addition, surveys, interviews, and observations suggested a high level of participant engagement by most competitors during both challenge implementations. In the student competitors’ post-challenge surveys, students noted that the challenge required creativity and challenged their ability to think critically and to adhere to deadlines. Student competitors listed interacting with others interested in engineering, guest speakers, applying engineering design principles to complete a project, gaining experience with 3D modeling, learning about virtual worlds, and learning about efficient collaboration as the most rewarding aspects of the participating in the challenge. Most student competitors agreed that they learned about working in a virtual environment, communicating through online tools, and the engineering design process by participating in the challenge.

Between both the 2010-2011 and the 2011-2012 post-challenge surveys, all but a few student respondents agreed that the challenge staff was responsive and supported the team’s work, and written comments noted that support from the technology specialists and the challenge facilitator were especially helpful. Similarly, most student competitors agreed that the team leader was responsive and supportive and they learned a lot in the challenge, including how to work on a team. In questions about collaborating in the virtual space, several student competitors commented that they liked using the virtual world to build and create within their own spaces and that working in the virtual world offered them the chance to meet different people from across the country.

In terms of the least-liked aspects of the challenge, technical difficulties and virtual team communication and collaboration were mentioned. Further, respondents from the first implementation wrote of limitations associated with the creation, movement, orientation, and rendering of objects within the virtual world, while some commented that working in the virtual space “was glitchy”, “resource intensive”, and “extremely challenging”. While most agreed that the technology was responsive and supported the team’s work and that the team received the help and support needed to complete the challenge, other student competitors were either neutral or dissatisfied with the help and support received. A review of the written comments suggested a desire for additional support regarding both the use of modeling programs and how to import and display the developed models within the virtual world.
**Challenge assessors.** Feedback from the challenge assessors during their interviews was generally positive about the challenge and the challenge assessor’s role and responsibilities. Overall, they felt those involved in the challenge did a good job in developing and facilitating the challenge. Yet, each offered constructive suggestions for the future, primarily geared toward guiding and supporting the challenge assessors, clarifying the team member expectations and objectives, and structuring the final synchronous presentations for team assessment. Suggestions included bringing the challenge assessors into the project earlier in the challenge. One recommended that the challenge assessors should view the teams’ work products early in the timeline, which would offer greater consistency across the challenge. In addition, periodic conference calls among challenge assessors were suggested as a means to raise and answer important and frequently-asked questions.

**Learner Assessments**

During Phase 1 of the challenge, no formal assessment occurred and the team competitors did not receive formal feedback from challenge facilitators. Instead, only the teams selected to progress to Phase 2 received the college team leader’s informal assessment of the design artifacts submitted by the teams at the end of Phase 1. All learner assessment in Phase 2 of the challenge was team based. The primary team assessments that occurred during Phase 2 portion of the challenge included both a first review (mini-assessment) and a final review of the project. The purpose of the first review (mini-assessment) of the teams was to give informal feedback to participants regarding each team’s progress in the challenge based on a three-tiered rating scale (well developed, developed, or not developed). The ratings were based on the extent to which the team space was formalized and personalized, the extent to which aspects of the problem were addressed, how thoroughly the documentation was presented, how clearly the documentation supported the proposed solution, and the overall navigation and organization of the space. The challenge facilitator noted that this first review served as a wake-up call that offered the teams advice on what areas were in need of development and a reminder of the specific assessment criteria in the challenge rubric.

The purpose of the final assessment of the teams was to select the top five finalists and to select the winner of the challenge based on the finalists’ presentations within synchronous sessions held in the virtual world at the end of the challenge. While only a few points separated the top finalists, the challenge assessors’ comments suggest a difference in both the amount and quality of work displayed between the low scoring teams (“very little teamwork evidence”, “knowledge space is lacking in content”, “vague descriptions”, and “I didn’t have much to go on”) and the high scoring teams (“team space was very thorough”, “high level of detail”, “organized”, “very nicely thought out and presented”, “Your team engaged in the design process, and “I am thoroughly impressed”). Given that the team’s performance was based on their presentation, the challenge assessors noted in the post-challenge interviews that they found it difficult to assess some team’s efforts due to the lack of a well-developed and sufficiently descriptive virtual world team space. One challenge assessor suggested that in future implementations the students should develop their virtual world team space as a museum that documents both the process and outcome of each team’s design effort. However, the challenge assessors reiterated the feedback of the technology specialists, team leaders, and student competitors that the students needed a certain level of skill and knowledge both in manipulating the virtual environment and in modeling. One challenge assessor noted that gaining those skills during the challenge was likely a large cost to the teams, one that may have influenced team performance in the challenge.

During the synchronous presentation sessions at the end of Phase 2, the challenge assessors scored each team’s (a) introduction, presence, and tour, (b) knowledge space, and (c) virtual models. Scores were based on an assessment rubric that focused on each team’s ability to explain the designs and design process, as well as the accuracy of the 3D representations of their proposed solution. Compiled feedback from the challenge assessors suggested an assessment emphasis on the relative strength of the team’s live presentation (such as delivery and timing), development of the team space (such as too much or too little detail), aspects of the models (such as uniqueness, development, and level of detail), and level of elaboration on the thought process that went into solutions. While the assessment rubric contemplated the accuracy of the proposed design solution, this aspect of the assessment...
accounted for less than 20% of the possible points. Further, little written commentary was provided by challenge assessors regarding design accuracy.

When asked to consider the overall performance and learning outcomes of students in the challenge, one challenge assessor noted during his interview that, given the nature of the challenge and the assessment parameters, the assessment centered on the quality of each team’s design process and design presentation versus the quality and accuracy of the design itself, or the individual student’s contribution or level of understanding. Another challenge assessor noted room for more "rigorous criticism for the students" while another suggested potential value in some form of standardized assessment. Another suggested giving teams the opportunity for peer assessment, in which students were able to analyze the work of other teams. In general, the challenge assessors found it effective to have at least three challenge assessors per team and they felt their comments during the first review assessment lead to team improvement.

Discussion

Results of this evaluation suggest the challenge offered student teams a unique opportunity to engage in authentic science and engineering problems with the support of college-level and professional experts. However, results also suggest recommendations to improve future implementations. The following summarizes the key strengths of the challenge, as well as the evaluation team’s recommendations to enhance the effectiveness and efficiency of the design challenge.

Strengths

**Authentic design challenge.** A key strength of the challenge was the authentic science and engineering design problems. As noted during the expert review, the challenge was tied to national standards and focused on the students’ skills and knowledge in science, technology, engineering, and math. Several teachers and coaches added written comments to their surveys indicating that they were able to integrate the project into curriculum and that the challenge aligned to course objectives and standards. Through a variety of online tools and virtual spaces, the students tackled real-world design scenarios using a range of new technologies to support their learning. Surveys, interviews, and observations suggested a high level of participant engagement by most student competitors.

Student competitors noted that the challenge required creativity and challenged their ability to think critically and to adhere to deadlines. Further, student competitors listed interacting with others interested in engineering, the guest speakers, applying engineering design principles to complete a project, experience with 3D modeling, learning about virtual worlds, and learning about efficient collaboration as the most rewarding aspects of the challenge. Overall, the structure of the challenge offered teachers and coaches a high degree of flexibility to incorporate the design challenge into both classroom and after-school settings while offering outreach and professional development to educators.

**Access to science and engineering resources.** Educators with the motivation to engage their students in the design challenge had a wealth of resources at their disposal. Once registered on the website, educators and students received recommended strategies to approach a design challenge, as well as a host of professionally produced documents, diagrams, and videos associated with the design problem. Within the surveys, teachers and coaches noted the value in the content, including the video clips of engineers and information about the design process.

**College recruitment.** A sufficient number of college-level participants were recruited to fulfill the roles of team leaders, challenge assessors, and technology specialists. Through word of mouth and by targeting engineering departments, recruitment of support roles was adequate for current participation levels. As noted in the surveys, the student competitors viewed the team leaders as responsive and supportive.

Recommendations

**Preparing for growth.** Both recruitment and support for teams are important future growth considerations. During the first challenge implementation, the recruitment of competing teams was lower than hoped (and lower in particular with teachers or coaches in a traditional school setting) with less than 10% of registered teachers completing Phase 1. A re-examination of recruitment strategies was recommended, particularly if a goal of the challenge was to support teachers and students in traditional classrooms. Recommendations
included not only outreach to traditional and online high schools, but also additional support to teachers and coaches, including added clarity regarding role definitions and challenge timelines, guidance on team building, and the inclusion of Phase 1 assessment activities to incentivize the teachers and teams to commit to the challenge. In addition, as seen by the strong participation of after-school online teams, intact groups that are looking for project-based activities for their members should be targeted.

The importance of the challenge facilitator role cannot be understated in terms of both implementation success and growth of the challenge. It was recommended that the challenge facilitation role be formalized and defined. A facilitation playbook should be developed for future challenges that address relevant implementation topics, such as communication, support, and mentorship to challenge competitors.

In addition, the challenge implementers must more closely examine the scalability of all support roles. How many teams can be supported within the challenge as it is currently designed? How many students can each team leader mentor? How many teams can each technology member support? Future challenge planning must answer these important questions as they directly affect the efficacy and effectiveness of the challenge.

Support for support staff. Additional support was recommended for those who support the student competitors. As found during observation, surveys, and interviews, the teams often stumbled over similar hazards (often in issues related to communication and technology) and technology specialists fielded similar questions across teams. Not all of the team leaders responding to the surveys agreed that the team leader role and responsibility was well defined within the challenge. Similarly, not all technology specialists agreed that training for the position prepared them for the tasks they performed and most learned as they performed their jobs. Recommendations included the creation of guides and frequently asked question (FAQ) responses developed by prior team leaders, challenge assessors, and technology specialists to assist those in the future by addressing commonly occurring situations or problems. Periodic live meetings among support roles would also offer the opportunity to share and compare ideas and to ask questions. Further, the inclusion of live orientation for the challenge assessors (as was done for team leaders) early in the timeline would add consistency in the assessment process.

In addition, college students provided much of the mentorship, assessment, and support needs to challenge competitors. An advisory committee that includes faculty in engineering and science at a college or research center would provide additional guidance to mentors, especially in grading and assessing designs. Further, support for team leaders regarding the technical aspects of the designs could be added as part of the professional guest speaker sessions.

Assessment. While the assessment process effectively and efficiently served the purpose of comparing teams for the selection of both finalists and the winning team in the challenge, all assessment was team-based without a focus on the individual student’s skill and knowledge development. In addition, no formal assessment occurred during Phase 1 of the challenge beyond the selection of Phase 2 by the team leaders. Further, the assessment placed a far greater emphasis on the design process and presentation choices of the students than the accuracy or viability of the engineering design, which may explain why one challenge assessor felt there was room for more rigorous criticism and why few student competitors ranked the level of difficulty of the challenge as high. Given that the assessment focused heavily on the team’s ability to display their skills and knowledge (which was based on how well the team used the modeling software and manipulated the virtual world), it was difficult to determine whether the low scoring teams did not have the ability to develop accurate designs or if they merely had difficulty in displaying their designs due to problems manipulating the modeling software and their virtual world space. Recommendations included (a) incorporating individual assessment, possibly in the form of team leader and/or peer review, (b) adding a formal assessment during the Phase 1 of the challenge, (c) offering an orientation regarding the use of modeling programs and how to import and display the developed models into the virtual world, (d) refining the Phase 2 assessment rubric to emphasize the quality of the design as much as the quality of the design presentation, and (e) amending the format of the final synchronous presentation sessions to assess the teams separately over a longer period.

Collaboration and technology considerations. Within the participant surveys, several respondents...
noted frustration over the difficulty in day-to-day collaboration and communication within the virtual teams. In addition, teams noted technical difficulties, including the creation and display of their models, which was a central requirement of the challenge. Particularly during the first implementation, teams relied heavily on communication tools outside of the provided virtual space, including email and Skype. In addition, teams sought out a variety of free or freely available modeling tools that may or may not have offered the greatest effectiveness and ease-of-use both outside and inside the virtual world. While offering the teams the flexibility and freedom to choose the tools that work for the team was important, it was recommended that team collaboration and technology considerations be addressed with team leaders at the start of the challenge, including suggestions for tools to support communication and modeling that offer the required capabilities for the challenge. The creation of a team leader guide and FAQ would also help to document what works and potential pitfalls. In addition, a mid-challenge team member assessment of the team leader and other team members helped to identify teams encountering collaboration problems.

Conclusion

As suggested by theory and research, while descriptive studies suggest instruction in virtual worlds offers an immersive online learning environment that fosters interaction and collaboration, research has long suggested no significant difference in learning achievement based on the media used to facilitate instruction. Instead, the results of both problem-centered and group-based instruction suggest the strategies employed affect learning outcomes. Therefore, the purpose of this implementation evaluation was to provide decision makers with a description of what happened during the implementations of this problem-centered challenge set in a 3D virtual world, as well as an examination of the efficacy and efficiency of the challenge as a group-based experience. Overall, the evaluation team found the strengths of the challenge included (a) the use of an authentic science and engineering design problem, (b) access to science and engineering resources and professionals, (c) effective challenge facilitation, and (d) successful recruitment of team mentors. Recommendations centered on (a) needed adjustments to both achieve and prepare for growth in team participation, (b) expanded support for team mentors and technical support, (c) refined assessment, including both individual and team-based assessment approaches, and (d) collaboration and other technology enhancements.

References


Integrating Student Analysis of Error into the Design of Customized On-line Modules for Teaching a Topic in Business Statistics

Jayson Kunzler, Brigham Young University — Idaho
D. Sammons, Idaho State University

Abstract: This paper describes an approach to student error analysis that was developed as part of a project to design, create, implement and evaluate customized instructional modules to teach the topic of normal distribution in an undergraduate business statistics class. In order to identify the required content for the modules, detailed steps within the ADDIE model were followed. These included using detailed objectives to conduct an even more detailed analysis of the tasks that would be required of students in order to master the objectives.

Keywords: Student analysis of error

Error Analysis

Error analysis is a term used by many different disciplines, and that has multiple meanings. A recent search of Google Scholar indicates tens of thousands of articles with error analysis in their keywords. And, while a generic definition of error analysis might suggest a simple determination of how or when errors occur, error analysis in the sciences may examine the degree to which a measurement may vary around a mean or how two estimated values may change if parameters are changed. In the field of education, error analysis has a long history of application in mathematics (e.g., Radatz, 1979) and in second language acquisition (e.g., Corder, 1967, 1978). More recently, Narciss and Huth (2004) explored error analysis in the context of developing informative tutoring feedback. In this paper, we propose a unique approach to using error analysis in the field of instructional design – that is, a way to integrate ethnography of errors, if you will, into the design and development of remedial learning objects.

The Project: Customization of Online Instruction in a Business Statistics Course

The purpose of the larger project was to implement customized online learning modules for undergraduates in a business statistics course. These modules were to act as intelligent tutors, providing highly individualized instruction and remediation as needed by the learners. A single topic, the normal distribution, was selected. The full accounting of the project is the subject of Kunzler’s (2012) dissertation research. In this current paper, we would like to address a specific part of the project: how student errors were identified and deconstructed as part of task analysis.

After the development of eleven specific objectives in the Analysis Phase, a task analysis determined the sequence of steps that a learner would need to complete in order to accomplish each objective. Table 1 displays Objective Four and its task analysis as an example. Eighteen different steps are needed to complete the task and demonstrate mastery of Objective Four.
Table 1

Task Analysis for Objective #4 (from Kunzler, 2012)

Objective #4: Given a normally distributed dataset, a computer spreadsheet, and a numerical value, the student will correctly calculate the Z-statistic that corresponds to the numerical value.

<table>
<thead>
<tr>
<th>Task Attributes</th>
<th>Required Tools</th>
<th>Domain(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Hi, Med, Lo)</td>
<td>Remediation</td>
<td>Cognitive</td>
</tr>
<tr>
<td>Difficulty</td>
<td>Duration</td>
<td>Computer</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>M</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Open the dataset in a Microsoft Excel® spreadsheet</td>
</tr>
<tr>
<td>2.</td>
<td>Identify the appropriate column or row of values that comprise the normally distributed dataset</td>
</tr>
<tr>
<td>3.</td>
<td>Select a blank cell on the spreadsheet</td>
</tr>
<tr>
<td>4.</td>
<td>Enter the first part of the formula to compute the mean value by typing “=average(“ in the cell</td>
</tr>
<tr>
<td>5.</td>
<td>Use the mouse cursor to select the column or row of values identified in Task #2 above</td>
</tr>
<tr>
<td>6.</td>
<td>Type “)” into the cell after selecting the values</td>
</tr>
<tr>
<td>7.</td>
<td>Finish the mean formula by pressing the enter key</td>
</tr>
<tr>
<td>8.</td>
<td>Select another blank cell on the spreadsheet</td>
</tr>
<tr>
<td>9.</td>
<td>Enter the first part of the formula to compute the standard deviation by typing “=stdev(“ in the cell</td>
</tr>
<tr>
<td>10.</td>
<td>Use the mouse cursor to select the column or row of values identified in Task #2 above</td>
</tr>
<tr>
<td>11.</td>
<td>Type “)” into the cell after selecting the values</td>
</tr>
<tr>
<td>12.</td>
<td>Finish the standard deviation formula by pressing the enter key</td>
</tr>
<tr>
<td>13.</td>
<td>Select another blank cell on the spreadsheet</td>
</tr>
<tr>
<td>14.</td>
<td>Enter the given value into the cell</td>
</tr>
<tr>
<td>15.</td>
<td>Select another blank cell on the spreadsheet</td>
</tr>
<tr>
<td>16.</td>
<td>Option A: Calculate the Z-statistic by entering the formula “=(x-m)/s”, where x, m, and s are entered by clicking on the cells that contain the given value, the calculated mean, and the calculated standard deviation, respectively</td>
</tr>
<tr>
<td>17.</td>
<td>Option B: Calculate the Z-statistic by entering the formula “=standardize(x,m,s)”, where x, m, and s are entered by clicking on the cells that contain the given value, the calculated mean, and the calculated standard deviation, respectively</td>
</tr>
<tr>
<td>18.</td>
<td>Round the Z-statistic to the nearest hundredth, tenth, or whole number (as specified)</td>
</tr>
</tbody>
</table>
In order to design and develop the customized learning modules, it was critical to understand what types of errors students might make in completing this task and in attempting to meet Objective Four. An analysis of student errors was undertaken in stages – the analysis first asked WHAT errors the students made, then WHERE in the task sequence the errors were made, and finally, WHY students made those errors. While the WHAT and WHERE questions are more typical of the Design Phase, it was the qualitative study of WHY that provided the best approach to designing the instruction itself.

**WHAT errors did the students make?**

To identify which errors students might make while attaining the objectives, a 10-item achievement assessment (which had been determined to be aligned with the objectives) was administered to the undergraduate business statistics class in the semester prior to the implementation of the study (Kunzler, 2012). These students had completed instruction on the topic, the normal distribution. Student responses were recorded and categorized by response. The frequency with which any given response occurred was calculated. Figure 1 shows the frequency of each response for Question 7, which was aligned with Objective 4. Question 7 was a free-response (not multiple choice) item. As can be seen, only six students (9%) returned the correct answer; 91% of students responded incorrectly.

Although the identification of WHAT errors occurred was useful in identifying preliminary patterns of incorrect responses, it was not adequate to facilitate the design and development of the customized instructional modules. Knowing WHAT errors occurred (and their frequency) primarily highlighted the most common errors and indicated that most students were unable to master the objective. In a routine ADDIE process, knowing that most students missed this question and could not meet the objective might provoke a design response of repetition and additional practice. However, merely adding more problems would not meet the goals of the project, which was to create highly individualized instruction.

![Figure 1](image-url). Sample Frequency Chart Showing Frequency of Given Student Responses.
**WHERE did students make their errors?**

The next attempt to analyze errors in a way that would inform the design process was to map the errors against the elements of the task. In this step, students were asked to describe their error, and then each students’ descriptions were compared to the specific steps in the task. In the example for Question 7 below, Table 2 contains a few of the students’ descriptions, and Figure 2 shows how all the students’ descriptions are summarized *vis à vis* the tasks pertaining to Objective Four.

As can be seen in Figure 2, almost all of the student errors were related to Task 4, #17: *Calculate the Z-statistic by entering the formula “=standardize”.*

**Table 2.**
Sample of Student Responses and Errors for Question #7.

<table>
<thead>
<tr>
<th>Response</th>
<th>Correct?</th>
<th>Self-Explanation for Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40</td>
<td>N</td>
<td>I didn’t use the right formula. I didn’t get the right Z, I also rounded the inputs, I used Normdist instead of standardize.</td>
</tr>
<tr>
<td>1.00</td>
<td>N</td>
<td>I didn’t know which function to use so I got it wrong. I calculated normdist of 660 to get 1.</td>
</tr>
<tr>
<td>0.25</td>
<td>N</td>
<td>I did it right but I put a positive .25, when it is a negative .25.</td>
</tr>
<tr>
<td>-0.54</td>
<td>N</td>
<td>I understood the concept but must have entered some info wrong I put -54.</td>
</tr>
<tr>
<td>-0.25</td>
<td>Y</td>
<td>I got it correct.</td>
</tr>
<tr>
<td>0.40</td>
<td>N</td>
<td>In this problem, you should use the “STANDARDIZE” function. I used the “NORMDIST” function instead.</td>
</tr>
<tr>
<td>1.00</td>
<td>N</td>
<td>I put 1 because I did the formula normdist and put 660 and it gave me one. I didn’t really understand what I was looking for.</td>
</tr>
<tr>
<td>0.40</td>
<td>N</td>
<td>I got this wrong because I used the NormDist formula instead of using the standardize formula.</td>
</tr>
<tr>
<td>0.35</td>
<td>N</td>
<td>I guessed, I really had no idea what to do.</td>
</tr>
<tr>
<td>0.61</td>
<td>N</td>
<td>I got it wrong and I used the normdist formula which was the wrong formula. Should have used the standard function.</td>
</tr>
<tr>
<td>0.40</td>
<td>N</td>
<td>I did the mean and the standard deviation but I used it in the wrong formula. I did the NORMDIST instead.</td>
</tr>
<tr>
<td>0.40</td>
<td>N</td>
<td>I couldn’t remember how to get the z score, I used the normdist function and put that as the answer.</td>
</tr>
<tr>
<td>0.25</td>
<td>N</td>
<td>I didn’t know if it needed to be written as positive or negative so I wrote it out as a positive number in the quiz answer.</td>
</tr>
</tbody>
</table>

**Figure 2.** Sample Frequency Chart Showing Frequency of Errors According to Task.
However, once again, using this method to identify potential topics for the customized instructional modules proved to be insufficiently helpful: there is not a fine enough discrimination between the student descriptions when those descriptions are mapped onto the task list. Therefore, combining an error analysis with the task analysis could not form an adequate basis for the design and development of the customized instructional modules.

**WHY did students make their errors?**

Although the task analysis itself was important in designing the instructional programs, categorizing student errors by corresponding task proved to only be marginally useful because it resulted in insufficient differentiation among the student error categories. Comparing the WHAT category of error (Figure 1) with the WHERE category of error (Figure 2) indicates that only three steps within the task analysis were involved. Five different incorrect responses were given by two or more students, and several other incorrect responses were given by individual students. The five different incorrect responses were made by 91% of the students! If customized remedial instructional modules are to be successfully designed and developed, the source of student error must be more fully understood. Therefore, a final and different approach to the problem was attempted: understanding WHY students made the errors they did.

In this approach, again using only Question #7 as an example, each of the six responses (one correct and five incorrect) were analyzed in conjunction with the students’ self-stated reasons for their answers. Students who had arrived at the same (incorrect) response had different reasons for coming to that response; and students who had arrived at different (incorrect) responses had actually committed the same error. Individual student self-reported reasons were analyzed and coded into error categories. The coded error categories were phrases that summarized specific student behavior that led to the error. As indicated in Figure 3, although five incorrect responses were given by two or more students, there were six different error categories identified by the researcher.

As shown in the sample data in Figure 3, the most common student error on Question #7 occurred when students mistakenly used the `normdist` function instead of the `standardize` function. Another fre-
ently occurring error for this question was the omission of the negative sign. This step in the process allowed the designer to identify the most common errors and to develop customized instructional modules based on the identified reasons for common errors. It also allowed the designer to determine if the cost of developing customized instructional modules would be too high for uncommon errors.

The process exemplified in the tables and figures in this paper for Question 7 and Objective Four were followed for each of the ten questions of the assessment, for each of the eleven instructional objectives, and for each of the elective task lists. In every case, the final qualitative consolidation of self-reported student error analysis (the WHY error analysis) proved to be the most useful in designing and developing the customized instructional modules. Only the final WHY error analysis provided critical discrimination among error types and supported the development of the final customized instructional modules.

The Application in Support of the Error Analysis

In a final note, among the unique aspects of this student error analysis is the fact that all the analyses themselves – the tabulation of correct and incorrect responses, the WHAT, WHERE, and WHY analyses – were all conducted within a single Microsoft Excel spreadsheet utility (Kunzler, 2012). The senior author was able to program Microsoft Excel to analyze the data and to display those data in a series of dashboard graphics enabling the user to move from one question to another, and from one analysis to another, by using drop down lists and option buttons. Programming these features in Microsoft Excel appears to be a new contribution to the functions of the spreadsheet application in error analysis.

Conclusion

The analysis of student errors was a very helpful and necessary input into the process of designing and programming the customized instruction. The results of the analysis were used to predict the errors students will most likely make in the future, thus enabling the development of logical algorithms for launching customized instructional content when student errors exist. The error prediction then warranted the development of a specific piece of customized instruction to be launched for students who made an error during one step of the process. In the custom module developed for this larger project (Kunzler, 2012), these pieces of customized instruction were delivered to individual students as video content. A unique piece of video content was developed for the purpose of instructing students for each type of error made during instruction. The customized modules would have been much more limited if WHAT student errors only had been identified. Instead, by also understanding WHERE and WHY student errors occurred, the resulting modules were completely customizable to student needs.

References


Teaching Online and Blended Courses: Perceptions of Faculty

Joseph Madaus, University of Connecticut

Abstract: With more postsecondary classes being taught online or in a technology blended format, faculty face new challenges in regard to planning their courses, delivering course content, and engaging students. This article presents the results of interviews with 25 faculty members from five postsecondary institutions about the advantages and challenges presented by online and blended courses, as well as specific techniques used to teach in the digital environment, and methods to enhance communication with students. Specific recommendations for faculty contemplating, or preparing to teach electronically are also presented.

Keywords: Online courses, blended courses, faculty perceptions

Online and technology blended courses are among the fastest growing trends in postsecondary education. In their analysis of responses from 2,590 postsecondary institutions, Allen and Seaman (2010) reported that 5.6 million students, typically undergraduates, were enrolled in at least one online class during the fall, 2009 semester. This represents one in three students total, and an increase of 21% from the 2008 academic year. In fact, the number of students enrolling in online courses increased 19% from 2002 to 2009, a number that greatly outpaces the less than 2% overall growth in student enrollment (Allen & Seaman, 2010).

As the number of electronic course offerings increases, the literature points to a divide between faculty who are willing to learn and utilize new technology-based pedagogical approaches and those who are unwilling to dispense with their established pedagogies for new methods of teaching (Georgina & Olsen, 2008). According to the literature, there are five key concerns faculty hold regarding teaching online, including: (1) trepidation relating to issues around technology; (2) concerns regarding greater workload; (3) apprehension over the lack of face-to-face communication with students; (4) worry about the lack of student autonomy; and (5) concerns over the quality of online courses (Allen & Seaman, 2006; Conceicao 2006; El Mansour & Mupinga 2007; Gahungu, Dereshiwsky, & Moan, 2006; Harker & Koutsantoni, 2005; Hathorn & Hathorn, 2010; Hensley, 2005; Koenig, 2010; McGee & Diaz, 2007; Mills, Yanes, & Casebeer, 2009; Murphy & Cifuentes, 2001; Oblinger & Hawkins, 2006). Each of these areas of faculty concern is summarized below.

Issues with Technology

Faculty adoption of technology is influenced by perceptions of the effectiveness of the technology (Zhao & Cziko, 2001). According to a survey of 24 faculty conducted at Chicago State University (Gahungu, Dereshiwsky, & Moan, 2006), there is a lack of knowledge, skills, and direct experience by faculty with the necessary technology to teach online. The lack of direct personal experience appears to create resistance to participating fully in online instruction.
Additionally, although faculty may receive little or no support to design and implement online courses, few faculty members possess the instructional design skills necessary to design effective online or technology blended courses (Oblinger & Hawkins, 2006). This can be the result of multiple factors, including a lack of administrative support, time constraints, and lack of institutional commitment to specific technologies (e.g., hardware or software) (Irani & Telg, 2002; McGee & Diaz, 2007). The lack of support of faculty and expertise by faculty with technology to develop and implement an online course can lead to feelings of isolation (Georgina & Olsen, 2008; Li & Akins, 2004).

Faculty may experience additional frustration when incorporated technology fails or provides access issues for students (Thomas & Parker, n.d.). Technology is not always user-friendly; for example, some software will not open in earlier versions or across multiple platforms (e.g., Windows and Mac, or Microsoft and Freeware). Although students’ experience and adoption of technology generally outpaces that of faculty (McGee & Diaz, 2007), students do not possess an innate knowledge of how to use all technology (Lorenzi, MacKeogh, & Fox, 2004). Furthermore, students tend to perceive their own technology skills as far greater than their actual skills (Grant, Malloy, & Murphy, 2009), which can create additional frustrations for faculty when attempting to assist students when issues arise.

**Increased Workload**

Several researchers have noted that many faculty are concerned about the workload involved in planning, designing and teaching online courses (Allen & Seaman, 2006; Conceicao 2006; Hensley, 2005; McGee & Diaz, 2007). In fact, Shelton and Saltsman (2006) observed that this is one of the greatest issues impacting faculty participation in digital teaching. Transitioning from teaching a traditional face-to-face course to teaching in the online environment is not a simple task for most faculty members (Grant & Thornton, 2007). It is not enough to post traditional material to a course web site; instructors must find ways to get students to engage with, analyze, and reflect on course content within the digital environment (Georgina & Olson, 2008). As Lindsay (2004) observed, “Transforming assignments, texts, and other course materials into an online environment can be difficult” and time consuming (p. 16). Additionally, once planned, the digital format makes a course “omnipresent”; meaning it requires faculty to rearrange their schedules to respond to the continuous posts, emails, and inquiries that are sent at all times of the day, everyday, which is time consuming (Conceicao 2006).

**Interaction with Students**

The lack of in-person contact with students also influences faculty perspectives of teaching in the digital learning environment (Koenig, 2010). In an online course, there is an inability to perceive students’ body language, initial responses or reactions to content, as well as a lack of visible, real-time engagement (Conceicao, 2006; El Mansour & Mupinga, 2007; Gahungu, Dereshiwsky, & Moan, 2006; Mills et al., 2009). Compounding this issue is that online classes require the building of a virtual learning community, which entails much more and more frequent feedback than in face-to-face courses (Baglione & Nastanski, 2007; Hathorn & Hathorn, 2010; Murphy & Cifuentes, 2001). Thus, it can be a challenge learning to communicate effectively in this electronic medium (Lindsay, 2004).

**Student Autonomy and Motivation**

The digital learning environment requires that faculty continually keep students focused, on-task, and engaged (Conceicao, 2006; Hathorn & Hathorn, 2010), due to the fact that faculty perceive difficulties in student autonomy and sustaining student motivation in online and technology blended courses (Harker & Koutsantoni, 2005; Murphy & Cifuentes, 2001). It is observed that students procrastinate and lack the time management skills to pace themselves to complete assignments on time in online courses (Gahungu, Dereshiwsky, & Moan, 2006). Some faculty members perceive that students also lack effective communication strategies to correctly express their ideas and needs in a digital format (not using proper spelling and grammar in online communication, incomplete sentences, unawareness of netiquette) (Gahungu, Dereshiwsky, & Moan, 2006).
Quality of Online Courses

Faculty members have also raised questions about the quality of education in the digital learning environment. Results from several surveys indicated that many faculty perceive online courses as an inadequate substitute for face-to-face, traditional courses (Allen & Seaman, 2006; Gahungu, Dereshiwsky, & Moan, 2006; Mills, Yanes, & Casebeer, 2009). This perception appears to be influenced by several factors, including a lack of confidence in technology to be an effective instructional medium (Mills et al., 2009), a lack of knowledge and research-based studies on how technology impacts learning in the digital environment (Koenig, 2010; Mills et al., 2009), and issues involving intellectual property and copyright (Oblinger & Hawkins, 2006; Passmore, 2000).

Rationale for the Study

The intent of this study was to examine the perceptions of college and university faculty related to the advantages and challenges offered by online and technology-blended courses. Additionally, the investigation sought to elicit information related to methods used by faculty in planning, delivery of content, and assessment of students in their courses. As noted in this literature review, researchers, in several existing studies, have examined a specific perception held by faculty of teaching online. However, in this study, information was elicited related to a wider range of perceptions held by faculty regarding advantages and challenges to teaching and engaging students in the digital environment. Moreover, most other studies have been focused on faculty from singular institutions. The present investigation worked with faculty across several states, from several different types of higher educational institutions (a community college, a liberal arts college, state universities, and a Research 1 institution).

Method

Interview Sample

The research team requested nominations of faculty to interview from contact people (disability services, Institutes for Teaching and Learning, Instructional design teams, faculty development offices) at each institution. In total, 73 faculty members were nominated and were then emailed directly and invited to participate. Twenty-six faculty members responded, and 25 from five schools were interviewed.

Interview Protocol

In order to gather information related to faculty experiences and perceptions about online and technology-blended courses, an interview protocol was developed. The interview (see Appendix A) began with three “icebreaker” questions, followed by two general questions about perceptions of differences, advantages, and challenges to teaching in a digital medium versus face-to-face, and about technologies used. The remaining questions were clustered around course planning, content delivery, assessment of learning, students, and professional development related to teaching online. The complete protocol was initially reviewed and refined by the authors and three other professionals, one of who was from an external institution. It was again reviewed after piloting with two faculty members at one of the participating institutions. One of three graduate assistants who were trained by the principal researchers conducted each interview, and a guide of terms (see Appendix B) was created to ensure consistency across interviews. Thirteen of the interviews were conducted over the phone and 12 were conducted face-to-face; each interview lasted between 20 to 50 minutes.

Data Analysis

Each recorded interview was transcribed completely by the graduate assistant who conducted the interview. The authors then read each transcript independently and a set of common themes and key words that emerged were developed. The transcripts and the key words were entered into NVivo9, a qualitative software program to provide additional frequency analysis of the data. The resulting NVivo reports were again coded to align the key words with supporting comments by the interview participants.

Results

The results will be presented according to the main themes that emerged in the interview data. First, the demographic information about the sample will be discussed, followed by faculty observations related to: (1) technology; (2) workload; (3) interaction with students; (4) student autonomy; and (5) quality of courses
with an online component course organization and planning, content delivery and student assessment, and communication and engagement with students. Within each of these areas, advantages and/or challenges will be described as presented by the participants. Finally, suggestions from the faculty to peers who are planning to teach online or blended courses will be presented.

Characteristics of Faculty Respondents
The interviewed faculty represented 17 different unique disciplines, while an additional six reported being affiliated with multiple disciplines. Eleven members of the sample reported teaching blended courses only, five had taught only online courses, and nine reported experience teaching in both formats. Seven faculty members had 6-10 years of experience teaching, while fourteen had 11 or more years of experience. Fourteen of the faculty reported having experience with students with disabilities in their courses, and 13 reported providing accommodations to students because of a disability. In terms of professional development in teaching online and blended courses, 14 of the faculty members reported using multiple sources, five reported attending a workshop, four described themselves as self-taught, and two stated that they looked to peers for help.

Issues with Technology
The primary emphasis related to technology from the participants was not on problems related to technology, but rather the need to focus on the pedagogical reasons and objectives for teaching online and blended courses, instead of on the technology alone. One participant stated, “you need to have a good pedagogical reason… You can’t just have technology because it’s shiny and new and sexy….I always asked, ‘does this make good pedagogical sense? What is my learning objective?’ That’s got to be your first question.” Another described conversations with peers who are preparing to teach electronically, stating:

The questions I ask them are: ‘what are your goals and objectives for the course? What is it that you want students to know and be able to do at the end of the course … then I would talk to them about the different kinds of technologies … I always ask about pedagogy first not about the technology.’

This idea was summarized by one participant who stated, “Let the technology support that journey as opposed to driving that journey.”

Whereas the literature points to issues with faculty knowledge of technology, and in keeping up with students, some of the respondents instead commented on students’ lack of knowledge of and facility with technology. One professor observed, “The non-traditional students that are a little older that are not as tech-savvy. They take a lot longer to get into the technology” which requires “more time teaching the students that are non-traditional how to use it”.

Increased Workload
Just as was found in the literature, the amount of time and planning required to teach online and blended courses was the most commonly cited concern (noted by 17 participants). As one faculty member stated, “to do it right, you have to put in an awful lot of time front ending it so you have the course completely thought out and designed up front”. Another observed:

You really have to write down each and every step. Because this is online, you’re not going to be there and they have to read everything and understand everything by themselves. You can’t really skip any steps. It’s challenging in that respect. Planning and organization is the hardest part of it.

Several faculty members also commented on the challenges of keeping up with students and responding to messages throughout the semester. One stated, “Especially if you do it right, which means a lot of involvement by the participants in threaded discussions and conversations. Because the online students expect very rapid feedback.”

However, the faculty also cited some time-related advantages offered by online and blended courses. Specifically cited was the flexibility offered by online and blended courses, both to faculty and to students. For example, it was noted that online courses
can be conducted while travelling, and that it allows busy people to plan the course “around your life.” One faculty member specifically noted that this has benefited a range of students, including students with disabilities, student athletes, and students who were studying abroad. One participant described an interesting benefit offered by this flexibility in teaching a blended course, stating that:

By the end of the semester, no matter who you are, the kids get tired of you, so there’s a point that’s really nice because you all have a break from each other. Where you just need to do some learning on your own and I think that’s a really nice aspect of hybrid.

Being able to complete the work at anytime, anyplace, as well as being able to break up learning, and the ability to go back to particular points were also specifically cited by the faculty as advantages for students.

Interaction with Students

Nine of the faculty interviewed observed that online and blended courses require student involvement, because students “can’t hide” in the digital environment as they can in a face-to-face course. One faculty member elaborated that:

Participation by students in our program can be a problem. They come to class, they want to be told exactly what they need to know, and don’t really ask questions or participate as much as I would like them to. But in an online format, they have to, because otherwise they can’t successfully complete the course.

Another respondent commented that, “They [students] have learning modules that they have to respond to every week and they can’t just go ahead. I know who’s participating.”

Ten of the faculty discussed how online and blended courses allow students increased opportunity for participation. This included allowing students both time and privacy to process and reflect on course information, particularly for those quieter students who don’t like to actively participate in a face-to-face course. As one faculty member explained, the online postings “gave the students who are quiet an opportunity to voice their opinions and voice their ideas online. In the [face-to-face] class I had to pick on those students a lot. Sometimes, I think they were intimidated.” Another respondent described that an online or blended course “allows for a level or participation from students who are not necessarily socially excited to be in the class.” One faculty member also noted:

I get 100% class participation in my online class, whereas a face-to-face class, you don’t get that. I know which people are the first to post, I know who does their research before they post, I know the people who post last, I know the people who post at two in the morning and do their work in the morning, I know the people who are trying to squeeze things in during their lunch breaks and maybe breakfast, posting at that time.

Eleven of the respondents also commented on the fact that online and blended courses provide opportunities for more frequent feedback to and engagement with students, as well as prompting them to higher levels of application of the course material. One specified, “any time a student wants to chat with me, e-mail me or speak on the phone, I am always there for them.” Another described that students get weekly feedback regarding their progress in the course, and that “keeps them in shape.” It was noted that because students are required to participate, there is the chance to obtain what one faculty member described as “an inside peek into many of the students where in a regular class only a handful of students are participating.” This contributor elaborated that this allows the gathering of “more examples of where students might be struggling with a concept.” Several faculty members talked about being able to jump into discussion postings, to get involved with prompts and follow-up questions, rather than just passively observing. As one faculty member summarized:

I participate. I’ll throw in challenging questions. So you mentioned this theorist, tell me more. How is he

The Journal of Applied Instructional Design • Volume 3 • Issue 1
directly related to the product? What
would he say about it if he were in
the room? Why would he be an ad-
vocate for it?

Another noted that the use of an online jour-
nal requires students to be “extracting key concepts
and bringing them to life somehow and making them
personally meaningful so that I know that they really
fully understood the concepts.”

The online environment can pose challenges
for student interaction, however. Twelve of the faculty
discussed the drawbacks caused by not being able to
see students, and to gauge their non-verbal reactions
and emotions in class to course expectations and direc-
tions, and to course content. One participant described
this as follows: “The most obvious one [challenge] is
lack of personal contact and dealing with problems that
are best handled face-to-face. Sometimes students have
trouble accessing the material and it’s more difficult to
explain it to them via e-mail rather than demonstrat-
ing.” Another respondent stated, “You don’t have feed-
back immediately from students. Usually you can read
the non-verbal to see if they’re getting it and you can
readjust, so that doesn’t seem to exist as easily in the
online environment.”

**Student Autonomy**

Supporting findings in the literature, some of
the participants described issues in student motivation
and engagement. One faculty member stated that:

Occasionally a student will drop off
the radar and you don’t have anyway
to grab them, whereas in a live class
you may be on campus and can give
them a call but online instructors
have to be very cognizant of if you
don’t hear anything for a week you
have to find them.

It was also noted that online courses are not a good
match for students who lack autonomy. One partici-
pant explained “they have to self-discipline themselves
so I think that’s the biggest challenge. You have to
courage them. I also find myself posting messages
like, ‘you guys are doing good. Keep up the good
work.’” This thought was described as follows: “online
students have to be with the class the whole way
through. If you are a procrastinator, don’t take an
online class. It’s not going to work because it demands
your attention every week and to drop off the radar for
two or three weeks, you’ll never get caught up again.”

**Quality of Courses**

Several faculty members explained that online
and blended instruction requires a thoughtful and or-
ganized approach to instruction, which can enhance
course quality. This included careful consideration of
learning objectives and instructional approaches. One
interviewee stated that:

I think you have to be more thought-
ful [while teaching in the digital en-
vironment] because I think people
tend to teach the way they’ve taught
or how they’ve seen people teach
and it can be kind of repetitive and
you have a tendency to be not as
reflective but if you’re in an online
environment you really need to think
about how you structure your course.

The most commonly cited advantage (noted
by 16 participants) was being able to assess students
differently and to provide increased feedback. The
faculty members described that, depending upon the
type of assessment, some of this feedback can be pro-
vided instantaneously, but also that the feedback can
be structured in such a way that the students “get in a
rhythm for it.” Technology also provides an avenue
for providing this feedback, as one respondent com-
mented:

I have found that even using track
changes in Word is really helpful, it
is a lot faster and easier to send feed-
back back to students online than it
is for them to wait three or four days
until I can see them again to give
them a paper back.

The online platform also allows for what one faculty
member called “touch points” and attitudinal surveys,
where the students can “pull it all together before we
move on.” Another described the use of an online poll-
ing program and stated:

At the end of a discussion or at the
end of the lecture, I present a ques-
tion. And whether it is a straight
knowledge or a critical thinking
question; I mix it up. I present that question at the end of a presentation or lecture and the students answer the question via texting. And we know the results right away of people who understood the main concept and was the class 50/50 of 98% understanding the main concept. Obviously, if it’s 50/50, there is a lot more discussion that needs to go on. But if everyone is getting the content, then I move on.

Suggestions from the Faculty

Just as the interviewed faculty stressed the issue of time in course planning and content delivery from their experiences, the most common suggestion provided by the respondents for their colleagues preparing to teach online or blended courses was to allow more time for course planning. Noted by nine of the participants, comments related to time included, “Definitely put in the time for planning, it is really rewarding and a good experience” and “give yourself a lengthy period of time to create the course because it does take longer than you think.” Another faculty member advised:

Be ready to spend as much if not more time than you do in preparing for your classroom situations. I thought this was going to be less time consuming; it was actually more, definitely more for the online course because with the classroom you prepare, you walk in, you deliver it once to whoever many, so you’re there for an hour, two hours, whatever your course is. When you’re online, we were asking for a lot of threads, and posting the content, and explaining it, so you had to explain it to each individual who asked you the question. You could make some announcements, but yet you may be answering some questions individually, and it does take a lot to prepare and post especially if you are having to interact with the conversation threads. It took a lot of time, and also monitoring it, you don’t want it to go too far and drift. I found it to be more time consuming so be ready for that. Be ready to support your students not only for teaching them the content but also making sure that they know how to navigate the technological part of it. Some students will be really savvy with it and some will not be.

In regard to the amount of planning required, one faculty member suggested:

Get prepared because we can’t really leave it to the last minute and be like ‘OK, I’m teaching online this semester. Let’s start’. It can’t be like that. I started preparing my stuff way earlier. I started preparing three months before. I’m telling you I’m still not done. I’m still preparing stuff, so it’s a long process. Start early.

On a related theme, six of the participants advised their peers to start slowly, and to “recognize that the first time through is not going to be that smooth, there are going to be bugs in it and it’s not going to be perfect. Give yourself a couple of years to work it out.”

Eight of the participants advised their peers who are thinking about going into online or blended instruction to seek out assistance and guidance from peers and other supports on campus. One faculty member suggested “enjoy this process, get good help, find resources, and develop relationships with the people who know more about this because those are the people who can solve problems of a technological nature or even content wide.” Attendance at professional development sessions on campus, independent research, and even being placed into a peer’s existing class were specifically recommended. As one faculty member summarized: “don’t plow into it independently, but learn from those who have gone before and have already been there and learned from those mistakes. You not only don’t have to re-invent the wheel, you don’t need to reinvent the flat tire.”
Discussion

Prior studies have identified technology as a barrier to faculty considering online and blended instruction. These studies have pointed to faculty comfort level and ability to work with technology in online and blended courses, as well as frustration when technology fails to work as planned (Gahungu et al., 2006; Oblinger & Hawkins, 2006; Thomas & Parker, n.d). The faculty interviewed for this study certainly acknowledged these concerns, but seem to be comfortable in working around them, regardless of institution type (a community college, a liberal arts college, state universities, and a Research 1 institution). Several faculty pointed out the need to start with only a few pieces of technology, and then to add more features as one’s comfort and skill level increases. Likewise, the faculty were clear in the need to seek out support and to get help, wherever possible, to work out many of the technology issues that might arise. However, perhaps most importantly for college teaching, the faculty encouraged their peers to think about their pedagogy first and foremost, and then the technology that helps them to meet their pedagogical needs.

Perhaps the most commonly cited challenge to online and blended teaching by the sample members was the amount of time required. This was noted in the challenges regarding planning a course and keeping up with students’ interactions throughout a course, as well as in the recommendations for peers considering online and blended instruction. This clearly reflects findings in the existing literature regarding greater workload required to teach an online or blended course and was a concern of faculty across disciplines and across types of institutions.

Although in the literature researchers have noted that some faculty have concerns with the lack of personal interaction with students, many of the faculty interviewed from all types of institutions appear to view online and blended courses as a way to promote and foster student involvement and communication. The lack of non-verbal feedback and the inability to monitor student reactions for understanding was certainly noted, but several of the faculty described that by focusing carefully on developing a course community, by setting clear expectations and providing clear directions, and by building in frequent assessment points and providing on-going feedback, this concern can be overcome.

Likewise, and often because of the lack of face-to-face contact, the faculty who taught online across institutional types confirmed some of the issues noted in the literature related to student self-motivation and autonomy. Some faculty described methods to prompt students and to keep them engaged to help overcome this, such as calendar postings or frequent emails with course updates. One faculty member noted that “I send out regular e-mails with regular announcements summarizing what we’re all doing….I do things like that but I’m [in] touch with them every other day as a group.” Providing frequent and fairly rapid feedback was described as method to engage students, as was offering positive comments after a strong posting. One faculty member explained that by using an audio program to create narrated messages, students reported that the course seemed more personalized. Certainly, many of these approaches tie into faculty observations about needing to allocate more time for online instruction, but the faculty also noted limits to how far they were willing to go. As one respondent stated:

Perhaps the most commonly cited challenge to online and blended teaching by the sample members was the amount of time required. This was noted in the challenges regarding planning a course and keeping up with students’ interactions throughout a course, as well as in the recommendations for peers considering online and blended instruction. This clearly reflects findings in the existing literature regarding greater workload required to teach an online or blended course and was a concern of faculty across disciplines and across types of institutions.

Although in the literature researchers have noted that some faculty have concerns with the lack of personal interaction with students, many of the faculty interviewed from all types of institutions appear to view online and blended courses as a way to promote and foster student involvement and communication. The lack of non-verbal feedback and the inability to monitor student reactions for understanding was certainly noted, but several of the faculty described that by focusing carefully on developing a course community, by setting clear expectations and providing clear directions, and by building in frequent assessment points and providing on-going feedback, this concern can be overcome.

Limitations and Areas of Future Research

This study is limited given the small sample size from each of the 5 institutions. An expanded investigation with a larger sample size across the types of postsecondary institutions will add weight to the findings. Also, future studies that examine outcomes related to retention and learning for students with disabilities, will add to our understanding of the impact of the digital learning environment at the postsecondary level. Students with disabilities make up approximately 11% of all undergraduates in the United States (National Center on Education Statistics, 2009) and students with learning disabilities made up roughly 3% of all incoming freshmen in 2008 (Pryor et al., 2008). As noted by several researchers (Bohman, 2004; Bohman & Anderson, 2005; Crow, 2008), the online access needs of students with such hidden disabilities is largely not addressed in the professional literature.
Summary

Colleges and universities are increasing the number of online and blended course offerings. Clearly, the digital environment offers advantages (e.g., flexibility, communication and engagement with students, varying assessments) and challenges (e.g., time demands, lack of in-person communication, required student autonomy) to faculty teaching in this medium. These advantages and challenges are paradoxical. For example, online courses give faculty the advantages of flexibility, but the challenge of the time required to teach online courses. Another example is the opportunity for communicating with and engaging students in online courses, but also lack of in-person communication. Faculty considering or planning to teach in an online or blended format should allow time to plan and organize their course, including activities that will develop a community of learners, set clear expectations, build in frequent assessment points, and provide on-going feedback. Additionally, faculty should focus on the pedagogical needs of the course content first, and then the technology that will implement those requirements.

References


Gahungu, A., Dereshiwsky, M. I., & Moan, E. (2006). Finally I can be with my students 24/7, individually and in groups: A survey of faculty teaching online. Journal of Interactive Online Learning, 5(2), 118-142.


Training for Impact on Sexual Harassment: A Case Study in Applied Learning Theory

William Swann, Youngstown State University

Abstract: In this study, principles drawn from behavioral and cognitive theories and related empirical studies were translated into practical guidelines instructional designers can apply in the process of developing e-learning courseware. The guidelines were then applied during the analysis and development phases of two new series of e-learning courses on the topic of sexual harassment prevention. One series was geared toward an audience of managers and the other to non-management employees. Comparisons are made with the previous e-learning series on the same topic developed by the same e-learning provider. Total course pages were reduced from 264 to 55 and 85, respectively; the percentage of content pages that use audio and imagery, without text, rose from 8% to 67% and 57%, respectively; total display of words on content pages decreased by 92%; and interactivity rose from 29% of total course pages to 38% and 39%, respectively.

Keywords: e-learning, cognitivism, behaviorism, cognitive load, multimedia, sexual harassment, compliance, Sweller, Mayer

Sexual harassment prevention is one of the most common topics for formal training in the workplace. A 2010 survey by the Society for Human Resource Management (SHRM), the world's largest human resource management organization, found that 80% of its membership of HR professionals work for companies that provide sexual harassment training to their employees (SHRM, 2010). Commercial e-learning providers have been eager to develop courseware relevant to this topic and to periodically upgrade their offerings. Development of sexual harassment courseware runs parallel to the evolution of the industry as a whole, from early courses that offered on-screen text and questions, to the addition of audio, to the application of animation, video, and more sophisticated forms of interactivity.

A full range of media elements are now available to instructional designers, which presents opportunities for relatively full application of learning research to the selection and blending of media. This study examines the application of research from the behavioral and cognitive schools of learning theory to the development of workplace sexual harassment training. Major findings from the research are examined, translated into concrete development standards, and applied in the process of developing two series of sexual harassment courses, one aimed at managers and the other at non-management employees. Data are then compiled regarding the usage of various page types, followed by analysis of the connection between page type usage and the application of specific development standards.

Training Objectives

The training initiative under discussion in this study focuses on sexual harassment in the workplace, including sexual harassment law, the steps that can be taken to prevent harassment, and how to respond to
incidents when they occur. The audience consists primarily of employees at companies in the United States, with separate modules offered to managers and non-management employees.

The training has three main objectives. The first is to provide a solid basic understanding of workplace sexual harassment issues, including the law, expectations regarding workplace behavior, strategies for prevention, and steps that can be taken when an incident takes place.

The second goal is to meet the requirements of state laws in California, Connecticut, and Maine, where workplace sexual harassment training is legally mandated. California requires at least two hours of training for management and supervisory employees. All three states require coverage of the provisions of Title VII of the Civil Rights Act of 1964 that underlie most sexual harassment law. All three also require coverage of the types of conduct that constitute harassment and remedies that are available to victims of harassment. California and Connecticut require coverage of strategies for prevention, practical examples drawn from case law, and the essential elements of a corporate sexual harassment policy (California Code of Regulations 2 §7288; Connecticut General Statutes, §46a; Maine Revised Statutes 26 §807).

The third primary objective is perhaps the most important. With a target audience that includes virtually anyone in the United States with a job, the full range of attitudes and perspectives on this controversial topic can be anticipated. Grappling effectively with the issue of workplace harassment involves impacting both the broad perspectives of employees at most workplaces and the perspectives of those who may be at risk for engaging in inappropriate behavior. The third training objective is to impact the perspectives of both sets of employees. Both the general workplace atmosphere and the attitudes of some sets of employees are key considerations if training is to contribute to meaningful change in the workplace.

Reaching this audience requires a balanced and realistic approach, one that learners can readily connect to the everyday workplace environment. It requires content that conveys both a strong sense of authenticity and substantial emotional impact. A review of training currently in the market underscores the difficulty in meeting this objective. The video vignettes commonly used to illustrate harassment often fail to match, in substance or impact, the real cases of harassment a training professional may learn about while developing relevant courseware. Giving the learner a genuine and substantive sense of the topic requires careful deliberation and novel approaches.

### Cognitive and Behavioral Learning Theories

Over the last half century, empirical research has made great strides in clarifying the processes that take place in the brain when human beings learn. Studies in the cognitive and behavioral schools of learning theory dramatically broaden and deepen our understanding of the factors that influence learning outcomes. These two schools converge on the subject from opposite directions, with behaviorists building an external model of environmental conditioning, and cognitivists focusing on internal processing that takes place in the brain.

### Cognitive Theories

The cognitive school has been broadly influenced by the rise of information technology in recent decades and the insights computers give us into the ways in which information may be efficiently processed. Cognitive models trace the way information enters the system through the senses, how it is maintained in short-term memory, how it interacts with previously acquired knowledge, and how it is processed and ultimately stored in long-term memory. The brain is viewed as an information processing system with input, storage, and processing components that interact in dynamic ways (Huit, 2003).

Recent research in the cognitive school carries special significance for practitioners in the field of e-learning. When training is delivered electronically, it often involves packages of media elements that are combined to create multimedia experiences for the learner. The focus in the cognitive school on the way the senses take in media elements and how they are processed addresses the practical issues faced by e-learning developers in their everyday work.

Recent empirical research in the cognitive school led to the development of two major learning theories. The first is Multimedia Learning Theory, associated with the research and theoretical analysis of psychologist Richard Mayer (Mayer, 2001). The second is Cognitive Load Theory, developed by psycholo-
gist John Sweller (Sweller, 1998). These two theories are strongly related, with interconnected research programs and largely complementary perspectives. Empirical support has steadily increased for both theories.

Basic research into the audio and visual channels of short-term memory provides the foundation for both theories. Each of the two channels is limited in capacity, and each is partially independent of the other. This means we can store more information if both are used than we can with either channel alone (Penney, 1989). This basic finding provides the foundation for multimedia as a learning tool. It tells us that multiple sensory channels can access greater capacity in working memory than any single channel.

Multimedia Learning Theory. From the perspective of Multimedia Learning Theory, the brain takes in information through the audio and visual channels, and it constructs verbal and visual models to make connections between information in the two streams. After processing the information, the resulting mental constructs are saved as schema in long-term memory and integrated with related information that was previously learned. Learning is the building of these schema in persistent, long-term memory (Mayer, 2001; Mayer & Sims, 1994).

Instructional design principles drawn from Mayer's work suggest that designers should utilize both the auditory and visual channels to present information, and that related information should be contiguous so as to facilitate connections between the information and the building of verbal and visual models (Mayer & Moreno, 1998).

Recent research into the audio and visual channels of short-term memory clarifies some of the important differences between them. In the auditory channel, information is taken in automatically. A learner who is exposed to an auditory stimulus will, in the absence of another stimulus, automatically draw it into the auditory buffer. The information is stored in an acoustic code (A-code) in short-term memory. If the information is verbal in nature, it also generates a phonetic code (P-code). Generation of the phonetic code suggests that humans automatically make language sounds out of the verbal acoustic signals they pick up (Baddeley, 1986; Penney, 1989).

In the auditory buffer, information persists over time. The acoustic code produces an echo effect that reverberates in the buffer and keeps the information in short-term memory. It may stay there for as long as sixty seconds, in the absence of another audio stimulus (Engle & Roberts, 1982). The echo effect causes acoustic information to associate in sequential fashion, so the brain correlates audio information in temporal sequence (Penney, 1989).

The visual channel has substantially different characteristics. It processes non-linguistic visuals (such as pictures, charts, and diagrams) efficiently. This is why Mayer and others found a combination of visuals with audio to be pedagogically robust (Mayer & Anderson, 1992). However, when language is conveyed visually (e.g., on-screen text), it is not taken in automatically in the manner of audio signals. The learner must make an effort to read.

Text taken in visually also lacks the quality of persistence found with audio. Language going through the visual channel has to be processed into the phonetic code, and the learner must attend to the task. The learner must then rehearse the phonetics mentally in order to maintain the information in short-term memory (Penney, 1989).

These empirical findings on the attributes of auditory and visual memory strongly influenced the way cognitive learning theorists such as Mayer and Sweller modeled the learning process. Their experiments show that combining non-linguistic visuals with linguistic audio is particularly effective at promoting learning (Mayer & Anderson, 1992; Sweller, 1998).

Cognitive Load Theory. Sweller's analysis of the learning process begins with the same broad observations of Mayer and others regarding the use of sensory information to store short-term information. He observed that working memory is limited, so it is important to use that capacity to process learning content while leaving aside unrelated information (Sweller, van Merrienboer, & Paas, 1998). Information we take in through these channels represents "cognitive load," partially or wholly filling our limited short-term capacity.

This, for Sweller, was a key finding with sweeping significance for instructional design: The implications of working memory limitations on instructional design can hardly be overestimated. All conscious cognitive activity learners engage in occurs in a structure whose limitations seem to preclude all but the most basic processes. Anything beyond the
simplest cognitive activities appear to overwhelm working memory. Prima facie, any instructional design that flouts or merely ignores working memory limitations inevitably is deficient (Sweller, van Merrienboer, & Paas, 1998, pp. 252-253).

This finding led to the development of the first of Sweller's three concepts of cognitive load. Elements of instruction that do not contribute to schema building are referred to as "extraneous cognitive load" (Paas, Renkl, & Sweller, 2003, p. 2). They occupy part of the learner's working memory with no instructional benefit, so they are harmful to the learning process.

Sweller's second type is "intrinsic cognitive load," which represents the information or content one is attempting to convey to the learner. Inclusion of this information is central because it constitutes the substance of the learning experience (Paas, Renkl, & Sweller, 2003).

The third type is "germane cognitive load," which involves the mental activities that take place as a learner processes information and uses it to build schema in long-term memory. germane cognitive load and intrinsic cognitive load are thus necessary components that function together as learning occurs. Extraneous cognitive load is to be avoided so as not to take up limited short-term memory with information unrelated either to the subject matter or the mental resources needed to process it (Paas, Renkl, & Sweller, 2003).

**Behaviorism**

From the behavioral perspective, learning involves increasing or decreasing the frequency of behaviors. Early behavioral studies focused on simple stimulus-and-response models, while later studies focus on operant behavior, or behavior that is initiated by the learner. The concepts of operant conditioning developed by Edward Thorndike and B. F. Skinner show the relationship between learner-initiated behavior and the stimulus that follows the behavior. Behavior is conditioned -- increased or decreased in frequency -- by the consequences that follow (Thorndike, 1933; Skinner, 1953; Graham, 2010).

Skinner tested the impact of various conditions on animal behavior using the operant conditioning chamber (widely referred to as the Skinner box). The controlled environment of the Skinner box allowed him to introduce different types of reinforcing or punishing stimuli and to vary the schedule of delivery. He found that reinforcers tend to work better than punishers, and that the optimum schedule for learning involved consistent reinforcement given with each episode of the behavior (Skinner, 1953).

While consistent reinforcement was best for initial learning, Skinner discovered that another schedule -- intermittent reinforcement -- worked best for maintaining behavior over time. One variety of the intermittent schedule (variable ratio reinforcement) is the principle upon which most gambling devices work. Rewards are given occasionally, and the number of behaviors that occur between rewards is determined randomly. Thus, a slot machine player continues to feed coins into the machine, and he may be rewarded after a single pull of the lever, or it may take eight or ten pulls. He cannot know how many it will take. This intermittent schedule maintains behavior over time, so what is learned is retained (Skinner, 1953; Ferster & Skinner, 1957; Zuriff, 1970).

Thorndike, another leading behaviorist, found that one of the most powerful reinforcers for human subjects was simply to say "right" to the learner after he got something right. Responding to incorrect answers was not as effective as giving positive feedback for correct answers (Thorndike, 1933). This finding suggests that frequent interactions with the learner in which he has the opportunity to provide a correct answer are effective reinforcers. Setting the learner up to provide frequent correct answers may be more effective than providing more challenging interactions that elicit greater proportions of wrong answers.

Behavioral learning strategies often provide reinforcers in a sequence of stages in which the learner acquires the necessary behavior for the first step, then builds on the first behavior with another behavior, and so on, until a complex task is learned.

**Translating Learning Concepts into Concrete Development Standards**

Courses were produced for the two series discussed in this study using a proprietary tool set developed and modified over a period of fifteen years by a commercial e-learning provider. The tools permit audio, text, still images, animation, video, and user inter-
actions to be combined in packages using an assortment of page layouts. Each course page is an individual HTML file viewable through a web browser. Courses are launched in a browser-based course player with built-in navigation elements.

How do learning concepts backed by empirical research translate into concrete standards that can be applied to the development of e-learning courseware? In this case, certain pedagogies drawn from learning theory were built into the standard tools and development processes as they evolved over the last decade or more. Others were addressed as a set of development guidelines to be applied specifically to the two new sexual harassment series. Both sets of guidelines -- standard and series-specific -- are listed below.

**Standard Tools and Processes**

The following guidelines are standard parts of the course development process with significant support in learning theory:

**Provide a simple, visually appealing course player with intuitive navigation elements.** Both major cognitive theories emphasize the limitations of working memory and the importance of eliminating extraneous information. Thus, an e-learning course player should be simple and clean, lacking in busy visual elements, and it should offer navigation methods that are limited in number and easy to understand upon first encounter.

The sexual harassment series under discussion in this study was released shortly following a full redesign of the standard course player that was released in November, 2011. While the previous course viewer was reasonably simple and intuitive, the new design offers more streamlined, icon-based navigation elements arranged around a larger, plain white content stage. The use of a white stage permits flow between the navigation elements and the stage without boxing of the stage as a visually separate element. More importantly, it permits flow between visual content elements, the stage, and navigation elements through the use of content imagery with transparent backgrounds. The new design minimizes extraneous elements and focuses the learner's attention on meaningful course content that represents intrinsic cognitive load to the learner.

**Apply a pre-production media treatment to the series.** Development of a series-specific media treatment early in the process, before individual courses are developed, allows color schemes and standard media elements to be coordinated and applied consistently to the series. The learner encounters similar icons, imagery, and color schemes as she proceeds through the course. This requires fewer cognitive resources than would be called upon if she encountered unfamiliar schemes or imagery with each new course page.

Pre-production treatment for this series called for the consistent application of photographic and video imagery to illustrate content, rather than a mixture of drawn images and photographs. It also involved developing a standard format for icons that presents them in the form of common office imagery. Finally, it included a collection of standard legal and court-related imagery to be used throughout the series.

**Scale the content to match needs of the learner.** A key consideration in the development of e-learning courseware is the scaling of content to meet the learners' needs, which means the course should not present too much or too little information. Mayer confirmed the significance of this factor in his seminal study on science textbooks, in which less information provided to the student resulted in 50% greater performance on subsequent problem-solving tasks (Mayer, Bove, Bryman, Mars, & Tapangco, 1996).

While a scaling standard seems relatively straightforward, and has long been included in the course development process, it is surprisingly challenging in application. The natural tendency of series analysts and course developers is to offer richer or fuller sets of information, with the expectation that learners will retain more when larger sets of information are presented, or that richer presentations make stronger impressions that support the recall of central points. Cognitive research suggests otherwise, that the limitations of working memory are so profound as to make inclusion of significant amounts of extra information counterproductive, however accurate or relevant to the topic the information may be.

Source materials for this series were obtained from a law firm that specializes in sexual harassment litigation. Part of the firm's work involves giving short presentations that summarize key information to audiences of employees and managers at various corporations. The presentation materials developed by the
firm were used as the content foundation for this series. This facilitated high-level treatment of most topics and in-depth treatment of a smaller set of key issues.

The series analyst reworked materials obtained from the law firm into content documents with appropriate pacing, examples, and interactive elements for development of e-learning courseware. The analyst then worked with a subject-matter expert (an attorney at the law firm) to verify that key topics were adequately covered. The analyst wrote video-based activities using real cases drawn from sexual harassment case law, which the subject-matter expert reviewed and revised. These activities were branded "You Be the Judge" to reinforce for the learner the sense of grappling with real events that sometimes take place in the workplace. The attorney who served as a subject-matter expert was ultimately video recorded in a courtroom setting giving brief explanations of each case, and these videos were used to initiate each "You Be the Judge" interaction.

The analyst discussed additional options and methods for increasing learner impact at length with the subject-matter expert and other training professionals. After reviewing a number of video vignettes available in the marketplace, a less common option was selected by the analyst and SME that involves testimonial-type videos. In that, they were influenced by a series of testimonial videos produced by the Minnesota Department of Human Rights (MDHR, 2008). The analyst wrote scripts for testimonial videos in which actors described the experiences of individuals with different facets of a sexual harassment incident or investigation. The subject-matter expert reviewed these scripts to confirm that they accurately reflected real sexual harassment cases.

Finally, the analyst made the decision to split the material into two series aimed at different audiences -- one for managers and another for non-management employees. Customization of content made it possible to eliminate material from one series that was only relevant to the audience of the other series. The result was an employee sexual harassment series estimated at 1.5 hours in length and a manager series estimated at 2.4 hours. These two series replaced a single previous series estimated at 3.3 hours.

Use full audio for the course. Broadly speaking, content pages for these courses convey information in two forms: text and imagery. Applying full audio ensures that the text portion of the content consistently has an audio component. Some text may be conveyed on-screen, but in those instances the text is also available to the learner as audio.

Full audio applied series-wide reflects a heavy design and resource lean in the direction of audio that is strongly backed by empirical research. Penny, Engle, Mayer, and others identified the special attributes of audio that facilitate easy retention in short-term memory and integration of audio with visual information from pictures, illustrations, and other non-text visuals (Penny, 1989; Engle, 1982; Mayer, 1992).

The courseware development toolset and standard processes applied to these series prompt the creation of audio for every course page. The course player presents audio and associated imagery as the standard and automatic delivery method, with an option provided to turn off audio and view a transcript for learners who either prefer to read or who do not have headphones or speakers.

Series-specific Guidelines

In addition to the four standard guidelines listed above, the series analyst developed five series-level guidelines based on pedagogical principles drawn from learning research.

Use on-screen text sparingly. This is an enhancement of guideline #4 in the standard section above. Full audio is provided for the course, and in some cases text is also shown on screen, but special attention should be paid to the circumstances in which the developer uses on-screen text.

Most content should be conveyed through a pairing of audio with non-text visuals. On-screen text is used sparingly, though it may be used in the following circumstances:

Key terms and concepts. When a major term or concept is introduced, visual display often carries significant benefit for the learner. For example, the first course in the employee series defines the two main types of sexual harassment (quid-pro-quo and hostile work environment). The learner may not know how to spell the Latin phrase "quid-pro-quo" and may feel more comfortable with the term once he sees it. Part of the benefit of displaying major terms has to do with the learner's ability to remain on the page and review the text at her own pace before proceeding to a
new page.

In some cases, major terms or concepts may be listed sequentially on the page as bullet points. On-screen text may be appropriate for bullets that convey concepts the learner is expected to remember and apply later in the course, or, more importantly, that he will need to remember when applying information in his work. On-screen text is less appropriate for concepts or lists when names of the list items are not critical. In the latter case, it is often best to present the information as icon bullets rather than as text bullets. (Icon bullets are small images that signify items in a list and roll out sequentially while the items are being described more fully in audio.)

Extended quotations. The introductory courses in both series call for occasional quotations from sexual harassment law. State-specific requirements in California, Connecticut, and Maine require coverage of the relevant provisions of Title VII of the Civil Rights Act. The analyst felt the most reasonable approach was to cite a paragraph from the law. The course developer’s original treatment involved a combination of audio and non-text imagery (so the learner would hear the definition while seeing relevant non-text imagery, such as an image of the U.S. Capitol Building, where the Civil Rights Act was passed). However, upon review of the course page, the quotation seemed difficult to understand in the absence of on-screen text. Legal terminology in the quotation and uncommon phrasings made it difficult to follow. Treatment of the page was then modified to show the quotation on-screen, with a parchment background to signify the law, along with related imagery. The learner can thus read the quote on the parchment at the same time she is hearing it in audio.

Interactions. When the learner is asked to respond to a question or scenario, the basic facts of the query generally need to remain on-screen after the audio has finished. This gives the learner the opportunity to review key information regarding the scenario, think about it, and consider various aspects of the question at her own pace before answering.

Introduction and summary pages. Each course lesson begins with an introductory page and ends with a summary page. Both pages provide a list of the learning objectives covered in the lesson. These are cases when it helps the learner to be able to pause and consider the topics that are about to be covered (intro pages) or were just covered (summary pages). An on-screen list of the objectives as concise bullet points facilitates those deliberations.

When text is used under any of the above circumstances, it should be phrased as concisely as possible, as bullet point lists or short phrases and sentences. For example, the page that introduces quid-pro-quo as a type of harassment displays the following text while the relevant audio is being heard:

“Quid-pro-quo = this-for-that.”

Using the equals symbol allows the developer to avoid more wordy formulations, such as:

“The term quid-pro-quo means this-for-that.”

Consistently presenting shorter sentences and concise bullet-points allows the learner to digest on-screen text with minimal application of the phonetic processing resources in short-term memory. It also allows the developer to leave behind information on the screen that the learner can digest and contemplate at her own pace before moving forward in the lesson.

Avoid combining the appearance of new imagery with new on-screen text. When information is conveyed via on-screen text, its appearance on the screen should be isolated temporally from the appearance of other visual elements. Thus, when text appears as a bullet point, it comes in as a singular visual change. This avoids compounding the cognitive stress of new text with the stress involved in simultaneous processing of new imagery.

Use a high proportion of interactivity. Both behavioral and cognitive principles support a course design that includes a high proportion of interactive pages in relation to content pages. Interactive pages selected for this series include questions addressed to the learner and video-based activities that present scenarios and ask the learner to evaluate and respond to them.

In behavioral terms, frequent use of interactivity facilitates positive reinforcement for correct answers. In cognitive terms, it places some limits on the amount of content conveyed in a given number of pages (intrinsic cognitive load), and it increases the number of pages that prompt integration of the information and application to examples or cases (germane cognitive load used to build schema in permanent memory).

Apply a variable ratio schedule of intermittent reinforcement to interactions that occur in the content portions of the course. Interactions can go either in the
content sections of the course or at the end of lessons to prompt recall and integration of material. Interactions in the content section provide the course developer with an opportunity to apply a variable ratio reinforcement schedule. Interactions are frequent, but the number of content pages between them varies, so the learner cannot anticipate when they will occur. Interactions should be easy enough for the learner to get right most of the time, thus triggering the positive feedback Thorndike determined to be effective with adult learners.

**Apply a left-side range theory when gauging the level of difficulty of interactivity.** E-learning professionals often discuss the relative value of questions and interactions that are easy for the learner in comparison to more challenging interactions. A combination of behavioral and cognitive principles can be applied to support a certain perspective on this issue.

One can think of interactions on a scale, with less challenging interactions on the left side of the scale and more difficult questions or activities on the right. In Cognitive Load Theory, difficulty is generally measured in terms of element interactivity. Easier questions involve material that can be understood individually, without reference to other information, while more difficult questions or activities have multiple interdependent parts so that the task as a whole cannot be understood without understanding the parts (Paas, Renkl, & Sweller, 2003).

Consider a scale that goes from low elemental interactivity (LEI) to moderate (MEI) to high (HEI), as follows:

![Interactivity Range](image)

**Figure 1. Interactivity Range**

Behaviorism suggests that the LEI side of the scale has substantial instructional value. Allowing the learner to be right, and telling him so, promotes retention of the information. Cognitive research also supports frequent use of LEI for building basic schema, which can be called upon later for completion of more complex MEI tasks. Interactions at the most complex end of the scale should be avoided whenever possible because they are likely to overrun the capacity of working memory.

Cognitive and behavioral principles suggest an ideal range of difficulty from the left end of the scale to roughly the middle:

![Target Interactivity Range](image)

**Figure 2. Target Interactivity Range**

Within this range, there should be a large number of LEI questions and a smaller number of MEI, with the middle interactions drawing on schema developed using LEI questions. In all cases, the developer should strive to make the format of questions easy to digest and interpret, leaving cognitive resources free for the processing of relevant information.

**Applying the Standards**

The guidelines described above can be summarized as follows:

<table>
<thead>
<tr>
<th>Standard Guidelines</th>
<th>Series-Specific Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use a simple, intuitive course player.</td>
<td>1. Use on-screen text sparingly.</td>
</tr>
<tr>
<td>2. Apply pre-production media treatment.</td>
<td>2. Avoid simultaneous appearance of imagery and text.</td>
</tr>
<tr>
<td>3. Scale content appropriately.</td>
<td>3. Use a high proportion of interactivity.</td>
</tr>
<tr>
<td>4. Apply full course audio.</td>
<td>4. Apply variable ratio intermittent reinforcement to content interactions.</td>
</tr>
<tr>
<td>5. Apply a left-side range theory to interactivity.</td>
<td>5. Apply a left-side range theory to interactivity.</td>
</tr>
</tbody>
</table>

These guidelines were applied by course developers in the process of developing both the manager and employee sexual harassment series. Data was then
collected regarding the number of pages in each course that apply various combinations of media, as shown in the following four tables. Application of guidelines B1, B3, and B5 can be assessed, in part, in terms of this data.

Table 2

*Page Usage: Sexual Harassment (employee series)*

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Intro &amp; Summary</th>
<th>Audio +Image</th>
<th>Audio +Image +Text</th>
<th>Text (words)</th>
<th>Vid.</th>
<th>Ques.</th>
<th>Act.</th>
<th>Ex.</th>
<th>Total Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>What Is Harassment?</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>208</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Prevention and Response</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>56</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>Totals</td>
<td>7</td>
<td>12</td>
<td>9</td>
<td>264</td>
<td>6</td>
<td>14</td>
<td>7</td>
<td>0</td>
<td>55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Title</th>
<th>% A+I (content)</th>
<th>% A+I (total)</th>
<th>% Interactivity</th>
<th>% Questions</th>
<th>% Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>What Is Harassment?</td>
<td>65%</td>
<td>34%</td>
<td>41%</td>
<td>22%</td>
<td>19%</td>
</tr>
<tr>
<td>Prevention and Response</td>
<td>70%</td>
<td>30%</td>
<td>35%</td>
<td>30%</td>
<td>4%</td>
</tr>
<tr>
<td>Totals</td>
<td>67%</td>
<td>33%</td>
<td>38%</td>
<td>25%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Table 3

*Page Usage: Sexual Harassment Awareness for Managers (manager series)*

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Intro &amp; Summary</th>
<th>Audio +Image</th>
<th>Audio +Image +Text</th>
<th>Text (words)</th>
<th>Vid.</th>
<th>Ques.</th>
<th>Act.</th>
<th>Ex.</th>
<th>Total Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>What Is Harassment?</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>208</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Prevention and Response</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>307</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>Preventing Harassment</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>36</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>Totals</td>
<td>6</td>
<td>16</td>
<td>20</td>
<td>551</td>
<td>10</td>
<td>22</td>
<td>9</td>
<td>2</td>
<td>85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Title</th>
<th>% A+I (content)</th>
<th>% A+I (total)</th>
<th>% Interactivity</th>
<th>% Questions</th>
<th>% Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>What Is Harassment?</td>
<td>65%</td>
<td>34%</td>
<td>41%</td>
<td>22%</td>
<td>19%</td>
</tr>
<tr>
<td>Prevention and Response</td>
<td>21%</td>
<td>13%</td>
<td>33%</td>
<td>33%</td>
<td>0%</td>
</tr>
<tr>
<td>Preventing Harassment</td>
<td>80%</td>
<td>41%</td>
<td>41%</td>
<td>24%</td>
<td>10%</td>
</tr>
<tr>
<td>Totals</td>
<td>57%</td>
<td>31%</td>
<td>39%</td>
<td>26%</td>
<td>11%</td>
</tr>
</tbody>
</table>
Above we have two data tables for the employee series and two for the manager series. The first table for each series provides the raw data and the second a set of calculations based on the data. Column three of the raw data table (Audio+Image) is key for considering guideline B1, the presentation of content through images and audio without use of on-screen text. Column six (Vid.) indicates the number of video pages. It also applies guideline B1, because videos in these courses included imagery and audio, but no on-screen phrases, bullet points, or other text.

Thus, in the second table, column two -- % A+I (content) -- the percentage of Audio+Image content for each course and each series is calculated, consistent with guideline B1, by adding values in the Audio+Image column to the Vid. column and dividing by the total number of content pages (columns 3, 4, and 6). Content pages that used audio and imagery, without text, accounted for 67% of content pages for the employee series and 57% for the manager series.

Calculations were also made for A+I pages as a proportion of all course pages, including intros, summaries, questions, activities, and exercises. For the employee series, A+I content pages constituted 33% of the total, while for the manager series, they were 31%.

Notice that one of the five courses accounted for a large proportion of the total number of pages that use audio, image, and on-screen text (Column four, Audio+Image+Text pages). There were eleven content pages that used on-screen text in the second course in the manager series, more than twice the average for the other courses. This boost in on-screen text reflects coverage of certain key topics. A manager needs to be familiar with the process that may occur in her department in the event that a sexual harassment complaint arises. The second manager course presents eight guidelines for handling sexual harassment investigations, with each guideline covered on a separate page. With each new page, a numbered item is added to the growing list of guidelines. On-screen text for each guideline ranged between two and four words, so each page added a small number of words to the previous page layout.

In this case, it was possible to apply the principle of minimizing on-screen text while also providing the learner with a key list of procedural items he can review at his discretion on any page in the sequence and print out once the list is complete. The application of guideline B1 is not fully reflected in the data, because each page in the sequence had some text and thus counted as an Audio+Image+Text page.

Guideline B3 (interactivity) can also be assessed in terms of the collected data. In the employee series, 38% of total course pages consisted of interactive elements (questions, activities, and exercises, as indicated in columns seven, eight, and nine -- the Ques., Act., and Ex. columns). The manager series had a 39% interactivity rate.

Guideline B5 is reflected in the types of interactivity used. Activities generally call for more complex processing of course content in ways that involve integration of the material. Questions usually take the form of multiple choice or true/false interactions that require fewer cognitive resources. The courses in these series present a large number of questions (25% of total course pages in the employee series and 26% in the manager series, as indicated in the % Questions column). They also present substantial numbers of the more challenging activity interactions (13% in both cases, as indicated in the % Activities column), but these are roughly half as frequent as questions. Altogether, close to 40% of the pages in these courses involve some form of interaction with the learner.

Comparisons to the Previous Series

The courses in these two sexual harassment series were designed to replace a previous series developed by the same e-learning company. Development guidelines A3, B1, and B3 can be assessed by comparing the new series to the previous series. The follow-

---

1The first course in the earlier series was a single 17-minute video, while the other three were standard HTML-based courses. The video course had different attributes that make it difficult to compare to anything else in the new or old series. Videos for the new series are all brief (less than 3 minutes) and do not display text, while the 17-minute video displayed text periodically in bullet-point format, in addition to audio and visuals. For purposes of measurement, the 17-minute video course was counted as a single video page. The video page was not classified as one of the A+I pages in calculated percentages due to text being displayed in the video.
ing two tables compile data for the four courses of the earlier sexual harassment series.

An adjustment to the scaling of content (guideline A3) is suggested by the 135 total course pages for the new series compared to 264 pages in the old (column ten). The difference is even more dramatic considering the split of new courses into two series aimed at different audiences. Employees in non-management roles complete 55 total course pages, while managers complete 85 pages.

Guideline B1 is reflected in the dramatic increase in A+I content pages (column three). For the old series, 8% of content pages presented imagery and audio, but no text. For the new, the employee series has 67% A+I content pages and the manager series 57%. Total word count (column five) tells a similar story. The old series displayed a total of 10,391 words on content pages, while both new series combined display a total of 815 words, a reduction of 92%.

Interactivity (guideline B3) was boosted substantially from 29% in the old series to 38% and 39%, respectively, in the new employee and manager series. Both the simpler question interactions and the more complex activity interactions were increased in the new series.

**Learner Response**

Both new series of sexual harassment courses were released in March, 2012. After taking a course in the series, learners were given the option to complete a course evaluation form. A total of 89 surveys for the
employee series and 47 for the manager series were received by the end of July, 2012.

Learners provided ratings for three questions on a six-point Likert-type scale, including their overall level of satisfaction with the course, how relevant it is to their job or career development, and how likely they are to take another course. They also provided qualitative feedback on what they liked most and least about the course, how they would change it to make it better, and what additional course topics they would find most helpful. Average ratings for the three quantitative questions are provided in the table below.

Table 5
Quantitative Learner Feedback

<table>
<thead>
<tr>
<th>Series</th>
<th>Overall Satisfaction</th>
<th>Job Relevance</th>
<th>Likelihood of Taking Another Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual Harassment in the Workplace</td>
<td>4.8</td>
<td>5.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Sexual Harassment Awareness for Managers</td>
<td>5.3</td>
<td>5.5</td>
<td>5.4</td>
</tr>
</tbody>
</table>

The highest quantitative scores were recorded for Job Relevance, which tends to be consistent with successful application of guideline A3 (appropriate scaling of content). Relatively high satisfaction rates may be consistent with a number of other guidelines, but it is not possible to evaluate the guidelines individually based on these data. It is interesting to note the substantially higher ratings for the manager series than for the employee series. The manager series is almost an hour longer than the employee series, which is normally a challenge in an e-learning context, but managers have responsibilities to monitor the workplace and respond to incidents that may cause them to view this subject matter more seriously.

Qualitative feedback gives us more insight into the way learners experience these courses. The "like most" and "like least" feedback included a few issues that were mentioned by more than one learner. Comments with multiple mentions are listed in the two tables below, along with their frequency.

Table 6
Qualitative Feedback: What Learners Liked Most

<table>
<thead>
<tr>
<th>Aspect Learners Liked Most</th>
<th>Sexual Harassment in the Workplace (employee series)</th>
<th>Sexual Harassment Awareness for Managers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick pace / conciseness</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Use of realistic case studies / court cases</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ease-of-use</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Richness / completeness of information</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Quality / frequency of interactivity</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
Pacing and length of the courses were mentioned most frequently in both the "liked most" and "liked least" feedback, further underscoring the importance of guideline A3 (appropriate scaling of content). It was mentioned eight times as a positive factor, in addition to four positive comments on the richness or completeness of course information. Compared to the four negative mentions, this suggests there were more learners who felt the material was appropriately scaled than those who felt it was too long or too slow. Scaling is a key issue, and may be close to the right level in these courses.

Ease-of-use received the third highest number of positive comments (a total of six), which may reflect a decrease in cognitive stress achieved through application of guidelines A1, A4, B1, and B2. Finally, the quality or frequency of interactivity received four positive comments, suggesting positive learner impact of the application of guideline B3.

Conclusions

Highly skilled e-learning developers are often tempted to design courseware in a spirit of abundance - applying a broad assortment of media types and using more of each type in a continual effort to enrich the learning experience. However, extensive cognitive and behavioral research suggests there are some combinations of media that work better than others for conveying information in ways that are readily digested, processed, and stored as schema in the human brain. Variety is good, but the right elements, in combination, boost the learning experience substantially.

Principles drawn from behavioral and cognitive research can be translated into practical guidelines instructional designers apply in the process of developing e-learning. The guidelines suggested in this study call for limiting the use of extraneous visual elements, applying full audio, appropriate scaling of content, limiting the display of on-screen text, frequent inclusion of interactive elements, and formulation of questions and activities in a defined range of difficulty.

Application of these guidelines resulted in a reduction of total course pages from 264 in the previous sexual harassment series to 55 pages and 85 pages, respectively, for the employee and manager audiences in two new series. The percentage of content pages that use audio and imagery, without on-screen text, rose from 8% to 67% and 57%, respectively. Total display of words on content pages decreased by 92%, and interactivity rose from 29% of total course pages to 38% and 39%, respectively.

These measurements suggest a dramatically more concise learning experience for the target audience, which encourages completion of courseware and makes it easier to integrate formal learning into the employee's workday. Comparative data also demonstrates the usage of media combinations that synchronize naturally with the learner's cognitive processes, thus drawing in the learner and keeping the learner engaged. Through a broad application of learning theory, course designers can engage with learners in ways that feel natural to the learner, making e-learning experience both more enjoyable and impactful.

References


