

Journal of Applied Instructional Design

Volume 7 | Issue 2 | October 2018

This Issue:

From the Editor

by Don Robison, Senior Editor

The Instructional Design Studio as an Example of Model-Centered Instruction

by Jason McDonald

Tessmer and Wedman: Ahead of Their Time

by John Baaki

Improving Online Course Design with *Think Aloud* Observations: A “How to” Guide for Instructional Designers for Conducting UX Testing

by Andrea Gregg

Is that My Cousin or My Mom... or Both? The *Unnatural* Similarity of Instructional Design and Human Performance Technology

by Don Robison

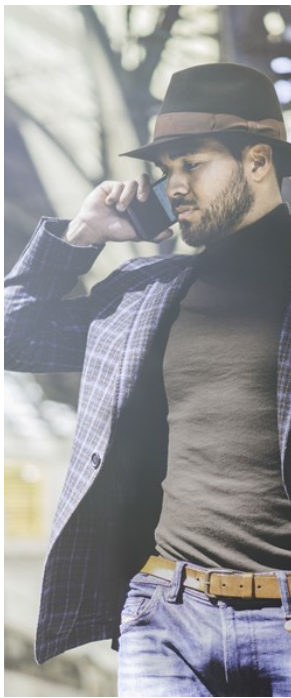
REALDESIGN: Perspectives from the Field of Instructional Design [Regular Feature]

by Jennifer Morrison

an Association for Educational Communications and Technology publication

AECT

View this journal at www.jaid.pub



Journal of Applied Instructional Design

Volume 7 • Issue 2 • October 2018

<https://doi.org/10.28990/jaid2018.071000>

This Issue:

- | | |
|--|----|
| From the Editor
by Don Robison, Senior Editor | 3 |
| The Instructional Design Studio as an Example of Model-Centered Instruction
by Jason McDonald | 5 |
| Tessmer and Wedman: Ahead of their Time
by John Baaki | 17 |
| Improving Online Course Design with <i>Think Aloud</i> Observations: A “How to” Guide for Instructional Designers for Conducting UX Testing
by Andrea Gregg, Ronda Reid, Tugce Aldemir, Amy Garbrick, Jennifer Gray, and Margaret Frederick | 21 |
| Is that My Cousin or My Mom... Or Both? The <i>Unnatural</i> Similarity of Instructional Design and Human Performance Technology
by Don Robison | 27 |
| REALDESIGN [Practical Instructional Design from Experts] Is it Information or is it Instruction?
by Jennifer Morrison | 29 |

About the

Journal of Applied Instructional Design

ISSN: 2160-5289

JAID STAFF

Senior Editor: Don Robison, Ph.D., CPT

Editor Emeritus: Wilhelmina Savenye, Ph.D.

Editor Emeritus: Douglas Harvey, Ph.D.

EDITORIAL BOARD

Andy Gibbons, Ph.D., Brigham Young University

David Richard Moore, Researcher and Author

Rob Foshay, Ph.D., Walden University and The Foshay Group

Wilhelmina Savenye, Ph.D., Arizona State University

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

Brent Wilson, Ph.D., University of Colorado Denver

Mike Simonson, Ph.D., Nova Southeastern 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

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.jaid.pub>

For questions contact Don Robison at robisodg@evms.edu

Cover Photo: Reproduced in accordance with license
Denis Birykov@123rf.com

Editorial

Don Robison, Ph.D., CPT
Eastern Virginia Medical School

User Experience Design, Design Thinking and the Designer Studio: Fresh Perspectives for Instructional Designers

We hope you are well! Welcome! In this issue of the *Journal of Applied Instructional Design* (JAID) we present perspectives on designers, design thinking, and a very practical how-to article about user experience design (UX Design).

In our work as designers we develop useful things for specific groups of people with specific characteristics: unique entering levels of knowledge or skills, unique motivational profiles, and very specific performance needs. We carefully identify where the learners are starting their journey and where we all need them to end up, and then design the best way to get them there.

This issue is about that design work.

Jason McDonald introduces us to the design studio as an example of model-centered instruction and provides seventeen practical options that instructional design educators can follow in structuring the instructional design studio. John Baaki examines the work of Martin Tessmer and John Wedman in the context of design thinking and makes a compelling case that these two thinkers were decades ahead of their time. Then, Andrea Gregg and her colleagues take us on a very practical tour of user experience design, providing how-to guidance focused on web-delivered courses. Then, I offer a short and not-so-profound reflection on the unnatural familial relationship of instructional design and human performance technology (My real motivation here is to highlight the great reference resources on the AECT website).

We are thrilled with our new regular feature, [REALDESIGN](#). In our effort to make this journal useful to practicing instructional designers, each issue we will be calling on experts in our field to share their real-life experiences with you. How do they practically do the things they say we should all do? Where have they blown it? How do you really *do* instructional design? Our first installments of this feature will be led by the authors of the upcoming eighth edition of *Designing Effective Instruction*. I'm excited about this feature because we take the theoretical and we take the models and we essentially say, "this is how you really do that."

What you do as an instructional designer is pretty great... You get to creatively, systematically, imaginatively, and with developed discipline engage with people to envision and then create paths to excellent performance. Thank you for doing it so well.

Best to you, Don

Don Robison, Ph.D., CPT



2018 AECT International Convention

Learning for All

Kansas City, Missouri
October 23 - October 27 2018

Workshop Sessions: Tuesday, October 23; Wednesday, October 24; and Saturday
October 27

Concurrent Sessions, Posters, Panels & Roundtable: October 24 - October 27

The Instructional Design Studio as an Example of Model-Centered Instruction

Jason McDonald, Brigham Young University

Abstract: This study describes how instructional design (ID) educators can better understand and implement design studio pedagogy, by comparing the approach to the principles of model-centered instruction (MCI). I studied this issue through a focused literature review of recent cases of ID studio implementations, comparing features and activities in each case to the conceptual principles of MCI. In aggregate, this analysis provides seventeen individual options for how educators can structure the ID studio. Additionally, comparing studio practice to MCI may also help ID educators experiment with their own studio improvements in a more systematic manner.

Keywords: studio pedagogy; design studio; instructional design; model-centered instruction; case studies; literature review

In recent years, the pedagogy known as the design studio has been explored as an emerging form of instructional design (ID) education (Knowlton, 2016). Developed in fields such as architecture and industrial design, the design studio is a form of project-based learning, consisting of activities such as having students complete authentic project work, under the direction of instructors who model meticulous design thinking, and where they receive rigorous feedback from instructors, fellow students, and outside experts (Schön, 1985). Conceptually, the design studio is also characterized by what Cennamo and Brandt (2012) identify as its surface structures, pedagogical activities, and epistemological understanding:

Surface structures refers to the easily observable components of studio: the space, furniture, time blocks, assignments and so forth, roughly equivalent to the tools available for the teachers' and students' use; *pedagogical activities* include activities and interactions, such as iterative cycles of design, hands-on investigations, and group discussions of work in progress, roughly equivalent to the practices of the studio; and *epistemological understanding* describes the beliefs that guide studio activities such as the nature of design knowledge and how it is constructed. (p. 844; emphasis in original)

The studio is not defined by any of these dimensions in isolation of the others, however. What makes the studio unique is that all its components work together to reinforce a distinctive culture of learning and teaching that is meant to prepare students for professional work in a chosen discipline. This is where the studio differs from other forms of project-based learning—the environment is meant to enculturate students into the “tools, practices, and beliefs” of their chosen profession, and so acts “as a bridge between [their] academic and professional communities” (Brandt et al., 2013, pp. 336-337).

It is purposes such as these that have drawn attention from ID educators. In the interplay between modeling, discussion, practice, and feedback, students in a studio begin to experience what it means to be an instructional designer, and start to develop competencies that are difficult to identify but almost universally recognized as attributes of the skilled professional (Clinton & Rieber, 2010). This is important because so many design skills are tacit, and difficult to explicitly teach. As Hoadley and Cox (2008) stated, “the paradox of teaching design is that designers know things, but they can't tell others about them in a way that novices will understand” (p. 19).

Some evidence suggests, however, that educators could benefit from support as they integrate the studio approach into ID curriculums. Traditionally, people learn to teach in a studio through their experience as students in a studio. If ID educators do not have this

background, they “may operate on vague notions of studio instruction, or on long-standing misconceptions” of how the approach works (Boling & Smith, 2014, p. 53). Even those with background in a studio (as teacher or student) can unconsciously replicate their prior experiences without reflection on whether their actions will be effective in a new context (Gray & Smith, 2016). Additionally, research on the ID studio does not yet provide “solid practical . . . guidance on how [to] maximize the studio experience toward learning” (Knowlton, 2016, p. 352). What is needed are ways of assisting ID educators when they are making tactical and strategic decisions about matters such as:

- The role the studio will play in their curriculum;
- What features of the studio will lead to outcomes they desire;
- How to shape traditional studio structures to fit the culture, constraints, or opportunities found in local situations; or,
- How to take advantage of their knowledge of learning and instruction to improve on what the studio offers.

To summarize, what support can be offered to ID educators, to assist them in thinking critically about options for structuring their own studio implementations?

In this paper I address this issue. I do so by framing the ID studio in terms of the instructional theory of model-centered instruction (MCI), and exploring what possibilities this reveals for making decisions about the forms that studio structures could take. MCI proposes that “effective and efficient instruction takes place” when people interact with dynamic representations (or models) of real-world environments, supplemented by “a variety of instructional augmentations designed to facilitate learning from the experience” (Gibbons, 2001, p. 512). This theoretical statement aligns with the purpose of the ID studio, which can be viewed as a model of authentic design practice where novices experiment with the complexity and unpredictability found in professional environments, under the guidance of experienced mentors who supplement the model with various forms of instructional support. The central question, then, guiding my inquiry is: what possibilities for shaping the ID studio are generated by viewing it as an example of model-centered instruction?

Literature Review – Background on the Design Studio and on Model-Centered Instruction

The design studio. Design studio teaching has a long history in many engineering and artistic disciplines. Dating back to at least the 19th century, it is considered the “signature pedagogy” in fields where the historic form of inquiry is “experimenting and collaborating, building things and commenting on each other’s work. . . . [and where] the focal point of instruction is clearly the designed artifact” (Shulman, 2005, p. 54). The traditional studio grew out of the apprenticeship system, allowing master professionals to oversee the work of more than one student at a time. It has become accepted as the way students develop tacit abilities that are difficult to define but almost universally identified as attributes of the skilled designer, such as judgement,

artistry, and the forms of thinking that designers apply to professional problems (Schön, 1985).

The studio cannot be considered a uniform, unalterable approach to education, however, and is more accurately described as a confederation of related instructional practices and forms. What unites various types of studio teaching is a shared commitment to the value of immersing students in an environment where they are guided through meaningful design projects, under the direction of experienced mentors (Brandt et al., 2013). Other common studio structures include: intense project work concentrated into long class sessions; both individual student workspaces along with some form of communal gathering space; the public display of student projects; and rigorous critique of student work by instructors, other students, or outside experts (Cennamo, 2016b). But individual studios, even within a discipline, will implement these structures at different levels of rigor, perhaps even eliminating some entirely and replacing them with others. Consequently, because “each studio faculty member [interprets] ‘studio’ a bit differently,” beyond general descriptions it can be difficult to develop a consensus of what, exactly, defines the approach (Brandt et al., 2013, p. 332).

Despite such variability, it is clear that studio environments encourage a unique culture of learning, and can be the defining feature of students’ educational experience (Gray, 2014; Koch, Schwennsen, Dutton, & Smith, 2002). This is the case in both positive and negative studio cultures. On the negative side, the studio can place heavy emotional burdens on students who are sometimes unprepared to cope with the intense levels of personal investment required (Anthony, 1991; Austerlitz & Aravot, 2007). Students may also be encouraged to develop such extreme commitment to studio activities that they neglect other dimensions of a healthy and balanced life (Gray & Smith, 2016). But when the culture is positive, the experience can be thrilling, and acts as an accelerant to students’ formation of design identity (Gray, 2014). At its best, the studio “offers tremendous potential for creative discovery, exploration of ideas, critical discussions, and risk-taking” (Koch et al., 2002, p. 4). Of course, most studios are an amalgam of positive and negative traits. But even given possible drawbacks, those who learned in a studio often look back on it as formative to their design education—an irreplaceable experience that “likely [provides] the most memorable and influential” memories of their training (p. 3).

It is this generally positive reputation that has facilitated the design studio’s adoption in disciplines beyond those in which it has been traditionally employed. Some of these fields include human-computer interaction (Brandt et al., 2013), engineering (Kuhn, 2001), and, most relevant for this paper, instructional design (Clinton & Rieber, 2010). Research on studio teaching in these fields is typically encouraging, although perhaps conducted “with little critical attention” towards some of the difficulties that can accompany the approach (Gray, 2014, pp. 12-13). Even so, as favorable reports of design studio pedagogy are disseminated within a discipline, the likely effect is that more educators are becoming disposed to try it themselves. This seems to have been the case in instructional design, as measured by reports of studio environments that have

been published in recent years (Knowlton, 2016).

It is my assertion that understanding how these ID studios have been implemented can become an asset to other instructional design educators adopting the approach. As has been noted, educators in disciplines where studio teaching is not the norm may not be aware of common critiques of the studio, nor be prepared to respond if they experience complications themselves (Gray & Smith, 2016). But educators who study the diversity in design studio environments can find other's experiences to be a source of practical wisdom when developing their own studio implementations (Boling & Schwier, 2016). To date, however, there has not been systematic study of variances among actual design studio practice, as it exists within the discipline of instructional design specifically.

Model-centered instruction. In model-centered instruction (MCI), learning is supported by creating representations of real-world systems or environments, that are intentionally constructed to simplify the complexity and unpredictability found in authentic situations (Gibbons, 2001). These representations can be conceptual, physical, or digital. What matters is that through interaction with these simplified models, learners can investigate, experiment, and practice skills important for their real-world action, without the risk that can accompany engagement with an actual system or environment. A typical example of MCI is a flight simulator; learning in a simulator allows pilots to prepare for new or unusual flight conditions, or refine their technique, without the hazards of attempting maneuvers for the first time in the air.

It must be noted that MCI uses the term model in a different way than is commonly used by instructional designers. MCI uses the term to describe the actual artifact of instruction—the product or situation with which

learners interact—whereas instructional designers often use the word model to refer to a design process or methodology, like the ADDIE model. While a common form of MCI is the instructional simulation, this is not the only form. Any system or environment that represents a more complex environment could be considered a model, in the terminology of MCI.

When designing model-centered instruction, one considers the following principles (Gibbons, 2001):

- Experience with models – Learning happens as people observe, and interact with, models of systems, environments, or expert performance, and should be supplemented by learning companions that help learners interpret the models (e.g., teachers, or guides like digital assistants). The first task in MCI is to specify models with which learners will interact, and companions that will assist them.
- Problem solving – Problems are selected for learners to solve, or to observe being solved, with a model; problems are the primary means through which learners interact with the learning environment.
- Denaturing – Models are modified to support learning purposes. Their fidelity to the systems/ environments on which they are based is decreased, to make them simpler or safer, to highlight processes otherwise difficult to observe, or to make uncommon phenomena occur more frequently. Generally, more concrete and simpler models are better for novices, while more abstract and complex models can be used with experienced learners.
- Sequence – Problems are ordered by task, size, or other characteristics, to support learning of a model's attributes or behavior.

Table 1. *Model-Centered Instruction (MCI) Compared with Studio Pedagogy*

Principles of MCI	Characteristics of studio pedagogy
Experience with models, augmented by learning companions	Studios model the environments in which professional designers work, as well as model the thinking and behavior of expert designers (Hooper, Rook, & Choi, 2015). Students in studios receive intense feedback on their work from instructors and others (Salama, 1995).
Problem Solving	Studio learning is focused on students engaging with authentic design problems; “they learn <i>about</i> design while <i>doing</i> design” (Cennamo, 2016b, p. 256).
Denaturing	The range of design activities in which professionals engage is simplified, shortened in time/complexity, or otherwise scoped for novices to complete on their own (Kendall, 2007; Rich et al., 2015).
Sequence	Problems within a studio are ordered to account for various goals, capabilities, or interests that exist at different phases of students’ developing identity as designers (Salama, 1995).
Goal orientation	Instructional goals for a specific studio implementation influence the types of problems chosen for students to complete (Knowlton, 2016).
Resourcing	Studio educators often supply students with the material and equipment needed to solve the problems they are given (Brandt et al., 2013).
Instructional augmentation	Instructors can supplement studio problem solving with additional activities or instructional strategies to facilitate student learning (Salama, 1995).

- Goal orientation – Problems are chosen to support the particular instructional goals of a situation.
- Resourcing – As appropriate for specific instructional goals, “resources, materials, and tools” can be provided to help learners solve a problem with a model (Gibbons, 2001, p. 514).
- Instructional augmentation – Models can be supplemented with additional instructional materials, to assist learners and learning companions during the problem-solving process.

Conceptual alignment between MCI and the design studio. Comparing the principles of MCI with common structures found in the design studio indicates conceptual alignment between the two. This comparison is summarized in Table 1.

MCI is meant to organize learning in any situation where the goal is for people to develop the skills needed to interact with a real-world system or environment; this is also the primary goal of design studio teaching. Based on this conceptual alignment, it is reasonable to conclude that MCI is an appropriate and useful means by which options for the ID studio can be analyzed. I propose, then, that ID educators can use the principles of MCI to shape studio features into forms that fit the constraints and opportunities of their circumstances—both in how they create a model of design practice with which their students engage, as well as how they generate effective types of instructional augmentation.

Method

Case selection. The purpose of this study is to understand what possibilities exist for shaping the ID studio when it is viewed as an example of model-centered instruction. I studied this issue through a fo-

cused literature review of ID studio case implementations, comparing features of each case to the conceptual principles of MCI. I selected possible cases of ID studio practice to study in three ways. First, I examined a recent collection of design studio teaching cases, to find reports that described ID studios (Boling, Schwier, Gray, Smith, & Campbell, 2016). Second, I examined reviews of the studio approach in ID education to find additional reports (Knowlton, 2016; Rich, West, & Warr, 2015). Third, I searched educational research databases, including ERIC and Google Scholar, for the combination of the terms *instructional design* (along with equivalents like *instructional technology*), and *design studio* (along with equivalents like *studio pedagogy*). Combined, the literature review and database searches returned 36 individual reports.

These 36 reports were then narrowed for actual inclusion in the study according to the following criteria:

- Primary focus – reports were included that focused on an ID studio, as opposed to those only mentioning an ID studio while reporting something else;
- Detail – reports were included that provided details about how the studio functioned, or what activities were engaged in by students and/or instructors;
- Uniqueness – some ID studios have been studied multiple times; for these cases, only the most recent report was included in my analysis;
- Bias – to avoid bias in my cross-case comparisons, I only included reports from institutions other than my own.

Based on these criteria, nine ID studio cases were chosen for analysis. Of the initial 36, 19 reports were removed because they did not include detail about studio activities. Six were removed because they were

Table 2. *Instructional Design Studio Cases Chosen for Analysis*

Reference	Studio context
(Boling, 2016)	Course in media production; part of a Master’s program in instructional design.
(Boling & Smith, 2014)	Course in instructional graphics production; part of a Master’s program in instructional design.
(Cennamo, 2016a)	Graduate course in applied theories of instructional design.
(Nelson & Palumbo, 2014)	Three graduate courses in an instructional technology program – instructional design; software development; and project management.
(Rieber, Clinton, & Kopcha, 2016)	Three related, graduate courses in educational multimedia.
(Rook & Hooper, 2016)	Graduate-level course in the development of learning technologies.
(Schwier, 2016)	Graduate course in instructional design, emphasizing product development.
(Tracey, 2016)	Graduate course in basic instructional design.
(Wilson, 2016)	Graduate course in advanced video design.

Table 3. *Surface Variability in ID Cases*

Dimension	Variety among cases
The type of skills taught in the ID studio	<ul style="list-style-type: none"> • Media development (Boling, 2016) • Introductory instructional design (Tracey, 2016) • Application of theory (Cennamo, 2016a)
How studio courses are organized in the curriculum	<ul style="list-style-type: none"> • Stand-alone studio courses (Boling & Smith, 2014) • Studio courses organized into a sequence (Rieber et al., 2016)
How course sequences are organized	<ul style="list-style-type: none"> • Structured around different levels of production expertise (Rieber et al., 2016) • Structured around different skillsets involved when developing a project (Nelson & Palumbo, 2014)
How student projects are organized	<ul style="list-style-type: none"> • Students complete one major project, perhaps with milestones evaluated at various points throughout the semester (Boling, 2016; Rieber et al., 2016; Schwier, 2016; Wilson, 2016) • Multiple, discrete projects on which students work throughout the course (Boling & Smith, 2014; Cennamo, 2016a; Nelson & Palumbo, 2014; Rook & Hooper, 2016; Tracey, 2016)
How students work with external clients	<ul style="list-style-type: none"> • Students are provided at least a simulated experience in designing for a client (Nelson & Palumbo, 2014; Rieber et al., 2016; Schwier, 2016; Tracey, 2016) • Students focus on learning design skills, without including a client (Boling, 2016; Boling & Smith, 2014; Cennamo, 2016a; Rook & Hooper, 2016; Wilson, 2016)

multiple reports of the same studios. Two were removed because they were from my own university. Table 2 lists the nine reports included for study, along with summary information about the context of each case.

Case variability. Before beginning analysis of these cases using MCI, I first examined the surface variability in how each studio was structured and organized. Even without applying the theoretical framework of MCI, variety within the practice of ID studio education is evident. This variety is summarized in Table 3.

While documenting this variability may be helpful to ID educators even without additional inquiry, its value in this study was to determine whether enough surface variability exists to justify additional analysis using the principles of MCI.

Analysis. The cases were analyzed in four steps. First, I studied each report, comparing phrases/sections that described studio activities with the definitions of each key principle of MCI. Sections of each report that correlated with an MCI principle were collected into lists. Second, I coded each section identified in step

one, based on significant features of the studio or studio activities reported by the original author. After coding was complete, my third step was to compare and contrast the individual codes, looking for relationships between them that indicated codes could be merged, or placed into a more inclusive category. Fourth, I prepared a matrix based on the final codes, which gathered the options of how ID studios have been configured into a table that summarized possible studio structures that other ID educators can use when shaping their own studio implementations.

Findings

Comparing cases of ID studio practice to the principles of MCI reveals differences in how studios have been implemented, that are not easily observable when making surface comparisons. Across the nine cases analyzed, each MCI principle yielded between two and seven configurations for ID studio features or activities, with the exception of the principle of Resourcing (the cases either did not include details of how studios were resourced, as the term is used in MCI, or only implied

information about resourcing). In aggregate, the cases provide seventeen individual options for how ID studio features or activities could be structured. Organized by each MCI principle, these options are:

- **Model experience:** Working within models of authentic design practice could be:
 1. The integral learning experience for students in a studio course; or
 2. Included as one learning experience among many.
- **Problem solving:** Solving authentic design problems could be:
 3. The central activity around which student learning is organized; or
 4. Included as one learning activity among many.
- **Denaturing:** Models of design practice could be modified to:
 5. Simplify the problems students solve;
 6. Have students repeat the same problem over time, with change in one of the variables;
 7. Simulate features of an authentic design environment;
 8. Provide more structure for novices than for experts;
 9. Personalize design problems based on students' prior experience;
 10. Limit the scope of a problem to fit the time available in a course; or
 11. Isolating students from distractions so they can focus on learning activities.
- **Sequencing:** The order of problems in a course could be:
 12. Intentionally shaped by the instructor; or
 13. Implicitly shaped based on the nature of the problems themselves.
- **Goal orientation:** Instructors can pursue specific learning goals by:
 14. Intentionally shaping models of design practice, or the problems solved in a course; or
 15. Implicitly pursuing goals, implied by the nature of design practice or design problems themselves.
- **Instructional augmentation:** Supplementary materials could be:
 16. Integrated as a required component of course activities; or
 17. Provided on an as-needed basis, if students needed additional support in solving a problem.

These categories and options are summarized in Tables 4 and 5. Table 4 describes how each option was reported by the original ID studio case author(s), and may be most helpful to those seeking to understand in more depth how ID studio configurations actually work. Table 5 only includes abbreviated descriptors of each option, and may be most helpful to those interested in an overview of the entire matrix of studio configurations.

Discussion and Implications

These findings indicate that viewing the ID studio as an example of model-centered instruction does provide ID educators with options for shaping studio features and activities. One form this takes is that MCI helps give vocabulary to the practical, concrete features and activities found in studio implementations, as found in the cases studied for this paper. For example, while all nine cases described how students worked in a studio to develop ID expertise, by using MCI one's attention is drawn to variations in the forms given to different models of design practice across the cases. Specifically, in seven of the reports, working in a model of authentic design practice was the integral learning experience for students, while in two (Cennamo, 2016a; Rook & Hooper, 2016) working with a design model was included alongside other learning experiences (such as course readings or in-class discussions). Distinguishing between these variations can be useful to ID educators who are interested in experimenting with the studio but are either not ready or not yet able to implement it as the dominant educational form in their course. Recognizing that there are viable examples of ID studios that combine traditional features of the approach with other educational activities can give them confidence to pursue the same route themselves. They could then examine the details of how these studios functioned for ideas about how to combine their own studio features with additional instructional events.

As another example, if ID educators need to adapt how their students solve problems in a studio curriculum, the MCI principle of denaturing helps them identify that in the cases analyzed in this study, there are at least seven alternatives they can consider. If it does not align with their goals to make the problem itself simpler, they could evaluate the possibility of providing additional structure to support students through problem complexity, or perhaps having students repeat a problem multiple times, as potentially more viable alternatives. After considering these possibilities, educators can use details from the case reports to analyze how the different forms of problem denaturing could actually be adapted for their own circumstances.

Comparing the ID studio with MCI could also provide other means for shaping features and activities of the approach, by helping educators experiment with studio improvements in a more systematic manner. Consider the matrix of studio options as found in Tables 4 and 5. ID educators might compare the options described in the tables to their own studio implementations, using them to help identify how their studios currently function (each column in the tables representing a parameter that describes studio features/activities). As they then consider how to adjust studio components to improve their functioning, the tables also draw attention to individual issues related to studio operations, and gives them a vocabulary by which they can discuss those issues meaningfully. Should they decide to adapt a component, the tables also help them specify what they are actually adapting, and how their adaptations might interact with, or integrate into, the rest of their studio environment.

One practical way this might take place could be

to examine the full description of ID studios in Table 4, and imagine how a studio in an individual row might function differently if a feature or activity were replaced with the configuration found in an adjacent row. For example, the studio reported in row eight (Tracey, 2016) used a model of design practice to solve problems as one type of instructional event among many. What if this studio were redesigned so model-centered problem-solving became the central learning activity, as found in the rows immediately above and below? How might the instructor begin redesigning the studio to account for such a change? How might this change be evaluated? How might the instructor judge whether the change impacts other activities in the studio, such as the type of denaturing that should occur to support novices in problem-solving, or the forms of instructional augmentation available to students? Although these questions are posed as a thought experiment, ID educators can ask themselves similar questions during the practical work of evaluating and improving a studio, by comparing details of their own environments to those already provided.

Finally, it is notable that neither the options reported in these nine cases, nor the guidelines suggested by MCI, provide a strict definition of what must be included in an ID studio for it to be considered an orthodox example of the approach. This is similar to Brandt et al.'s (2013) observation that "each studio faculty member [interprets] 'studio' a bit differently" (p. 332). What this study additionally indicates is that different interpretations of the studio need not relate to minor or superficial details of how the environment functions. While some studio configurations were more common than others in the case reports analyzed in this study, overall they also describe major differences in the types of studios in which students learned while developing ID expertise. Additionally, the interpretive framework suggested by the principles of MCI allows (perhaps even encourages) ID studio educators to develop more variability in studio configurations beyond what has already been reported in the literature.

This is consistent with two other observations made by scholars examining design studio teaching. The first is Boling and Smith's (2014) note that instructors adopting the studio in disciplines where the approach is not widespread do not have the same expectations for what the experience should be, as do those whose initial training took place in a studio. In other words, ID educators likely feel less attachment to traditional studio norms than do those whose formative learning experience took place in the studio, if they are even aware of what those norms are. This interpretation is strengthened by Clinton and Rieber's (2010) description of the ID studio developed at the University of Georgia (one of the cases studied in this paper), when they stated, "the founding designers of this Studio curriculum were less interested in specific studio-based learning models than in using the general metaphor of a studio as a vehicle for implementing constructivist and constructionist learning experiences" (p. 763). The ideal of the studio, then, was attractive to the extent it helped these educators shape a curriculum that was consistent with a broad range of ideals they held about learning and education, and not as an end goal in itself.

Although Boling and Smith's (2014) observation

suggested a note of caution—that it is possible for ID educators to believe they are implementing the studio approach when they are really not—I am optimistic about the possibilities that could be opened by ID educators experimenting with studio forms. This is the case even if those forms are not always recognizable to those trained in studio traditions. Ultimately, the objective is not to remain true to the studio approach for its own sake. Rather, the objective is to help students develop higher levels of ID expertise. While ID educators should learn from what traditional studio educators know about developing this expertise, established studio methods are not above critique (Gray & Smith, 2016). It may also be that the context of instructional design demands unique flavors of customary studio features or activities. Or, ID educators may find that their expertise in creating instructional events can improve on even those studio forms that have traditionally been successful.

This study has some limitation of which readers should be aware. First, the sample is small—nine cases of ID studio practice. The options found in this set certainly do not exhaust the range of possibilities available in ID studio configurations. However, the study's purpose was not to achieve this goal, but rather to compare enough cases to the principles of MCI so that ID educators can better understand what kinds of possibilities for shaping the studio are available to them in their own adaptations of the approach. A second limitation derives from the literature review methodology used in the study. I defined these nine cases as examples of ID studio practice because that is how the original authors described their own practices. But I recognize that some readers may disagree with those authors' evaluations of the instructional approach they were implementing. But while this could limit the study's usefulness in defining the studio approach more precisely, as noted above I do not consider it a significant limitation for accomplishing the purpose of generating possibilities for shaping ID studio forms using the principles of MCI.

Conclusion

In this paper, I compared cases of instructional design studio practice to the theoretical principles of model-centered instruction. My goal in doing so was to understand what possibilities this opens for shaping ID studio forms in the variety of contexts in which the studio teaching may be implemented. Across the nine cases analyzed, six of the seven MCI principles yielded between two and seven configurations each for ID studio features or activities (one principle did not yield any possibilities, due to lack of detail in the studied cases). In aggregate, the analysis provides seventeen individual options for structuring ID studio features or activities. Combining just these seventeen options in different ways could allow for dozens of possible ID studio environments. Additionally, the matrix of ID studio options can also be used to help educators experiment with other studio forms, beyond those reported in this study. I conclude, therefore, that MCI does provide fertile and energetic ideas for educators to consider, about how to shape their own implementations of the ID studio.

I also conclude, however, that ID educators should not end their examination of the studio approach with this comparison to MCI. Other theoretical frameworks

Table 4. An Expanded Description for Describing Instructional Design Studio Cases Using Model-Centered Instruction

Studio reference	Experience with models, augmented by learning companions	Problem solving	Denaturing
(Boling, 2016)	Integral: Students work in a model environment for developing a multimedia product; instructor role is to give feedback on student work in the environment.	Central: All class work focused around one realistic problem.	Simplified: Instructors simplify the scope the problem so it can be realistically completed in the time allowed.
(Boling & Smith, 2014)	Evolved from Included to Integral: A model of expert performing for producing instructional visuals was initially included as one environment among many, over time becoming the central component of the course; instructor role is to give feedback on student work in the environment.	Central: All class activities centered around solving visual problems.	Simplified: Assignments simplified and de-contextualized from full design practice to focus on visual production.
(Cennamo, 2016a)	Included: Students are exposed to a model of expert performance for applying learning theory, which is one learning experience in the course among many; instructor role is to give feedback on student work on the performance.	Included: Students use different learning theories to solve instructional problems, among other class activities.	Repetition: Students repeat the same problem-solving exercise multiple times, with variation by using different theories in successive exercises.
(Nelson & Palumbo, 2014)	Integral: Students work in a model environment for producing instructional products for a client, spread across three courses; instructor role is to give feedback on student work in the environment.	Central: Multiple problems are chosen to give students experience with different aspects of expert performance.	Simulated reality: Although problems were presented as being for real clients, sometimes this was simulated if a client could not be found.
(Rieber et al., 2016)	Integral: Students work in a model environment for developing multimedia products; instructor role is to give feedback on student work in the environment; more advanced students given feedback to beginning students.	Central: Multiple courses, each with a central problem to develop a multimedia product.	Structured for novices: More structure and support is provided when students are novices.
(Rook & Hooper, 2016)	Included: Students are exposed to a model of expert performance for developing an instructional software product, which is one learning experience in the course among many; instructor role is to give feedback on student work in the environment.	Included: The course includes multiple software development problems students complete both individually and as teams, among other class activities.	Personalized: Problems can be personalized based on students' prior experience.
(Schwier, 2016)	Integral: Students work in a model environment for producing an instructional product for a client; instructor role is to give feedback on student work in the environment, in the role of a project manager.	Central: Course organized around problems to create individual product components, ultimately delivered to a client.	Bounded scope: Instructor negotiates with a client before class begins, to ensure they act in ways that provide learning value for students; projects scoped to be completed in a 13-week semester.
(Tracey, 2016)	Integral: Students work with a model of expert performance for producing an instructional product for a client; instructor role is to give feedback on student work in the environment.	Included: Students are given a problem created by another student in the class to solve as the culminating class activity, among other activities.	Simulated reality: The client is another student in the class.
(Wilson, 2016)	Integral: Students work with a model of expert performance for developing a video product; instructor role is to give feedback on student work in the environment.	Central: Students are given the problem of producing a video in the course.	Isolation: For part of the course, students are isolated from outside distractions so they can focus on their project work.

Sequence	Goal orientation	Resourcing	Instructional augmentation
Implicit: One problem occupies the work of the class, with sub-problems sequenced by the order in which they happen during production.	Intentional: The problem in the studio focus on media development, not the full range of instructional design activities.	Implied: Not stated explicitly, but the case implies that software and hardware tools are provided for student use.	Available as-needed: Online tutorials in media production tools.
Not discussed: Multiple problems in the class, but no discussion on how they are sequenced.	Intentional: Problems in the studio focus on visual production, not the full range of instructional design activities.	Implied: Not stated explicitly, but the case implies that software and hardware tools are provided for student use.	Available as-needed: Visual examples provided for students to use as precedent in assignments; design books provided as resources.
Intentional: Problems are sequenced based on theories to be learned, with a culminating project to synthesize class experiences.	Intentional: Problems in the studio focus on applying learning theories, not the full range of instructional design activities.	Not discussed in the case.	Integrated: Readings on learning theories.
Implicit: One problem occupies the work of the three classes, with sub-problems sequenced by the order in which they happen in professional practice.	Implicit: Problems were selected based on the availability of clients; no discussion of whether problems were shaped for more specific instructional goals.	Not discussed in the case.	Not discussed in the case.
Intentional: Problems are sequenced across multiple studio courses to support students' growing expertise.	Intentional: Problems in the studio focus on media development, not full range of instructional design activities.	Implied: Not stated explicitly, but the case implies that software and hardware tools are provided for student use.	Integrated: Class discussions on how to learn in studio environments; video tutorials on software skills.
Intentional: Small problems based on components of design processes feed into later problems that integrate all learned skills.	Intentional: Problems in the studio focus on software development, not the full range of instructional design activities.	Implied: Not stated explicitly, but the case implies that software and hardware tools are provided for student use.	Integrated: Readings and class discussion; software tutorials.
Implicit: One problem occupies the class, with sub-problems sequenced by the order in which they typically happen in professional practice.	Implicit: Problems were selected based on the availability of clients; no discussion of whether problems were shaped for more specific instructional goals.	Not discussed in the case.	Integrated: Reflection activities for students to consider what students they are learning about instructional design by working on the selected problems.
Not discussed in the case.	Intentional: Problem chosen to support the instructional goal of doing high quality work for a client.	Not discussed in the case.	Integrated: Readings in design and instructional design; in-class analysis of design examples; reflection assignments.
Implicit: One problem occupies the class, with a milestone assessed part-way through the class; sub-problems sequenced by the order in which they typically happen in professional practice.	Intentional: Problems in the studio focus on video development, not the full range of instructional design activities.	Implied: Not stated explicitly, but the case implies that software and hardware tools are provided for student use.	Available as-needed: Many examples provided for students to use as precedent.

will likely reveal other options of how to shape ID studio forms, some of which will more closely approach the ideals that educators have for their ID curriculums, or the opportunities and constraints found in their local situations. I encourage readers, then, to be reflective in their implementations of design studio teaching, and use whatever tools are available to them in developing a studio that is closely aligned with the goals they hope to achieve. To the extent that the comparison in this study helps educators identify options they may not have been aware of before, they should be better able to create an instructional design studio where students develop more meaningful depths of ID expertise. Yet if this study also encourages educators to thoughtfully examine still other ways of framing and shaping their ID studio environment, I consider this to be an equally beneficial outcome. In either case, more students will be prepared to work the increasingly complex environments where instructional design practice takes place, which is the ultimate aim of the ID studio approach.

References

- Anthony, K. H. (1991). *Design juries on trial: The renaissance of the design studio*. New York, NY: Van Nostrand Reinhold.
- Austerlitz, N., & Aravot, I. (2007). Emotions of architecture students: A new perspective for the design studio. In A. M. Salama & N. Wilkinson (Eds.), *Design studio pedagogy: Horizons for the future* (pp. 233-245). Gateshead, UK: Urban International Press.
- Boling, E. (2016). How I learned, unlearned, and learned studio again. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 88-100). New York, NY: Routledge.
- Boling, E., & Schwier, R. A. (2016). Curators' notes. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 4-20). New York, NY: Routledge.

Table 5 A Summary Description for Describing Instructional Design Studio Cases Using Model-Centered Instruction

Studio reference	Experience	Problem solving	Denaturing	Sequence	Goal orientation	Resourcing	Instructional augmentation
(Boling, 2016)	Integral	Central	Simplified	Implicit	Intentional	Implied	As-needed
(Boling & Smith, 2014)	Evolved from Included to Integral	Central	Simplified	Not discussed	Intentional	Implied	As-needed
(Cennamo, 2016a)	Included	Included	Repetition	Intentional	Intentional	Not discussed	Integrated
(Nelson & Palumbo, 2014)	Integral	Central	Simulated reality	Implicit	Implicit	Not discussed	Not discussed
(Rieber et al., 2016)	Integral	Central	Structured for novices	Intentional	Intentional	Implied	Integrated
(Rook & Hooper, 2016)	Included	Included	Personalized	Intentional	Intentional	Implied	Integrated
(Schwier, 2016)	Integral	Central	Bounded scope	Implicit	Implicit	Not discussed	Integrated
(Tracey, 2016)	Integral	Included	Simulated reality	Not discussed	Intentional	Not discussed	Integrated
(Wilson, 2016)	Integral	Central	Isolation	Implicit	Intentional	Implied	As-needed

- Boling, E., Schwier, R. A., Gray, C. M., Smith, K. M., & Campbell, K. (Eds.). (2016). *Studio teaching in higher education: Selected design cases*. New York, NY: Routledge.
- Boling, E., & Smith, K. M. (2014). Critical issues in studio pedagogy: Beyond the mystique and down to business. In B. Hokanson & A. S. Gibbons (Eds.), *Design in educational technology: Design thinking, design process, and the design studio* (pp. 37-56). New York: Springer.
- Brandt, C. B., Cennamo, K., Douglas, S., Vernon, M., McGrath, M., & Reimer, Y. (2013). A theoretical framework for the studio as a learning environment. *International Journal of Technology and Design Education*, 23, 329-348.
- Cennamo, K. (2016a). Orchestrating learning. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 152-163). New York, NY: Routledge.
- Cennamo, K. (2016b). What is studio? In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 248-259). New York, NY: Routledge.
- Cennamo, K., & Brandt, C. (2012). The "right kind of telling": Knowledge building in the academic design studio. *Educational Technology Research and Development*, 60(5), 839-858.
- Clinton, G., & Rieber, L. P. (2010). The studio experience at the University of Georgia: An example of constructionist learning for adults. *Educational Technology Research and Development*, 58(6), 755-780.
- Gibbons, A. S. (2001). Model-centered instruction. *Journal of Structural Learning and Intelligent Systems*, 14, 511-540.
- Gray, C. M. (2014). *Living in two worlds: A critical ethnography of academic and proto-professional interactions in a human-computer interaction design studio*. (Unpublished doctoral dissertation), Indiana University, Bloomington, IN.
- Gray, C. M., & Smith, K. M. (2016). Critical views of studio. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 260-270). New York, NY: Routledge.
- Hoadley, C. M., & Cox, C. (2008). What is design knowledge and how do we teach it? In C. DiGiano, S. V. Goldman, & M. Chorolet (Eds.), *Educating learning technology designers: Guiding and inspiring creators of innovative educational tools* (pp. 19-35). New York: Routledge.
- Hooper, S., Rook, M. M., & Choi, K. (2015). Reconsidering the design of a learning design studio. In B. Hokanson, G. Clinton, & M. W. Tracey (Eds.), *The design of learning experience: Creating the future of educational technology* (pp. 63-76). New York: Springer.
- Kendall, S. (2007). Teaching studio exercises to help students manage distributed design. In A. M. Salama & N. Wilkinson (Eds.), *Design studio pedagogy: Horizons for the future* (pp. 167-176). Gateshead, UK: Urban International Press.
- Knowlton, D. S. (2016). Design studios in instructional design and technology: What are the possibilities? *TechTrends*, 60(4), 350-358.
- Koch, A., Schwennsen, K., Dutton, T. A., & Smith, D. (2002). *The redesign of studio culture*. Retrieved from Washington, DC:
- Kuhn, S. (2001). Learning from the architecture studio: Implications for project-based pedagogy. *International Journal of Engineering Education*, 17(4/5), 349-352.
- Nelson, W. A., & Palumbo, D. B. (2014). When design meets Hollywood: Instructional design in a production studio environment. In B. Hokanson & A. S. Gibbons (Eds.), *Design in educational technology: Design thinking, design process, and the design studio* (pp. 75-88). New York: Springer.
- Rich, P. J., West, R. E., & Warr, M. (2015). Innovating how we teach collaborative design through studio-based pedagogy. In M. A. Orey & R. M. Branch (Eds.), *Educational media and technology yearbook* (Vol. 39, pp. 147-163). Switzerland: Springer International Publishing.
- Rieber, L. P., Clinton, G., & Kopcha, T. J. (2016). The studio approach at the University of Georgia: Always a work in progress. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 37-59). New York, NY: Routledge.
- Rook, M. M., & Hooper, S. (2016). Design thinking in action: Perspectives on teaching and redesigning a learning design studio. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 235-247). New York, NY: Routledge.
- Salama, A. M. (1995). *New trends in architectural education: Designing the design studio*. Raleigh, NC: Tailored Text & Unlimited Potential Publishing.
- Schön, D. A. (1985). *The design studio: An exploration of its traditions and potentials*. London, England: RIBA Publications Limited.
- Schwier, R. A. (2016). Hither and yon: Learning ID in a studio-based authentic ID context. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 21-36). New York, NY: Routledge.
- Shulman, L. S. (2005). Signature pedagogies in the professions. *Daedalus*, 134(3), 52-59.
- Tracey, M. W. (2016). How I gave up ADDIE for design thinking, and so did my students. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 195-205). New York, NY: Routledge.

Wilson, J. (2016). The lake course: A studio apart. In E. Boling, R. A. Schwier, C. M. Gray, K. M. Smith, & K. Campbell (Eds.), *Studio teaching in higher education: Selected design cases* (pp. 123-136). New York, NY: Routledge.

Tessmer and Wedman: Ahead of their Time

John Baaki, Old Dominion University

Abstract: In 1990, Martin Tessmer and John Wedman introduced a new perspective to instructional design. Rather than a sequential waterfall approach, which dominated instructional design in the 1980's and 90's, the layers-of-necessity approach is a way of thinking about instructional design. Tessmer and Wedman viewed instructional designers as they truly are: designers who design instruction. They embraced the nature of design. Rolling back time almost 30 years, Tessmer and Wedman certainly were ahead of their time.

Keywords: instructional design, design thinking, layers-of-necessity

Introduction

Now pushing 30 years ago, Martin Tessmer and John Wedman introduced the layers-of-necessity model (Tessmer & Wedman, 1990). Visually disguised as a model, Tessmer and Wedman, modestly and maybe even a bit sheepishly, actually pronounced the layers-of-necessity as a new instructional design (ID) approach and perspective. In the model-dominant instructional design playing field of the 1990s, who could blame them for being a bit modest and sheepish in calling the layers-of-necessity a new perspective? Let's take a closer look at the layers-of-necessity. Tessmer and Wedman were ahead of their time.

Think back to the late 1980's and early 1990s. Most instruction was designed using sequential waterfall models. The output of one box in the model was the input to the next box in the model. Designing and developing instruction was a process: step-by-step, box-by-box. Tessmer and Wedman proposed a new perspective. The layers-of-necessity is not a process. The layers-of-necessity is a way of thinking about instructional design. It is this way of thinking about instructional design that places Tessmer and Wedman ahead of their time as they viewed instructional designers as they truly are: designers who design instruction.

In this article, I enthusiastically present how in 1990, with the publication of this work, Tessmer and Wedman were ahead of their time. I briefly overview the layers-of-necessity as a model and then explore Tessmer and Wedman's stance that the layers-of-necessity is a way of thinking about instructional design. My exploration focuses on what Tessmer and Wedman considered the critical differences between a layers-of-necessity approach and the traditional ID models. I do not labor in the details of the differences (see Tessmer and Wedman, 1990 for that discussion),

but rather I look at these differences in light of the nature of design that all designers such as graphic and web designers, engineers, and architects embrace, engage in, and enjoy. I conclude with reflections on what the layers-of-necessity means to me as a designer who designs instruction.

ID in the 80's and 90's

To provide some context, let's recollect what was going on with ID in the 1980's and 90's. Models continued to guide instructional designers as they embraced the increasing interest in the use of microcomputers for instructional initiatives (Reiser, 2001). In fact, Reiser noted that there were discussions to develop more ID models to assist with the interactive abilities of computer-based instruction. The 1980's saw the emergence of the relatively new performance technology movement, which emphasized front-end analysis, on-the-job performance, non-instructional interventions, and organizational results (Reiser, 2001). In the 90's, instructional designers witnessed an expansion of the types of activities that confronted them. Non-instructional solutions broadened the range of the ID field. Interests in constructivism, electronic performance support systems, rapid prototyping, and the internet to deliver distance instruction all impacted what was happening in an instructional designer's world.

Layers-of-Necessity at Work

This is the only section where I refer to the layers-of-necessity as a model. What makes the layers-of-necessity work? As a practitioner's model (Figure 1), the layers-of-necessity represents what instructional designers do on the job. It takes into consideration a breadth of designer expertise and practice, from simplified to highly complex ID approaches and everything else in between. An essential element of the layers-of-

necessity is the constraints facing the designer. Constraints can include time, duration, money, personnel, stress, difficulty, content and project familiarity, and material resources (Tessmer & Wedman, 1992). Each layer is self-contained and is, “matched to the necessities of the project,” (Tessmer & Wedman, 1990. p. 79). For ID situations with severe constraints, only layer 1 (See Figure 1) may be possible. For situations where more time and resources are available, a designer could choose to use a more sophisticated layer (layer 3 to ‘n’).

A Way of Thinking about Instructional Design

A critical difference between a layers-of-necessity approach and traditional ID models is that following a layers-of-necessity approach is a way of thinking about instructional design. Tessmer and Wedman provided compelling insight into how instructional designers think about design; no easy task. Even though people have been designing since the beginning of time, the ways in which people design has been poorly understood for a rather long time (Cross, 2011). It is designers and scholars like Nigel Cross who have cultivated the growing bodies of knowledge about the nature of designing and the essential aspects of design ability. Tessmer and Wedman viewed instructional designers as designers like their colleagues in architecture, engineering, graphic design, web design, and other design professions. To illustrate that the layers-of-necessity is a way of thinking about instructional design and that the nature of design is alive and well among instructional designers, I discuss how the layer-of-necessity characteristics of task enhancement, principle-based design, merged stages, opportunistic perspective, and efficiency-based design are embedded in the nature of design. Cross summarized what designers say about the nature of design:

There is a need to tolerate and work with uncertainty, to have the confidence to conjecture and to explore, to interact constructively with sketches and models, and to rely upon one’s “intuitive” powers of reflection in action. (p. 26)

Task Enhancement

In the layers-of-necessity approach, subsequent layers enhance the previous completed design work. Enhancement is not iteration where earlier design components are revised. Enhancement is adding onto the design work that was already done. Designers discover the layers of their project (Cross, 2011). A designer first sees things in his/her mind and then starts to sketch, organizing ideas. Design then becomes a journey where each external representation (e.g. a sketch, draft, prototype, or three-dimensional model) is another layer following on from the previous external representation as design ideas develop. Designers push along encouraging design paths, making progress. From time to time, designers pause, take stock of the design situation, and then keep enhancing the design process.

Principle-based Design

In a layered approach to thinking about instructional design, principles, not procedures, govern design and development activities (Tessmer & Wedman, 1990). A principle-based perspective contends that instructional design is based on layer-selection principles and layer-implementation principles. Layer-selection principles determine which instructional design activities are feasible given the design constraints while layer-implementation principles guide how the various design and development activities are implemented.

Designers design in uncertainty because design is dynamic and complex. Cross describes uncertainty as the joy and frustration that designers get from their design activity. A way to cope with uncertainty is to provide some order. Architects are known for imposing order by bringing a set of guiding principles that help provide starting points to the particularities of the site on which they have to build (Cross, 2011). The result is that the starting points or principles limit the problem to something manageable. With a narrower focus, the designer can work.

In studying urban designers, Levin (1966) witnessed designers jumping to partial solutions before

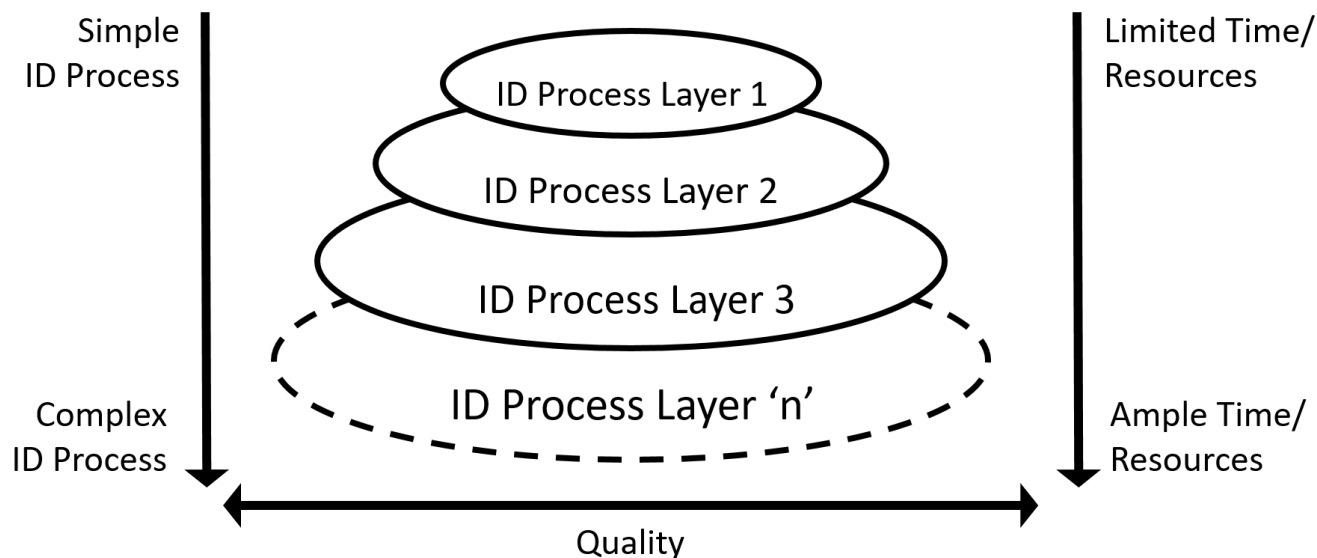


Figure 1. Layers of Necessity Model (Wedman & Tessmer, 1990)

they had fully formulated the problem. In order to formulate partial solutions, designers provide information or the “missing ingredient,” (Levin, 1968, p. 8). Levin called the missing ingredient an “ordering principle” which is the formal properties that are evident in a designer’s work (p. 8). Like a town designed from a rectangular grid. Like a teacup designed as a regular cylinder. Like an instructional design project designed from a situational assessment. Good designers are good at coping with uncertainty.

Merged Stages

Tessmer and Wedman contended that a layer is not distinguished by the type of instructional design task, but by the complexity of tasks in a layer. A layer is a merged set of specific tasks that enhance the design within the design constraints. Donald Schön’s (1983) reflection-in-action helps to explain what happens when an instructional designer is dealing with a layer. Schön presented reflection-in-action as a designer having a reflective conversation with a design situation. Because designers are faced with complex situations, a designer’s specific design moves can produce consequences other than those intended. When a designer makes a move, the designer takes into account the intended changes he/she has made in the situation by forming new understanding and making new moves. A designer takes stock in the new moves in a design situation, and the design situation talks back. In his observation of an architect student working with an architect tutor, Schön witnessed the tutor asking “what if” questions that were design moves that had implications on later moves. Each design move was local and contributed to the bigger design situation. Schön concluded that the designer listens to the design situation’s back-talk and then forms new appreciations which enhance further design moves.

Opportunistic Perspective

Ambiguity and constraints are necessary to the design process. Ambiguity allows all those involved in the design process the freedom to manoeuvre independently among the design objects (Cross, 2011). Constraints allow for reflection and taking stock in what has been done and what can be done. Tessmer and Wedman explained that instructional design is opportunistic. In a layered approach, design components may be deleted or minimized. Taking an opportunistic perspective, instructional designers identify what can be done with constraints. In my experience studying and observing designers, one thing is clear: designers want to know the constraints. When designers know the constraints they then can design.

No designer will settle for good or better when the can have the best. However, this is not how a problem usually comes about in actual design situations. “In the real world we usually do not have a choice between satisfactory and optimal solutions, for we only rarely have a method of finding the optimum,” (Simon, 1968, p. 64). It was Herbert Simon who introduced the term satisficing to describe such situations. Tessmer and Wedman claim that a layers-of-necessity approach is consistent with Simon’s satisficing. Instructional designers oftentimes have to select actions, “which get the job done while not necessarily in an optimal manner,” (Tessmer & Wedman, 1990, p. 79). “The layer is matched to the necessities of the project,” (Tessmer & Wedman, 1990, p. 79). Designing is not a search for an

optimum solution to a given problem. It is an exploratory process where a designer interprets a design initiative or brief as a starting point (Cross, 2011).

Efficiency-based Design

In discussing efficiency-based design versus effectiveness-based design, Tessmer and Wedman reiterated that a layers-of-necessity approach stresses that effective instructional design is determined by “what can be done not what ought to be done,” (1990, p. 81). For example, if an instructional designer had 20 hours and \$2000 to design an instructional product, what can a designer accomplish? Tessmer and Wedman explained that that a layered approach is time and resource sensitive. Constraints drive how instructional designers think about design.

Reflections on a Way to Think About Instructional Design

As a designer who designs instruction, I embrace a layers-of-necessity approach because it encourages intuitive design and provides me the freedom to do what I want to do – design instruction.

Designers rely on their intuition (Cross, 2011). When I design, I take an empathic design approach where I immediately put myself in my learners’ shoes. I want to know all about my learners’ hopes, dreams, and fears. I want to know what my learners want to accomplish. When I intimately appreciate my learners my design juices just bubble. I design a partial solution like a learning experience. I grasp a constraint like what delivery method I can use. I take stock in my partial solutions to see if I can shed more light on the real problem. I enhance the design process.

Since the layers-of-necessity is a way to think about design, I have the freedom to explore and discover something new. I have the freedom to design. The layer, not the sequential process, is important. What makes up one of my layers? It depends on the constraints. In some form or another, you will find components like context, outcomes, learning experiences, and an empathic design approach. Solid ID principles infuse each layer.

Martin Tessmer and John Wedman, thank you. You embraced the nature of design. You saw instructional designers as they really are: designers who embrace uncertainty and constraints, designers who confidently conjecture, designers who interact with partial solutions, and designers who continually take stock in what they have designed and add onto work that was previously done. In 1990, you, Martin and John, were ahead of your time. Today, your layers-of-necessity perspective is alive and well in this designer’s design approach.

References

- Cross, N. (2011). *Design thinking: Understanding how designers think and work*. London: Berg Publishers.
- Levin, P. H. (1966). *Decision making in urban design*. Text of a talk given to a meeting of the Design Research Society on April 27, 1966 at Imperial College, London.

- Reiser, R. A. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational technology research and development*, 49(2), 57-67.
- Schön, D.A. (1983). *The reflective practitioner: How professionals think in action*. Boston: Basic Books, Inc.
- Tessmer, M., & Wedman, J. F. (1990). A layers-of-necessity instructional development model. *Educational Technology Research and Development*, 38(2), 77-85.
- Tessmer, M., & Wedman, J. (1995). Context-sensitive instructional design models: A response to design research, studies, and criticism. *Performance Improvement Quarterly*, 8(3), 38-54.
- Wedman, J. F., & Tessmer, M. (1990). The “layers of necessity” ID model. *Performance Improvement*, 29(4), 1-7.

Improving Online Course Design with *Think Aloud Observations*: A “How to” Guide for Instructional Designers for Conducting UX Testing

Andrea Gregg, The Pennsylvania State University

Ronda Reid, The Pennsylvania State University

Tugce Aldemir, The Pennsylvania State University

Amy Garbrick, The Pennsylvania State University

Jennifer Gray, The Pennsylvania State University

Margaret Frederick, The Pennsylvania State University

Abstract: User experience (UX) problems in course design can be challenging for students as the web interface mediates most online learning. Yet, UX is often underemphasized in e-learning, and instructional designers rarely receive training on UX methods. When our university transitioned from ANGEL to Canvas, we conducted a study in order to identify best practices for online course design in the new LMS. In this study we observed 19 students as they performed common course tasks while verbalizing their thought processes (i.e. thinking aloud). The learners’ reflections and actual behaviors were then analyzed thematically in order to identify perceptions of Canvas, navigation tendencies and preferences, and non-intuitive design elements that interfered with seamless navigation. In this paper, we talk briefly about the study and offer a “how to” guide for conducting usability testing to evaluate the UX of online courses. This “how to” guide is based on our work as reflective practitioners who conducted usability research and synthesized our experiences with the research literature.

Keywords: User experience (UX), think aloud observations (TAOs), learner experience, instructional design

User experience (UX) research puts the emphasis on the perspectives of users: what they value, need, and how they actually work (U.S. Department of Health & Human Services, 2016). The emphasis on user understanding is imperative (Nielsen, 2012) as often times misalignment between designer intention and actual user experience can result in unintended consequences. Figure 1 illustrates this misalignment between designers and “users” by revealing a somewhat common scenario in which a path for walking is designated and paved, yet pedestrians routinely chose a more direct route through the grass. Such misalignment is often true in web design as well since web users have preferred ways of navigation that may not be consistent with the web designer’s vision.

In the online realm, user experience testing provides a crucial bridge of understanding between designer intention and user execution. As usability proponent Krug (2014) has stated, “Testing reminds you that not everyone thinks the way you do, knows what you know, and uses the Web the way you do” (p. 114). Given the web interface mediates nearly all of online learners’

experiences with their courses, online learning seems a natural, if not critical, area for UX research. Indeed, as Koohang & Paliszkievicz (2015) argued, “The sound instruction that is delivered via the e-learning courseware cannot alone guarantee the ultimate learning. It is the usability properties of the e-learning system that pair with the sound instruction to create, enhance, and secure learning in e-learning environments” (p. 60). Zaharias & Poylymenakou (2009) also describe the direct tie between the usability of e-learning designs and pedagogical value noting, “An e-learning application may be usable but not in the pedagogical sense and vice-versa” (p.1). In other words, both pedagogical usability and web usability are important components in course design.

However, even with the clear merits of UX testing with online learning, such efforts in the e-learning context have typically lagged behind other fields (Fisher & Wright, 2010). This may be in part because for many educators, there is a natural aversion to the conflation of “learners” with “users,” which some feel a UX perspec-



Figure 1. Desire Path photograph. Licensed under Creative Commons on Flickr.com (Wetwebwork, 2008).

tive suggests. We argue, however, that e-learning course designers can prioritize pedagogy and academic rigor while still taking seriously the importance of intuitive course design. We consider intuitive course design to be design that allows learners to “focus on a task at hand without stopping even for a second” (Laja, 2017, para.2), when either the current and target knowledge is identical or the design helps learners bridge the gap without any explicit training (Spool, 2005). As Ardito et al. (2016) argued, “A poorly designed interface makes students spend more time in learning it than in mastering the provided knowledge, thus becoming a barrier to effective learning” (p.281). In online courses, the time and cognitive energy learners expend on non-intuitive course navigation is time and energy taken away from more important learning activities.

Notess (2001) emphasized the importance of knowing the learner in order to implement learner-centered design: “All too often, we assume we know everything about the people for whom we’re designing. But do we?” (Know your learner section, para. 1). We would argue that UX testing, especially through the think aloud observation (TAO) method, provides an excellent means by which to learn more about your learners and how they interact with your course design.

TAO at its most basic involves observing individuals as they navigate a website while they attempt to complete specific tasks and simultaneously externalize their internal thought processes. It is the cognitive processes that are typically hidden and not articulated that TAOs can make explicit (Nielsen, Clemmensen, & Ys-

sing, 2002). In the specific context of evaluating the user interface of online course designs, the TAO method involves observing individuals in front of a computer as they attempt to complete common course-related activities (Cotton & Gresty, 2006). For example, a learner might be asked to “Determine what the lesson 2 reading is” and while externalizing their internal cognitive processes, might say something like “I’m wondering if I should click this link or that one.” The combination of observing how they attempt to complete the task alongside the externalization of their thought processes can reveal where design is intuitive and where there is a disconnect between designer intent and user experience.

Learning the ADDIE framework is a hallmark of many instructional designers’ education and includes the following five steps: Analyze, Design, Develop, Implement, Evaluate. The ADDIE framework includes a distinct phase for the evaluation of learning design. When it comes to online courses, instructional designers sometimes get feedback on problematic areas of course design from instructors and student surveys. Rarely, however, do they receive specific feedback on the UX of the online course. Therefore, if designers are interested in conducting TAOs to evaluate online course design, they may not know where to begin or how to proceed. Because of this we share our specific UX testing experiences with TAOs in a higher education. We also attempt to demystify the process by providing a guide for other course designers to conduct this testing in similar educational contexts. Additionally, we created a companion website with supplementary materials for conducting the testing. Before describing the recom-

mended steps, we first briefly discuss our experiences with UX testing.

Our Experience with UX Testing

The authors of this paper all work at a large, multi-campus university which recently underwent a system-wide LMS transition from ANGEL to Canvas. This transition impacted all courses offered, including the online distance courses. The instructional design of the online distance offerings at this university is decentralized, and there are multiple design units responsible for different portfolios of courses. Four design units distributed across the university worked together to conduct TAOs on four online courses redesigned within the Canvas LMS. In brief, 19 students, approximately 4-5 per course design, were observed individually as they performed common course tasks while verbalizing their thought processes (i.e., thinking aloud). Each unit made improvements to the tested course design based on what they observed in the TAOs. The learners' reflections and actual behaviors were also video-, audio-, and screen- captured, and all of the data were then collectively analyzed. This analysis was done in order to identify more generalizable practices related to students' perceptions of Canvas, navigation tendencies and preferences, and design elements that interfered with seamless navigation (Jingjing & Qinglong, 2010; Mulwa, Lawless, Sharp, & Wade, 2011; Robal & Kalja, 2012).

The study included some elements that were more formalized, like IRB approval, and others that were less formalized, like agile design improvements. Please see Figure 2 for an overview of our TAO study at-a-glance.

From the beginning of the study, we intentionally positioned ourselves as reflective practitioners wherein we iteratively improved research instruments and processes. As we were new to UX testing, we also spent time researching, creating, reviewing, and piloting information and technologies before bringing in actual participants to our facility to test. The practitioner-oriented recommendations below were developed through a systematic synthesis of the literature and the critical continuous self-reflections of our experiences with the TAO method. As an attempt to bridge theory and practice to address the disparity between these two strands of current TAO praxis (Boren & Ramey, 2000), we offer practical guidelines that are also theoretically consistent and grounded.

Determine, Pilot, Do: Conducting TAOs for Course Design

The recommendations below for conducting UX TAO testing are organized in three broad sequential categories: determine, pilot, do. First, the course designer determines foundational elements, next those foundational elements are piloted, and finally the actual

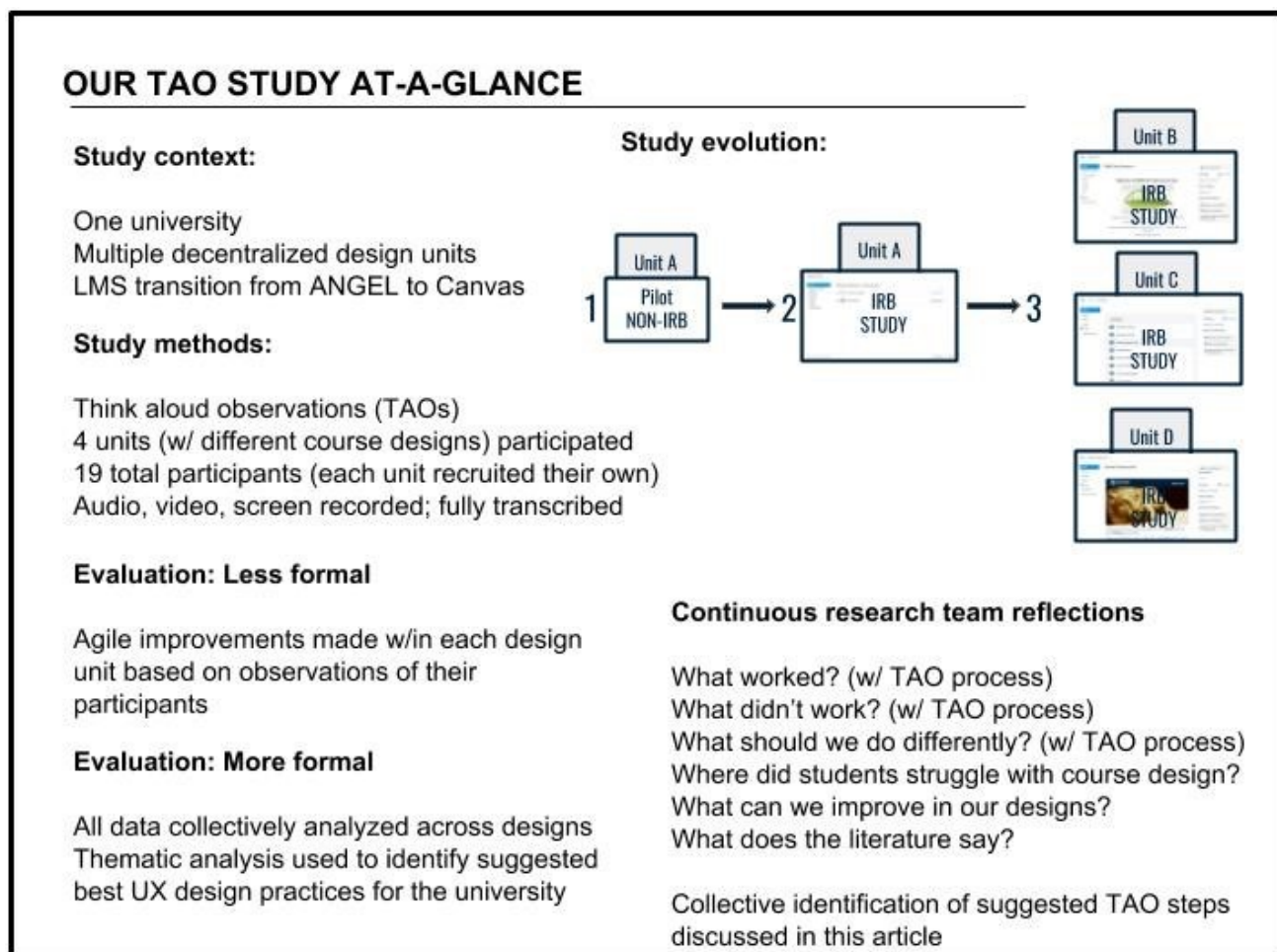


Figure 2. Our TAO Study at-a-glance.

UX testing is conducted with recruited participants.

Determine Foundational Elements

When beginning any new endeavor, oftentimes the best course of action is making key determinations at the onset which then serve as a blueprint for the rest of the project (Farrell, 2017). In this section, we outline the key elements course designers should determine before undertaking your actual TAOs:

- What should be tested,
- The questions that should be asked,
- Who you should test,
- How TAO information will be captured,
- Where and when the test will be conducted
- The necessary forms and potential funding

Pilot Key Steps in the Process

After determining in advance the “blueprint” for your TAO testing, pilot key steps in the process as well as the whole process from start to finish. Piloting is a very important part of conducting successful TAOs as it provides the opportunity to (1) rehearse for the study to ensure it will run smoothly; (2) test the tasks themselves to ensure none of them are misleading or confusing; (3) make more realistic estimations of timing; and (4) validate the data and the wording of the tasks for reliable findings (Schade, 2015). While this may seem like a duplication of efforts, we found it invaluable. We would strongly recommend this practice to ensure more useful data collection and better participant experience. In this section, we outline the most important parts of the TAO process to pilot:

- Pilot your test questions and scenarios
- Pilot the equipment and room set-up
- Pilot getting participants to “think aloud”
- Pilot the entire process

Conduct the UX Testing

Once the key elements of TAO testing have been determined and piloted, shift into the actual recruiting of participants and conducting of the UX tests. In this section, we highlight the practical steps for conducting a TAO:

- Recruit participants & schedule TAO sessions
- Conduct TAOs
- Capture observations during & immediately following each UX test
- Analyze the data
Make improvements to your UX design

Companion Website

Our companion website contains examples of our UX test materials and resources we used to conduct our own testing. These can serve as a starting point for creating your own materials. <https://sites.psu.edu/canvasUX/companion/>

Determine Foundational Elements

We strongly suggest frontloading the work in terms of determining foundational elements and piloting. If course designers do a thorough job preparing, the actual conduct of the TAOs will be smoother and more productive. This section emphasizes the areas we suggest designers “determine” early in the process.

Determine: What will be tested. Because we were transitioning to a new LMS, we decided to test full course designs in the new environment in order to yield the most useful information pertaining to UX experience within the new system (i.e., real-life usability evaluation) (Nørgaard & Hornbæk, 2006). The course designs represented what actual students would see and experience when enrolled in the course. For our testing, the course content was placed in a test space within the LMS, only accessible to the participant and UX team members. Additionally, there was a separate course instance for each participant.

While transitioning to a new LMS led to our full course testing, the TAO method could have easily been adopted at a much smaller scale and without the impetus of a new LMS. In many ways, doing the UX testing earlier in the course design process is beneficial as “...evaluation is more formative the closer it occurs to the beginning of the development process” (Crowther et al., 2004, p.291). Practitioners may want to examine a new or existing course design, or even an individual course content element or assessment. When identifying what to test, consider things like UX design areas in which there is disagreement over the best approach, courses (or course elements) that have proven to be difficult to use in your experience, and developing a new interface or navigation scheme.

Determine: What to ask. After selecting what to test, we next focused on determining which specific elements to evaluate and then crafted questions to address those elements. In our case, we created realistic scenario-based tasks which corresponded to typical student experiences. These are typically described as “task scenarios” or “test questions.” For example, the following is an example of a task scenario we used: “Imagine it is week 7 of the course and you have a team assignment due at the end of the week. Please find your list of team members and demonstrate how you would reach out to them, speaking aloud while doing so.” Our approach is consistent with what Nørgaard & Hornbæk (2006) call “real-life usability evaluation”: evaluation that aims to obtain realistic inputs regarding the object of interest through authentic context and task implementation. We also created open-ended questions to probe the participants for more information in a post-test debriefing (Boren & Ramey, 2000).

In addition to crafting the questions for participants to think aloud while they performed the tasks, we also asked participants to rate each task on a difficulty scale of 1 - 5. This allowed us to collect quantifiable information which added to the qualitative data collection inherent in the think aloud process (Boren & Ramey, 2000).

An important note is that while developing these task scenarios, you will also need to determine where the participant should be located in the course. For in-

stance, it may be desirable to start on the course home page for each task or to start from a different location depending on the task.

Determine: What to ask

Please see the companion website for examples of test questions and screenshots of tasks. <https://sites.psu.edu/canvasUX/companion/>

Determine: Who should be tested. Related to what is being tested and which questions are asked, is determining who will ultimately participate in the test. With UX testing, the goal is typically to try to find five “representative” participants, some designers recommend more and others recommend fewer (Nielsen, 2000). In general, it has been argued that testing five users can help yield roughly 80% of the usability problems in a system (Nielsen, 1993, & Virzi, 1992). Often-times, “representative” is defined in terms of demographics. In the case of distance education-related testing, representative participants can often mean students who are not located near your physical location. One decision focuses on whether the TAO testing will be conducted remotely and/or on-site. In our case, several distance education students were willing to travel to be a part of our UX testing, so we were able to do all of our testing on-site. However, these tests can also be done remotely using screen sharing web conferencing systems.

When trying to define your “representative user” we suggest keeping in mind Krug’s (2014) pragmatic suggestion that the designer should: “[T]ry to find users who reflect your audience, but don’t get hung up about it. Instead, try to make allowances for the differences between the people you test with and your real users” (p. 42). While representative users are nice, the most important thing is that you observe real people navigating the online course while completing authentic tasks. This will tell you much about what is working and what needs to be improved from a UX perspective, even when the participants do not exactly match the student target audience.

Determine: How TAO information will be captured. Another decision we made was how we wanted to capture the TAO information. The most important thing is that you be able to watch an individual attempt to navigate your course to complete common tasks while you observe what is easy and where there is confusion (Ericsson & Simon, 1980). While this is the minimum, you will learn important things about your course design from simply observing someone attempt to navigate. It is difficult to simultaneously facilitate, take notes, and monitor the TAOs (Boren & Ramey, 2000; Nørgaard & Hornbæk, 2006; Rankin, 1988). Therefore, we suggest also doing some sort of audio recording since a retrospective analysis of the think-aloud session can yield deeper understandings and improve the reliability and validity of the findings (Ericsson & Simon, 1993; Rankin, 1988).

For our UX testing, we decided we wanted observer notes taken by hand or computer. If at all possible, we would recommend two facilitators conducting the UX testing to allow for greater observation and note

taking. In our case, for four of our nineteen observations we had two facilitators and noted this allowed one to focus on making sure everything ran smoothly while the other took notes on the participant’s navigation.

Additionally, we used screen capture video which recorded the participants’ screen while they were performing tasks within the LMS course environment as well as using external cameras to record participant audio and facial cues.

Determine: How TAO information will be captured

Please see the companion website for technology suggestions for capturing your TAO information. <https://sites.psu.edu/canvasUX/companion/>

Determine: Where and when will the test be conducted. For our testing, we used a dedicated room for most of the testing. This was especially helpful not only for logistical purposes, but it also facilitated using the same technologies (hardware and software) without having to spend extra time setting up and taking apart the space for each individual test. If TAO testing is conducted at a distance, if at all possible, a dedicated place to conduct the testing will allow more consistency.

The use of technologies may impact room or location selection. For example, the use of external cameras may mandate that more floor space is needed. Whatever technologies are chosen, we would also recommend selecting a space that can accommodate two to three people and chosen equipment comfortably. If a dedicated testing room cannot be used, we would at least recommend using a room that is quiet to help eliminate external noise and distraction for the participant. To the extent possible, the testing space should be a quiet space that will comfortably accommodate you, your participant, and the necessary technologies. In terms of when testing should be conducted, plan ahead to when participants are likely to be available and then make sure that facilitators will also be available during these times.

Determine: Necessary forms and potential funding. If conducting a more formal study and IRB approval was required, insure that informed consent forms are available that participants sign indicating the purpose of the study and how their data will be used. A consent form is advisable even if the testing did not require IRB approval. Some universities have people sign performance release forms if videos will be played later. At a minimum, in a consent form the purpose of testing should be transparent so participants can understand how their data will be used.

In this case, additional funding for graduate assistant time and to provide incentives to participants was received. All 19 participants in our study received a \$50 gift certificate to Amazon.com as an incentive for participation. While funding and/or incentives are not a requirement to conduct TAOs, it is described here as a step to consider early in the process.

Determine: Necessary forms and potential funding.

Please see examples of forms we used on the companion website. <https://sites.psu.edu/canvasUX/companion/>

Pilot Key Steps in the Process

After making our foundational determinations, we piloted many of the areas including test questions, equipment, and room setup. In our case, all UX team members reported that it was very helpful to practice in the actual location, with the equipment, and to do a complete run through of every step we would take with an actual participant. Below we have identified specific areas which should be piloted.

Pilot: test questions and scenarios. We advocate for UX testing because it can highlight disconnects between designer intent and actual student navigation experiences. This same disconnect can be found in the test questions and scenarios where designer assumptions may be present. The tasks need to be adequately complex yet feasible for testing for the participants (Boren & Ramey, 2000; Nørgaard & Hornbæk, 2006; Rowley, 1994). Importantly, the scenarios and specific tasks asked of your participants should be clear and unambiguous. Do not assume that just because a task scenario makes sense to you that it will also make sense to your participants. If a question contains misleading wording it may not be possible to accurately determine if participant confusion is due to a non-intuitive inter-

face or problematic task questions.

For us, piloting test questions and scenarios emerged as one of our most important lessons learned as we did not conduct a thorough enough pilot of the questions themselves. An example is this task question: "You are ready to submit the Lesson 02 Fundraising Scenario assignment. How would you accomplish this task?" In trying to complete this task, some participants thought they needed to submit an actual assignment while others assumed they just needed to demonstrate how they would submit it. This task should have included specific directions clarifying just what participants were being asked to do. To avoid this type of situation in TAOs, we suggest asking a colleague or someone else not involved in the writing of the questions to read the question and then describe exactly what they think they are being asked to do. The usefulness of 'testing the tests' has also been empirically supported in a trial-run usability test to improve a usability test questionnaire and its implementation process (Rosenbaum et al., 2002).

Pilot: The equipment and room set-up. At times technology does not perform as intended. Based on this, it is strongly suggested that you complete a run-through of the technology to be used for the UX testing, ideally in the room in which it will be used. Such piloting will help detect any problems with audio and video capturing (Rowley, 1994; Schade, 2015). Practicing in the room itself will also provide a chance to discover potential issues with noise, temperature, and room configuration. It is better to figure out solutions to these potential problems in advance of your actual UX tests. See Figure 3 for a picture of our actual room setup.

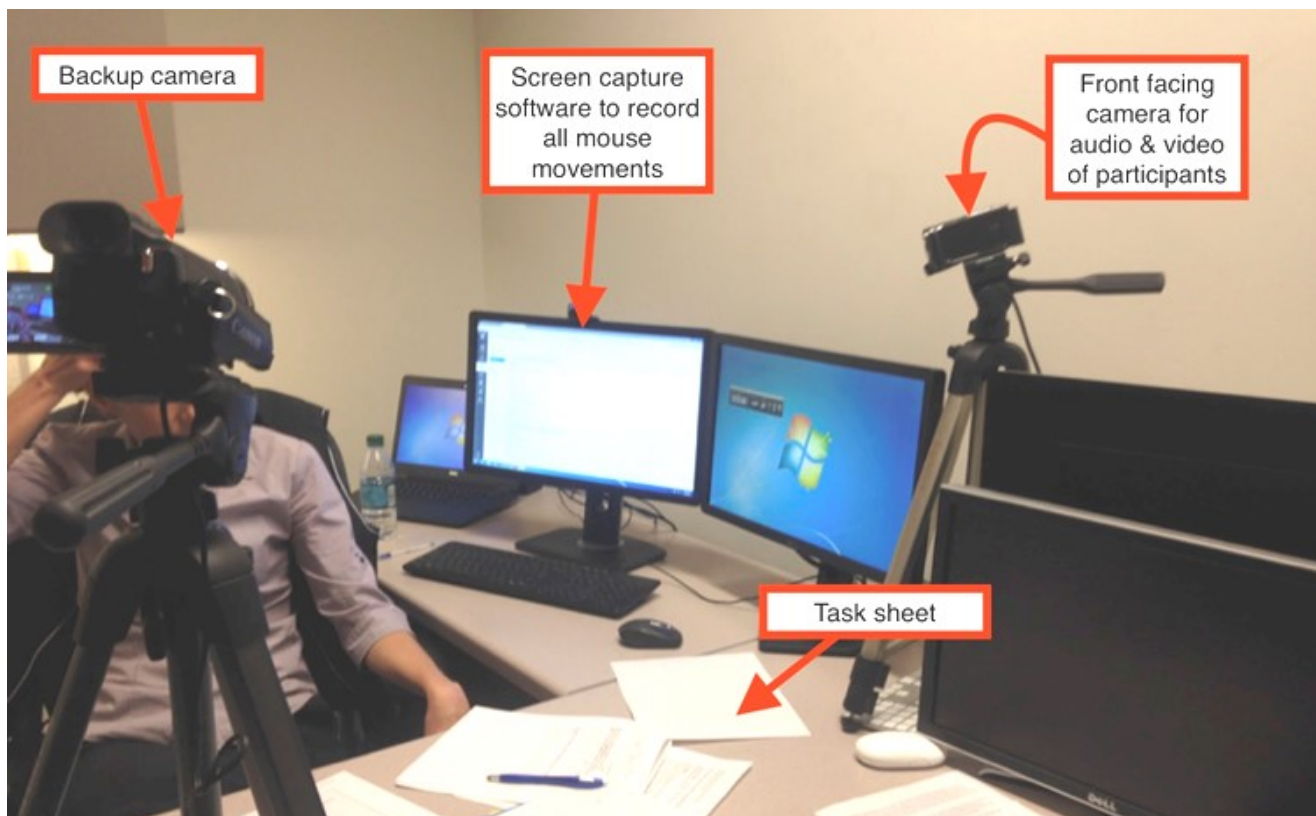


Figure 3. Picture of the room and technology setup for the TAOs.

Pilot: Getting participants to “think aloud”.

While you will learn important things from watching how your participants navigate and where they seem to get confused, it is the “thinking aloud” part of the TAOs that can be especially revealing. After all, as Rubin and Chisnell (2008) assert, through the think aloud technique, one is able to “...capture preference and performance data simultaneously...” (p. 204). This strategy can also expose participants’ emotions, expectations, and preconceptions (Rubin & Chisnell, 2008).

While thinking aloud can be very revealing, it is likely something the participant has not been asked to do before, and it is something that does not come naturally to most people (Nielsen, Clemmensen & Yssing, 2002). Therefore, we recommend that you demonstrate the “thinking aloud” process for your participants. Here we suggest a task scenario be prepared on a website that is not the site being evaluated and then “think aloud” while completing the task to demonstrate what it is like.

Additionally, since most practitioners do not have experience facilitating the thinking aloud process we suggest practicing the think aloud process and being prepared for two extreme types of participants: the reticent and tangential participants (Boren & Ramey, 2000).

The reticent participant. Some participants will not naturally verbalize their thought processes. For this type of participant, the evaluator can politely say something like: “Just a reminder to please say outloud what is literally going through your mind as you are attempting to complete this task.” For some, that is all it will take to remind them. For others, emphasize again that any information expressed about what they are thinking as they attempt to navigate the course is useful. Additionally, it can help to remind them that you are evaluating the UX of the course design, not their abilities to navigate.

The tangential participant. On the other extreme are participants who naturally editorialize rather than verbalize their cognitive processes. For this type of participant gently suggest that they hold onto their reflections until later in the process. Be sure to reserve space throughout the TAOs to invite participants to share additional thoughts.

Asking someone to think aloud, especially while being recorded, can make for an awkward encounter. But, in this phase, you can pilot your own skills of helping the participant through any nervousness or frustration (Boren & Ramey, 2000; Rowley, 1994). If there are multiple facilitators, they can practice with each other. If there is only one, a colleague should be enlisted to help. Either way, someone should play the role of the participant while practicing to help learners think aloud.

Pilot: The entire process. Finally, while it is important to practice and pilot each of the individual elements discussed above, we also strongly suggest piloting the whole process from start to finish before bringing in actual participants. The full pilot will not only reveal potential elements of testing process to change, but may also highlight design areas that can improve the course before beginning actual testing (Boren & Ramey, 2000; Rowley, 1994; Schade, 2015).

Here, it is important that a script is developed and that facilitators/evaluators read it faithfully in testing. A script will ensure that processes are consistent with each participant. The script should welcome the participant and outline the different phases of testing. It should also include information about how the facilitator may not be able to answer navigation-related questions from the participant during the testing phase. It is also very important to emphasize in the script that you are evaluating the UX of the course, not evaluating the participant. Additionally, create a detailed checklist of items to present or check during testing. This checklist may include

Pilot: The entire process.

Please see the companion website for examples of a moderator script and a checklist for UX testing.

<https://sites.psu.edu/canvasUX/companion/>

items such as turning on all cameras, making sure the participant has access to the test environment, and having the participant sign any necessary form.

Do the Actual UX Testing

Now, it is time to recruit and bring in actual participants for the testing. The following steps will cover items not already outlined in the pilot area, although there will be obvious repetitions from piloting to conducting the actual UX testing. Additionally, this is ordered this in a linear way, there may be steps that can be performed earlier or simultaneously such as recruiting participants.

Do: Recruit participants and schedule TAO sessions. Now that it is time to move forward with UX testing, you will have to recruit from your identified audience. If the decision was to use non-student representative testers, then your recruiting process may be as simple as asking a few non-learning design coworkers to assist.

If you recruit from actual students, there may be addition steps. In our case most of our participants were actual online students and because each design unit recruited their own participants, we used different methods. Some were recruited through an online survey which was forwarded to students by instructors. Others were recruited through a more direct effort where faculty members identified and approached specific individuals to participate.

Once the participants have been successfully recruited, then work out the logistics of scheduling a time for them to come to the testing facility for the UX testing. Having a dedicated room for the testing can be

Do: Recruit participants and schedule TAO sessions.

Please see the companion website for examples of recruitment documents. <https://sites.psu.edu/canvasUX/companion/>

beneficial. You will typically want to schedule tests with a gap in between testing times to allow for the facilitator(s) to record additional reflections and properly set up for the next participant.

Do: Conduct TAOs. It is normal to be nervous on “game day,” especially when meeting with the first participant. But here is where the earlier work in the process will pay off since you have already determined and piloted all elements of your TAO testing, including a run-through of the entire process from start to finish. When the actual UX testing is conducted, we use your script and checklist with *each* participant. This can serve as a safety net to ensure all participants have consistent experiences. Lastly, given the foibles of both technology and humans, expect at least one thing to go wrong: a participant will be late or will not show up at all, your screen capture software will fail to work, you will realize a task you piloted and were confident was clear was actually ambiguous. Here we suggest keeping

Do: Conduct TAOs.

Please see the companion site for demonstrations of both a strong example of a think aloud test and an example of one with some largely avoidable challenges.

<https://sites.psu.edu/canvasUX/companion/>

in mind Krug’s always practical advice: “[T]esting one user is 100 percent better than testing none. Testing always works, and even the worst test with the wrong user will show you important things you can do to improve your site.” (Krug, 2014, p. 114).

Do: Capture your observations during and immediately following each UX test. It will be easier for one facilitator to take notes during the testing if there are two facilitators. But even if there is one, brief notes and audio recordings can still be taken during the test itself. In either scenario, capture your thoughts immediately after the testing is complete and the participant is no longer in the room. What is absolutely fresh in your mind while doing the TAO will be a distant memory very soon. It can be hard to recall specifics even thirty minutes later. This is such a crucial step that we suggest putting it explicitly in your checklist. Having a template created in advance for each participant can help as well.

When capturing your reflections, document anything that gives context for the particular participant and what was observed related to UX areas. Note both what was observed--e.g., “participant struggled with locating

Do: Capture your observations during and immediately following each UX test.

Please see the companion site for observer notes written following a TAO test.

<https://sites.psu.edu/canvasUX/companion/>

his group”- as well as your thoughts about how design improvements might be made. The more e-learning course designers can capture during and immediately following the testing, the better for making improvements to your design.

Do: Analyze the data. After conducting the TAOs, the next step is to use the information collected, both the recording of your testing and your documented observations--to make UX design improvements to your course. After testing was complete, we went through our observer notes and watched the captured video. We were able to do this in small groups within our respective design units which enabled productive discussion about where participants were struggling. Having the design team watch together also gives credibility to any suggested changes as you now have objective data to support arguments for change.

In addition to the agile analysis reviewing the data and identifying areas to improve, we also conducted a more formalized analysis (Gregg, Reid, Garbrick, Williams, & Aldemir, 2017). We found the data in the formal report was supported by the informal observations. While this formal analysis was useful in our case because in the middle of the university-wide LMS transi-

Do: Analyze the data

Please see the companion site for the report of the formal analysis.

<https://sites.psu.edu/canvasUX/companion/>

tion we were able to identify suggested best practices across individual designs, in general, designers do not need that level of analysis to identify and make meaningful UX improvements to the design.

Do: Make improvements to your UX design. In the end, the purpose of conducting UX testing is to improve course design and ultimately the student navigation experience. In our case, even during the testing itself, we were able to immediately observe ways in which students were confused by certain terminology, naming conventions, and navigational structures. While these areas seemed intuitive to the designers, after watching students struggle, it became apparent that changes needed to be made to improve the design. Krug (2010) recommends a “path of least resistance” approach to what should be changed by asking, “What’s the smallest, simplest change we can make that’s likely to keep people from having the problem we observed?” (p. 111). Changes to our design included renaming assignments, adding better course and group identification descriptors, and adjusting course navigation to better align with participants’ natural behavioral tendencies.

Conclusion

As educators, we know that students are so much more than simply “consumers” and that teaching and learning is far more complex than a simple transaction or exchange of money for a service or product. Education involves personal challenge, change, growth, and development, no matter the discipline. At the same time, we also know that online students lost in a non-intuitive course interface have a lot in common with users who cannot easily navigate a consumer website. And, one of the biggest barriers in online learning environments that negatively impacts learning and learners’ satisfaction are technical challenges encountered by learners (Song et al., 2004). And while our

learners are probably less likely to simply leave their course website than a typical web user, bad UX design does have learning consequences.

Ultimately learner time and cognitive energy are limited resources, and time and energy spent on trying to find assignments or identify teammates in a poorly designed interface are time and energy they are not dedicating to the learning itself. Naturally, instructional designers want the navigation of course designs to be seamless from a UX perspective so that students can attend to the more important elements of the learning experiences. At the same time, designers can work in a vacuum without much, if any, direct feedback from students on the usability of their course designs. Additionally, there is often a distance between the designers of online courses and the actual learners' experiences of those courses (Rapanta & Cantoni, 2014). Consider that many designers go into the field because they like technology and are likely not representative of the average student.

The authors of this article – working practitioners who conducted UX testing on their course designs – have witnessed firsthand the power of student feedback through the TAO method in improving course design. We would argue that receiving this form of feedback is a crucial element in course design which can help bridge the gap between designer intention and student execution. As we discussed in the beginning, UX testing is increasingly becoming the norm in industries that rely on web interfaces to reach their audiences. We strongly believe it should also play more of a role in e-learning. The framework and discussion here are a part of our efforts to ensure that UX testing plays a stronger role in our field.

References

- Ardito, C., Costabile, M. F., De Marsico, M., Lanzilotti, R., Levialdi, S., Roselli, T., & Rossano, V. (2006). An approach to usability evaluation of e-learning applications. *Universal Access in the Information Society*, 4(3), 270-283.
- Boren, T., & Ramey, J. (2000). Thinking aloud: Reconciling theory and practice. *IEEE Transactions on Professional Communication*, 43(3), 261-278.
- Cotton, D., & Gresty, K. (2006). Reflecting on the think-aloud method for evaluating e-learning. *British Journal of Educational Technology*, 37(1), 45-54.
- Crowther, M. S., Keller, C. C., & Waddoups, G. L. (2004). Improving the quality and effectiveness of computer-mediated instruction through usability evaluations. *British Journal of Educational Technology*, 35(3), 289-303.
- Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*, 87(3), 215.
- Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis. Verbal reports as data*. Cambridge, MA: MIT Press.
- Farrell, S. (2017, September 17). *From Research Goals to Usability-Testing Scenarios: A 7-Step Method*. Retrieved from <https://www.nngroup.com/articles/ux-research-goals-to-scenarios/?lm=test-tasks-quant-qualitative&pt=article>
- Fisher, E. A., & Wright, V. H. (2010). Improving online course design through usability testing. *Journal of Online Learning and Teaching*, 6(1), 228.
- Gregg, A., Reid, R., Garbrick, A., Williams, V., & Aldemir, T. (2017). *Canvas UX Think Aloud Observations Report*. University Park, PA: The Pennsylvania State University.
- Jingjing, L., & Qinglong, Z. (2010, October). Design of model for activity-centered web learning and user experience. In *International Conference on Artificial Intelligence and Education (ICAIE)* (pp. 301-304). IEEE.
- Koohang, A., & Paliszkievicz, J. (2015). E-Learning Courseware Usability: Building a Theoretical Model. *The Journal of Computer Information Systems*, 56(1), 55-61.
- Krug, S. (2010). *Rocket science made easy: The do-it-yourself guide to finding and fixing usability problems*. Berkeley, CA: New Riders.
- Krug, S. (2014). *Don't make me think, revisited: A common sense approach to web usability*. (3rd ed.). Berkeley, CA: New Riders.
- Laja, P. (2017, May 8). *Intuitive Web Design: How to Make Your Website Intuitive to Use* [Blog Post]. Retrieved from <https://conversionxl.com/blog/intuitive-web-design-how-to-make-your-website-intuitive-to-use/>.
- Mulwa, C., Lawless, S., Sharp, M., & Wade, V. (2011, August). A web-based framework for user-centred evaluation of end-user experience in adaptive and personalized e-learning systems. In *Proceedings of the 2011 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology-Volume 03* (pp. 351-356). IEEE Computer Society.
- Nielsen, J. (1993). *Usability engineering*. Boston: Academic Press.
- Nielsen, J. (2000, March 19). *Why E-learning course designers Only Need to Test with 5 Users*. Retrieved from <https://www.nngroup.com/articles/why-e-learning-course-designers-only-need-to-test-with-5-users/>
- Nielsen, J. (2012, January 4). *Usability 101: Introduction to Usability*. Retrieved from <https://www.nngroup.com/articles/usability-101-introduction-to-usability/>
- Nielsen, J., Clemmensen, T., & Yssing, C. (2002, October). Getting access to what goes on in people's heads?: Reflections on the think-aloud technique. In *Proceedings of the Second Nordic Conference on Human-Computer Interaction* (pp. 101-110). ACM.
- Nørgaard, M., & Hornbæk, K. (2006, June). What do usability evaluators do in practice?: an explorative study of think-aloud testing. In *Proceedings of the 6th Conference on Designing Interactive Systems* (pp. 209-218). ACM.

Notess, M. (2001). Usability, user experience, and learner experience. *Elearn*, 2001(8), 3.
doi:10.1145/566933.566938

Journal of Human-Computer Interaction, 25(1), 75-98.

Rankin, J. M. (1988). Designing thinking-aloud studies in ESL reading. *Reading in a Foreign Language*, 4, 119-132.

Rapanta, C., & Cantoni, L. (2014). Being in the users' shoes: Anticipating experience while designing online courses. *British Journal of Educational Technology*, 45(5), 765-777.

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: How to plan, design, and conduct effective tests* (2nd ed). John Wiley & Sons.

Robal, T., & Kalja, A. (2012, July). Learning from users for a better and personalized web experience. In *Proceedings of PICMET'12: Technology Management for Emerging Technologies* (pp. 2179-2188). IEEE.

Rosenbaum, S., Wilson, C. E., Jokela, T., Rohn, J. A., Smith, T. B., & Vredenburg, K. (2002, April). Usability in Practice: user experience lifecycle-evolution and revolution. In *CHI'02 Extended Abstracts on Human Factors in Computing Systems* (pp. 898-903). ACM.

Rowley, D. E. (1994, April). Usability testing in the field: bringing the laboratory to the user. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 252-257). ACM.

Schade, A. (2015, April 5). *Pilot Testing: Getting It Right (Before) the First Time*. Retrieved from <https://www.nngroup.com/articles/pilot-testing/?lm=which-ux-research-methods&pt=article>.

Song, L., Singleton, E. S., Hill, J. R., & Koh, M. H. (2004). Improving online learning: Student perceptions of useful and challenging characteristics. *The Internet and Higher Education*, 7(1), 59-70.

Spool, J. M. (2005, January 10). *What Makes a Design Seem 'Intuitive'?* Retrieved from https://articles.ue.com/design_intuitive/.

U.S. Department of Health & Human Services (2016). *Usability testing*. Retrieved from: <http://www.usability.gov/how-to-and-tools/methods/usability-testing.html>.

Virzi, R. A. (1992). Refining the test phase of usability evaluation: How many subjects is enough? *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 34(4), 457-468.
10.1177/001872089203400407

Wetwebwork. (2008, September 11). *Desire Path* [Photograph]. Retrieved from https://www.flickr.com/photos/wetwebwork/2847766967/in/pool-desire_paths/

Zaharias, P., & Poylymenakou, A. (2009). Developing a usability evaluation method for e-learning applications: Beyond functional usability. *International*

Is That my Cousin or my Mom? ...Or both? The *Unnatural* Similarity of Instructional Design and Human Performance Technology.

Don Robison, Eastern Virginia Medical School

I love debates about whether or not instructional design and human performance technology are twins, siblings, or cousins (see Foshay, Villachica, & Stepich, 2014). Put 12 instructional designers or performance technologists in a room, and you will get 12 different perspectives on this.

Without bringing up jokes about family trees not branching, and other such tasteless things, let me just put my position out there right at the start: instructional design and human performance technology are closer than siblings. That family tree doesn't branch. They have a pretty *unnaturally* close relationship when you really think about it.

I recently re-read Foshay, Villachica, and Stepich's (2014) chapter in the *AECT Handbook of Research in Educational Communications and Technology* (4th Ed.) about the relationship between these two fields. I love that chapter, and, if you haven't availed yourself of this valuable online resource, you can access the *Handbook* for free if you are an AECT member. On the AECT website, you simply click on the "Reference Library" after logging in with your member credentials. It is a great resource for AECT members. Foshay, Villachica, and Stepich (2014) conclude that while the two fields share common backgrounds and perspectives, they have matured into two distinct fields of practice

with two different research and methodology bases.

And that is a fair conclusion, if you focus on methodologies and research bases.

But the two fields have one common component that ultimately dictates their relationship. At their highest and best, both fields point directly to accomplishment.

So the two fields are not the same, but they point to the same end.

So maybe not so different, after all?

Except for academia (how many times must we start a sentence that way?), the relationship between these two fields is crystal clear. Because, except in academia, the goal of organizational entities is accomplishment. And for most organizational entities, there is a kind of agnosticism towards how they get there. Don't get me wrong, most organizations have their values, and most conduct themselves with integrity. But they have their missions, and really, for the most part, they are willing to accomplish their missions in as expedient a way as is morally possible.

To them, learning is most often a means to an end, not the end in itself. And for most, if they can accomplish their mission without having to teach people things, that is a win (continued next page).

Episode 1: The Awkward Truth...

When HPT and Instructional Design first met, there was a very awkward moment.

Of course instructional design—the older of the two—knew the secret. It was HPT that had to deal with it.

So, wait! You're saying you are my brother and my mom, right?

Ummmm, so our family tree doesn't really branch?

PERFORMANCE TECHNOLOGY

INSTRUCTIONAL DESIGN

THE PERFORMANATOR



Biker Man images reproduced under license, Andrey Armyagov@123rf.com

Don Robison

Accomplishment does not always require learning, but intentionally designed learning should always lead to accomplishment.

For this reason, though I self-identify primarily as an instructional designer, I ultimately see myself as a performance professional. I invest my skills, imagination, creativity, sweat, and time in the task of helping individuals or organizations achieve their visions.

Ask practically any senior business, medical, industrial or military leader which is more important: learning or accomplishment, and they will invariably answer, “accomplishment.”

Reference

Foshay, W. R., Villachica, S. W., & Stepich, D. A. (2014). Cousins but not twins: Instructional Design and Human Performance Technology in the workplace. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research in Educational Communications and Technology*. New York, NY: Springer Science+Business Media.

REALDESIGN

PERSPECTIVES FROM THE FIELD OF INSTRUCTIONAL DESIGN

REALDESIGN is a regular feature that brings leaders in our field to you discussing their challenges in actual design contexts. For the next issues, we have invited the authors of the soon-to-be-released next edition of *Designing Effective Instruction* (Morrison, Ross, Morrison, & Kalman, in press) to share some of their practical design experiences.

Is it information or is it instruction?

Jennifer Morrison, Johns Hopkins University

An architect house hunting. A chef dining out at a restaurant on vacation. A professional musician attending a concert. Picture yourself as an expert, engaging with your professional environment in a non-work context. I suspect that the chef may be particularly critical, and the musician, uniquely attuned to the lines played by each member of the group. Experts in their respective fields likely have a challenging time letting go of their professional lens when in these sorts of situations. The same is true for me. My background in instructional design is rarely muted when I encounter instruction or training materials.

Whenever one of us has to take the refresher course for human-subjects research, there's sure to be some grumbling and general frustration that we have to endure training that's just so tedious. The training is online and involves an assessment at the end of the course. It's one of the "nonexamples" of good instructional design where someone just dumped a manual with definitions of terms into an online platform. Perhaps they went the extra mile and divided content into "modules." Sure, each course may have behavioral objectives presented at the start, but in no way, shape, or form does the design of the course actually support attainment of the objectives. At the end, you're presented with a quiz consisting of application-type multiple-choice questions that you must pass in order to receive your certificate allowing you to conduct research for the next few years. The good news is that while you have the quiz open in one screen, you can open the modules in another to reference. You can also retake the quiz and just memorize the correct answers for the next go-round. While I'm confident none of us are violating any principles, the course is certainly not helping one to truly understand the concepts and principles of conducting responsible research.

Given my frequent experience with bad online training, it's no surprise I was skeptical of the online course I'm taking as part of the process to register my

dog, Faya, as a therapy dog. The registration process involves two parts: a behavioral assessment for the dog and the owner's completion of a handler course, which is administered online. I was a little apprehensive when I saw it had seven different lessons. I paid the fee, made a cup of coffee, and prepared myself for the worst. I briefly considered what else I could do while "watching" the lessons.

To my pleasant surprise, this online course was in stark contrast from what I'd expected! The lessons were presented using a simple platform, and without any fancy/frivolous animations or "flash." Rather than dumping some printed manual online and calling it a course, the authors began each lesson with three or so well-written behavioral objectives. Then, they presented only the relevant content that supported the objectives, including forward and back buttons to offer learners control of their progression through the materials. What was most impressive was that the instructional approach employed was thoughtful, encouraging the learner to engage with the content.

What do we mean by engagement with content? Wittrock (1974, 1989) describes the importance of learners making sense of instruction through creating meaningful relationships between concepts and between new information and existing knowledge. A designer might incorporate instructional strategies to encourage learners to more deeply process content and ultimately attain the objectives for the instruction. Jonassen (1988) identified four categories of generative strategies including recall, integration, organizational, and elaboration. Examples of strategies one might employ include mnemonics (recall), paraphrasing (integration), categorizing (organizational), and explanations (elaboration), among others. There's a vast body of research demonstrating the effectiveness of these strategies, but the strategies you might use vary based on the type of content learned and whether the learner should be able to recall or apply the content.

Our expanded-performance content matrix (Morrison, Ross, Morrison, & Kalman, in press) uses content categories to prescribe appropriate instructional strategies. Merrill (1983) offered a tool to classify objectives and our expanded model adds categories to include psychomotor, affective, and interpersonal tasks. When designing instruction, we note that you must first classify the objective based on the content category (e.g., fact, concept, principles and rules, procedure, interpersonal, and attitude). Then, based on the type of performance the learner must demonstrate (e.g., recall or application), we offer prescriptions for strategies to encourage generative learning described by Wittrock (1974, 1989).

But, how does a designer employ such strategies in a self-paced online course? Sure, you could prompt a learner to paraphrase or explain why something is true, but there's also the importance of providing feedback to ensure the learner is on the right track. One option consistent with the audiotutorial method (Postlethwait, Novak, & Murray, 1972) is to present the learner with a model answer and have the student compare what they wrote and analyze what might be missing or different. The therapy dog handler's course (Pet Partners, n.d.) is an excellent example of another approach for how one can engage learners without needing an instructor to weigh in on the generative content the learner produces. Take, for example, the three concepts of proactive, reactive, and inactive handler behaviors with dogs. The course presents definitions of each concept, followed by an example for the learner to examine. The categorization results in immediate, elaborative feedback, describing why a response is correct or incorrect.

Designing instruction that engages the learner in content is challenging and takes more effort on the part of the designer. But, this approach to instruction is similar to the concept of a proactive handler setting their animal up for success in performing what we want them to do. We can all do the same by incorporating instructional strategies to set our learners up for success. That is, preparing them to demonstrate the performance described in the instructional objectives through encouraging engagement and sense-making of new content.

References

- Jonassen, D. (1988). Integrating learning strategies into courseware to facilitate deeper processing. In D. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp. 151-181). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Merrill, M. D. (1983). Component display theory. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 282-333). Hillsdale, NJ: Erlbaum.
- Morrison, G. R., Ross, S. M., Morrison, J. R., & Kalman, H. K. (in press). *Designing effective instruction* (8th ed.). Hoboken, NJ: John Wiley & Sons, Inc.
- Pet Partners (n.d.). *Pet Partners handler course*. Retrieved from petpartners.org
- Postlethwait, S. N., Novak, J., & Murray, H. (1972). *The audio-tutorial approach to learning*. Minneapolis, MN: Burgess.
- Wittrock, M. C. (1974). Learning as a generative process. *Educational Psychologist*, 19(2), 87-95. doi: 10.1080/00461520903433554
- Wittrock, M. C. (1989). Generative processes of comprehension. *Educational Psychologist*, 24, 345-376. doi: 10.1207/s15326985ep2404_2