Design for Learning

Principles, Processes, & Praxis

Jason K. McDonald
Richard E. West

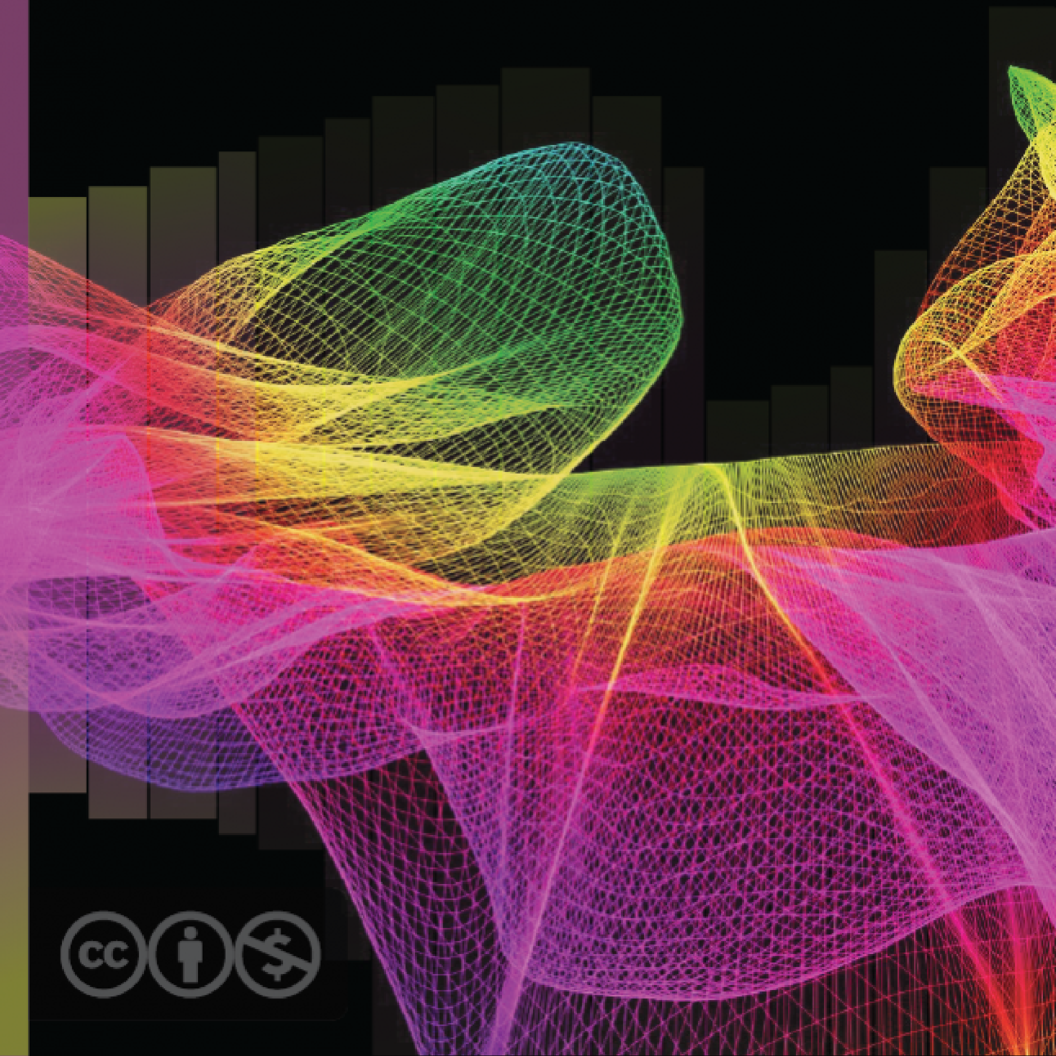

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Table of Contents

Introduction

Jason K. McDonald & Richard E. West

Our purpose in this book is twofold. First, we introduce the basic skill set and knowledge base used by practicing instructional designers. We do this through chapters contributed by experts in the field who have either academic, research-based backgrounds, or practical, on-the-job experience (or both). Our goal is that students in introductory instructional design courses will be able to use this book as a guide for completing a basic instructional design project. We also hope the book is useful as a ready resource for more advanced students or others seeking to develop their instructional design knowledge and skills.

Our second purpose complements the first: to introduce instructional designers to some of the most current views on how the practices of design thinking contribute towards the development of effective and engaging learning environments. While some previous books have incorporated elements of design thinking (for example, processes like prototyping), to date no instructional design textbook focuses on design-oriented thinking as the dominant approach for creating innovative learning systems. Our aim is to provide resources to faculty and students for learning instructional design in a manner consistent with a design-oriented worldview. But because the classic approaches to instructional design are still important for many professionals, we also include chapters that introduce some of the traditional, systematic processes for designing instructional environments. We hope this blend of traditional and innovative views provides readers with a competitive advantage in their own work, providing them with a larger set of conceptual tools to draw on as they address the professional challenges they face.

This book is divided into two major sections. The first, ***Instructional Design Practice***, covers how instructional designers ***understand, explore, create, and evaluate*** situations requiring educational interventions and the products or systems used to support them. In this section, chapters address how we understand diverse learners and their needs; how to explore and frame the educational problems one is solving; how to analyze the context and tasks associated with the problems; how to iteratively generate decisions, prototypes, and solutions; and how to evaluate and understand the effectiveness of an instructional design.

The second part, ***Instructional Design Knowledge***, covers the sources of ***design knowledge***, a variety of ***instructional design processes***, approaches for designing ***instructional activities,*** and the ***relationships important for instructional design practice***. This section includes chapters addressing learning/instructional theory, design precedent, both systematic and agile design processes, and practical strategies for using technology wisely, managing projects, and creating instructional activities.

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One of the exciting things about the field of instructional design and learning technology is how quickly it evolves. As soon as new technologies are introduced we see instructional designers experimenting with how they might be put to use for learning purposes. The same is true regarding new scientific findings from psychology, sociology, communications, or other human sciences, with professionals in our field scrutinizing them to understand what relevance they might have for improving the learning or teaching process. We hope this book becomes a similar, cutting-edge resource that helps readers implement our growing understanding regarding how to design effective and engaging learning environments.

Good luck!

Part I

Instructional Design Practice

1

Designing for Diverse Learners

Susie L. Gronseth, Esther Michela, & Lydia Oluchi Ugwu

Designing educational programs and curricula involves developing understandings of the learner and instructional environment characteristics that could impact learning success. While there may be some commonalities among learners, it is important for designers to recognize that there will likely be a great diversity of learning preferences, abilities, and experiences that learners will bring to a course or other learning experience. Rose (2015) remarked that the notion of an “average” learner is a misnomer, and learner diversity (rather than uniformity) is actually the norm. When learner variability is not addressed in a design, it is inevitable that many learners will experience obstacles to their learning, limiting the effectiveness of the learning experience for them and inducing additional costs in time and resources to make adjustments and accommodations (Brinck, 2005). Planning for learner variability from the outset is therefore a valuable step in the design process that can lead to more robust, accessible, and impactful designs. Being able to plan for diverse learners begins with developing empathetic understandings of the characteristics in which learners will vary. This chapter first describes ways that instructional designers can become familiar with the diverse needs of target learners and then offers recommendations for next steps in implementing inclusive design practices as part of curricular planning.

Recognizing Learner Needs

Learners vary along many different dimensions, with a learner's profile as "individual as DNA or fingerprints" (Rose & Strangman, 2007, p. 388). In general, people have different preferences and habits for how they approach learning that are worth noting in the design. Some learners may have specific disabilities that can impact how they absorb, process, and express information. Disabilities can affect sensory areas such as vision, hearing, speech, and motor control. They can also be characterized by neurodiversity in that there are distinct differences in an individual's neural networks involved with cognitive processes that impact how learners attend to, organize, and remember information. Learners may have varied needs in their social-emotional tendencies, which can drive how they work in groups, initiate and sustain engagement through the learning process, and create meaningful connections with content. It is also important for designers to recognize learner diversity in linguistic proficiency and cultural backgrounds that can play into how learners bridge their prior knowledge with new learning and the kinds of scaffolds and tools that could enable learning success.

Further, the use of technology as part of instruction and learning can pose challenges to ensuring equal access among learners. Digital educational materials and tools can introduce accessibility and usability issues. For example, some learners may use screen readers or closed captioning to review content; some learners may use voice-command, keyboard navigation, or gestural movements to interact with digital applications. When instructional designs do not support these varied means of access and interactivity, learners will experience barriers to being able to fully engage and benefit from the instruction.

Educational programs that require the use of specific technology equipment for access of computer-based instruction can be met with barriers to obtaining the equipment in parts of the world that have limited financial resources or under-developed infrastructures. For instance, the International Telecommunications Union (ITU, 2018) reports that just under half of households worldwide have a computer in the home. Similarly, web-based instruction is often dependent on learners having sufficient bandwidth through which to access the materials and activities, and this is not yet available in some areas. In the Americas, for example, about 70% of broadband subscriptions in 2017 reported access 10 Mbit/s or faster (ITU, 2018), which is generally sufficient speed for streaming video and making fast downloads. However, in least developed countries (LDCs, as designated by the United Nations according to their low socioeconomic development and Human Development Index ratings), access to high-speed Internet is not as prevalent. In 2017, 30% of broadband connections were at very slow speeds of less than 2 Mbit/s, which would make content streaming and course material downloads quite difficult. Designers can simulate slow internet in a variety of ways to understand how this impacts their learners.

Therefore, it is important in instructional design practice to recognize such elements and characteristics of the target learners and learning environments that relate to how learners will access, participate in, and show what they have learned through the instruction. Planning strategically to enable learners to navigate learning pathways that best meet their needs may involve greater investment of designer attention, time, and resources at the front-end. However, accessibility is necessary, and workaround solutions and accommodations are often costly and can have social implications that make them less than equal access for all learners.

Intentional effort in developing empathetic understandings of target learners during initial design phases can support more sustainable implementation of the educational program. This approach is characterized as universal design (UD), or designing for all people.

UD “defines ways of thinking about and designing environments and products that work for the greatest number of people possible” (Null, 2014, p. 12). Robert Mace coined the UD term, noting that UD is “a process, rather than an achievement” (Story et al., 1998, p. 2). Applied to education, UD involves designing instruction that will be usable to the greatest extent possible by the target learners. The design should facilitate equitable use, offering equivalent means of access and engagement for learners with diverse abilities, and flexible use, providing options that accommodate varied learning preferences and abilities (Story et al., 1998). Thus, designing for diverse learners yields great benefits. Harris (2018) provides an example from nursing education, “Implementing UD concepts in nursing classrooms which support equity and inclusion of students with diverse learning needs is a practical and sustainable alternative to granting reasonable adjustments to students on a case-by-case basis” (p. 180).

Developing Empathy in Design

Designers of all types, and especially novice designers, can be somewhat self-centered. This is not to say that they are selfish, but they can be self-referential, reflecting their own needs, experiences, and preferences in their designs rather than those of the learners. For example, Molenbroaek and de Bruin (2006) related the story of a hearing aid designer who fit the shape of his designed hearing aid to the comfort of his own ears instead of those of older people who would actually wear them. This created great frustration for those who purchased the hearing aids when they found that they could not find a comfortable fit in their ears. (For more examples, search for “bad design style” or read *The Design of Everyday Things* by Don Norman.)

So, too, in designing for education, attempts at universally designed instruction can fail to meet the actual needs of the learners. While self-referential design can certainly be used as a starting point, designers should not stop there but continue to develop empathic understanding for the target learners who will be using their designed materials. Empathic understanding is not binary, that is, it is not simply present or absent; rather, it is a skill that can be developed and deepened over time through experience and effort. As Brinck (2005) related in the book *Cost-Justifying Usability*, the investment of time and attention will be well worth it.

There are many ways that instructional designers can build empathic understanding for target learners. Fila and Hess (2015) described five techniques often used by instructional designers. First, designers can directly observe learners, both within the target learning context and in related places beyond. By watching how learners interact with environments, tools, and problems, designers can see barriers and points of confusion, as well as learner-initiated workarounds and strategies. Another technique is for designers to directly interact with sample target learners. Face-to-face, phone, and email conversations can lead designers to ask pointed questions that can help them learn more about the learner’s experiences. Having a conversation with someone close to a target learner can also yield insights, such as discussing learning needs with parents of young target learners.

Designers may also project themselves into the viewpoint of a target learner in order to envision what his/her experience within the planned instruction might be like. To do so, designers can imagine how learners with various characteristics and abilities would experience the exercise, activity, or lesson and where they may encounter barriers, misalignments, or other frustrations. Finally, designers can simulate participation by piloting drafted designs and materials to gain understanding for how learners may experience interacting in the learning context.

Tools for Understanding Target Learners' Experiences

- Dyslexia
- Vision Disabilities
- Hearing Loss
- Slow Internet

For example, Dr. Temple Grandin uses a simulation technique when designing livestock facilities to build understandings for how to improve the designs for the users (Raver, 1997). Her ability to empathize with the reactions of livestock have made her an international expert on designing humane animal processing plants.

Explanatory Videos With Dr. Temple Grandin

Animal Behavior

Watch on YouTube https://edtechbooks.org/-WRFt

Visual Thinking and Animal Behavior

[Watch on YouTube https://edtechbooks.org/-mLKZ](https://edtechbooks.org/-mLKZ)

Applying Empathy in Design

Empathic understandings of target learners can then be applied to design parameters, such as how content will be communicated to learners through the designed instructional experience, how learners will practice concepts and skills during a lesson, or how learning will be assessed formatively and summatively. As designers generate ideas for these parameters, they can integrate their empathic understandings of the target learners with expectations and requirements from stakeholders and the realistic constraints of available resources and the target learning environment. See Table 1 for a sample of learner characteristics, potential instructional barriers, and supports that can be built into a learning experience.

Table 1

Non-Exhaustive List of Potential Considerations, Barriers, and Supports

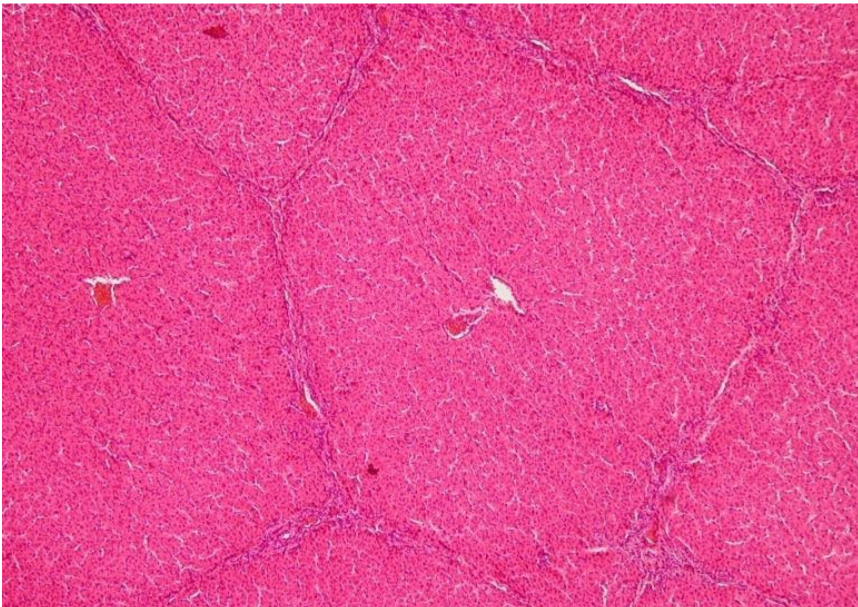
Considerations	Potential Instructional Barriers	Supports
Hearing difficulties	• Video • Podcasts • Screencasts • Lecture	• Captions (complete and synchronized) • Interpreters • Audio transcripts
Vision difficulties (such as low vision and color blindness)	• Presentation materials and demonstrations • Printed texts • Color use in presentations • Tasks requiring color differentiation	• Audio descriptions of visible motion on a video • Zoom functionality • Screen reader accessibility • Braille alternatives • Image alt-text • Designations other than color for conveying key information
Physical mobility difficulties	• Using a mouse • Physical requirements • Inaccessible spaces • Stairs and platforms	• Keyboard accessibility • Furniture rearrangement for increased mobility • Varied seating options
Information processing difficulties	• Assessment time limits • Extensive, complex tasks • Language comprehension • Technical jargon	• Remove time limits • Chunk information • Support strategy development (small goals, organize tasks, more deadlines for smaller sections) • Flexible schedules • Use simple language and/or provide vocabulary support
Language differences	• Spoken language • Written language • Collaborative activities • Writing tasks • Idiomatic language	• Translation tools • Vocabulary instruction • Captioning • Transcripts • Starter text for writing
Low Internet bandwidth	• Slow loading of large files (video, audio, images) • Poor connections for real-time interactions • Multimedia streaming limitations	• Provide alternatives to video • Reduce image file size • Have options for asynchronous participation • Mobile-friendly interface • Chunk content in smaller sections
Cultural differences	• Gender roles or relationships between genders • Power differences between students and instructors • Concepts of authority and respect • Behavior expectations	• Collaboration with knowledgeable stakeholders • Guided group collaboration structure and specified roles • Communicated expectations • Examples of expected contributions and activities • Connections between learner culture and new content
Digital literacy	• Tasks requiring technical skills • Navigation of online environments • Learning curve for digital tools • Frustration or discouragement	• Specific instruction or tool tutorials • Emotional support and encouragement • Time and scheduling guidance • Just-in-time help desk support

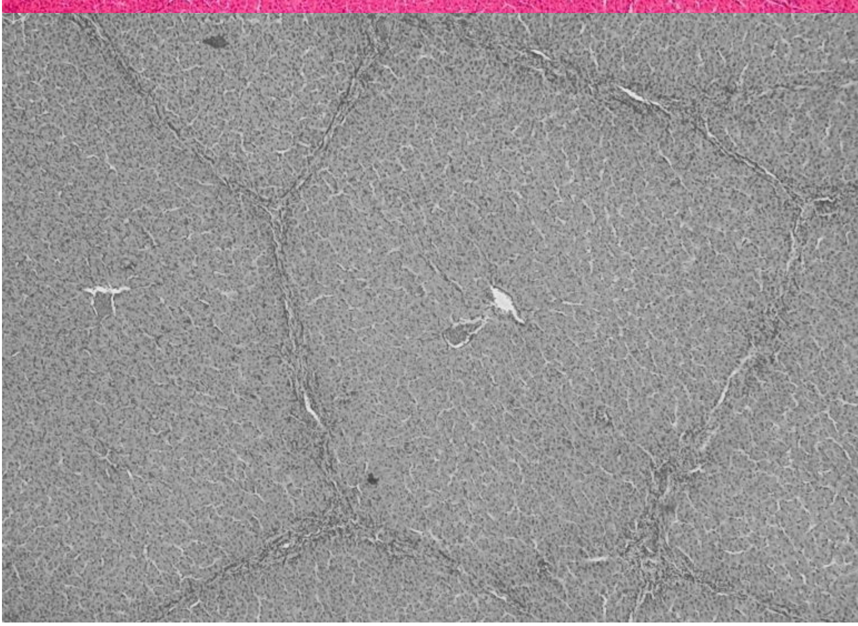
Learner voice can be a valuable contributor to applying empathy in design. Checking in with learners and giving them a chance to respond to the design throughout the development process will likely result in meeting pertinent needs and avoiding miscommunications and misinterpretations. This can be done through formal and informal presentations of a drafted design to learners for feedback and further suggestions. Thus, instructional design is an iterative process of continual refinement through such feedback loops and checks for congruency and alignment across components of a module or educational program.

To illustrate how empathy can be applied in the instructional design process, two cases will be described. First, a case mentioned in Meeks, Jain, and Herzer (2016) related how medical students with color blindness experienced difficulty in histology courses when they were asked to identify microscopic structures, as the slides used to depict these structures were often stained using red or green colors that tended to obscure some key distinguishing features. The instructors addressed this barrier by converting the slides into grayscale, which enabled all students to view the structures. Thus, a recommended practice in designing instructional materials is to use shapes, labels, or other means to differentiate elements in illustrations, graphs, and other visuals, rather than color only. Doing so will facilitate a more universally designed experience for target learners.

Figure 1

Using Stain to Help Students with Color Blindness Identify Microscopic Structures





A second illustrative case is from the Industrial Design program at the University of Illinois at Urbana-Champaign. Students in this program are coached to build empathy for users of their designed products and then use these empathetic understandings to refine their designs. One strategy that they use is to explore what it feels like to intentionally impair each of their senses and attempt to use their designs in representative home, school, and public spaces. This pushes them to develop insights regarding users who may have specific sensory impairments and how they may experience use of the design in varied environments. The design students also team up with non-design students who have both visible and invisible disabilities to review and pilot their drafted designs. Doing so allows them to build empathy through the interactions and dialogues with their team members, then they incorporate their user experience insights into future revisions (McDonogh, 2015).

Design Approaches to Address Learner Variability

Differentiated Instruction (DI)

Since learner variability is the norm rather than the exception, it is important that designers incorporate instructional approaches that will meet the needs of individual students and optimize their capacity to learn. One such approach is differentiated instruction (DI). Stradling and Saunders (1993) defined *differentiation* as “the process of matching learning targets, tasks, activities, resources and learning support to individual learners’ needs, styles and rates of learning” (p. 129). This means incorporating flexibility in the modes of learning, types of provided resources, and assessments in order to respond to specific learner differences. Instructional designs can be differentiated in content, process, and product (Tomlinson, 2017).

Each of these dimensions will be discussed in further detail.

Differentiation of content involves varying the concepts and skills students will learn. While engaging in instructional planning, designers may work alongside subject matter experts or instructors to identify learning goals and outcomes for a course. Within the goals and outcomes, there can be variance in the levels of knowledge, skills, and dispositions that learners could be expected to gain from the course. For example, the content can be differentiated into concrete and abstract concepts, and students could be provided with a range of options (additional links, supplementary material, multimedia) to access learning materials and to work at their own pace. A pre-assessment could be used to gauge prior content mastery among learners and identify areas of additional needed support. Pre-assessments may also be used to determine learner readiness levels, interests, and learning preferences (Tomlinson & Allan, 2000). Gaining insights into learner interests and learning preferences (including preferences regarding individual/group work, personality traits, and internal/external motivators) will enable appropriate matching of course design to these learner characteristics. A pre-assessment can be in written form (such as a survey or test), or it can take the form of one-to-one interviews, focus groups, or demonstrations.

Differentiation of process refers to the varied ways that students make sense of learning materials and take ownership of their own learning. For a designer, it means factoring in activities that are engaging and intellectually challenging and that lead students to practice and apply targeted concepts and skills. Some examples are problem solving, mind mapping, and reflective journaling. What learners create through such activities, that is, the products of their learning, can also be varied. Products should demonstrate knowledge and skills that learners have gained from a course, but they can be in various forms, such as written, physical demonstration, spoken performance, or a video compilation. Designers can develop performance expectations to guide learners to incorporate critical thinking and connections to real-world applications through their products.

Universal Design for Learning (UDL)

Universal Design for Learning (UDL) calls for a flexible approach to learning that supports all students. Similar to the tenets of Universal Design mentioned earlier, UDL aims to minimize barriers for learners as part of the design of curricula and learning environments so that they are accessible to as many people as possible. UDL involves building in flexibility into the curricula from the outset instead of retrofitting and adapting inaccessible curricula after the fact (Meyer et al., 2014).

It is worth noting that UDL differs from DI because it provides learners with multiple options to pursue self-directed learning whereas DI is often more instructor-directed.

Differences Between UDL and DI With Katie Novak

[Watch on YouTube https://edtechbooks.org/-eMQN](https://edtechbooks.org/-eMQN)

The UDL framework contains three key principles:

- Provide multiple means of engagement that stimulate interest and persistence in learning, thereby producing learners that are purposeful and motivated;
- Provide multiple means of representation so that content is delivered in varied formats, enabling learners to become resourceful and knowledgeable; and
- Provide multiple means of action and expression in which learners can show their developing knowledge in varied ways, supporting them to become strategic and goal-directed (CAST, 2018).

Each principle has guidelines and checkpoints that detail implementation strategies.

To access the UDL framework, visit http://udlguidelines.cast.org/.

Hall, Strangman and Meyer (2003) offer four steps for implementing UDL in the planning and delivery of curriculum: set goals, analyze status, apply UDL, and teach the UDL lesson. When setting goals, it is important to establish the context for the instruction. Designers may need to consider, for example, if target goals would need to align with state or organizational standards. Designers can also consider if the methods that students use to accomplish the learning goals can be separated from the goals themselves. For instance, a goal that requires students to “write a paragraph about how the circulatory system works” may be reframed to prompt learners to “describe a complete cycle in the circulatory system,” which would facilitate flexibility in the means that learners could achieve that goal.

Analyzing the status of instructional materials involves evaluating the methods, materials, and assessments that will be used, considering their accessibility and flexibility in the ways that students engage and demonstrate their learning and identifying potential barriers. UDL can then be applied to elements of the instruction wherein potential barriers and opportunities for flexibility have been identified. Ultimately, the intentional flexibility in the UDL approach to design is aimed to position learners to be more self-directed and self-regulated, as learners are provided options for their learning pathways that align with their individual needs.

So, how might that look in practice? To provide multiple means of engagement, students are provided with tools that enable them to take ownership of their learning. Challenge levels should match their readiness, and there should be built-in opportunities for mastery-oriented feedback. This could begin with a well-designed syllabus that clearly states learning goals and objectives, course expectations and structure, information on how to navigate the learning environment, methods of assessment, and options for participation. Learning environments should support varied navigation and control methods that are accessible to all learners. Designers may also consider incorporating checkpoints that can help learners chart their progress in a course and provide opportunities for feedback and self-reflection after completing a unit of study.

Providing multiple means of representation offers learners options to customize the display of information, make sense of language and symbols, and enhance their levels of comprehension. Course materials can be presented in a variety of formats to provide varied means for students to connect with the content. Materials may be customizable, enabling learners to adjust text size, color, contrast, etc. and access content in varied forms, such as video, interactive simulations, audio, and text-to-speech.

In providing multiple means of action and expression, designers can incorporate planned flexibility in learner response options, navigation, access to tools and assistive technologies, forms of communications, and demonstration of learning. One strategy to achieve this is to maintain uniformity in the design of the content, both across functionalities and through consistency of visual appearance. Another strategy is to offer multiple options for learners to demonstrate their mastery of the content, such as through text, mind maps, audio, and video.

Culturally Relevant Education

Culturally relevant education is built on the premise that culture is an essential component of students' learning, as instructional practices, curriculum, and modes of assessment that are couched in "mainstream ideology, language, norms, and examples often place culturally diverse students at a distinct educational disadvantage" (Howard, 2012, p. 550). Culturally relevant education is characterized by several frameworks, including culturally responsive pedagogy, culturally relevant teaching, and culturally congruent teaching. It is empowering to students intellectually, socially, politically and emotionally by using culturally relevant frameworks to convey knowledge, abilities, and attitudes (Ladson-Billings, 2009). Consequently, a culturally relevant education recognizes the culture, attributes, and knowledge that ethnically diverse students bring to their learning experiences and uses those resources to maximize their learning (Howard, 2012).

Culturally Relevant Pedagogy With Irvine, Gay, & Gutierrez

Watch on YouTube https://edtechbooks.org/-CNIp

The question then becomes, how can instructional methods and materials be designed for cultural relevancy to learners, especially those on the fringes of dominant culture? An initial step for designers is to develop cultural sensitivity through becoming familiar with target learner interests, core values, traditions, modes of communication, and backgrounds. Knowledge about the learners can then be strategically integrated into plans for instructional methods and materials (Gay, 2002). To help learners see the relevance of instructional materials to themselves, instructional resources can be situated within the cultural and ethnic contexts of the target learners. Designers can incorporate materials and activities that reflect multiple voices and perspectives rooted in the personal experiences and cultures of the learners. Learner autonomy can be enhanced through the provision of varied options for expression. For example, learners can be provided an array of materials and activities to choose those that are relevant to their backgrounds of experience. Designers can also plan for ways that learners can share personal experiences as they are related to course topics, creating meaning-making opportunities.

Conclusion

Universally designing instruction involves recognition and intentional planning for components and features that often do create accessibility challenges for learners so that all learners can access and engage in learning experiences equitably. As learners vary in their characteristics, preferences, and experiences, so do the approaches through which designers can develop empathetic understandings and incorporate flexibility to meet diverse learner needs. This chapter offers an initial look into these strategies, and designers are encouraged to revisit these strategies in the instructional design process so that they can anticipate variability in their target learners and address this variability strategically.

Activity/Exercise Ideas

1. Explore built-in accessibility features. There are built-in accessibility features in many of today's tools that support varied vision, hearing, mobility, and learning needs. Explore the built-in accessibility features of one of the following:
    1. Mac OS: https://edtechbooks.org/-suAu
    2. Windows: https://edtechbooks.org/-dpZm
    3. iOS: https://edtechbooks.org/-HRy
    4. Android: https://edtechbooks.org/-xSo
    5. Chrome OS: https://edtechbooks.org/-haKY
    6. Other Google tools: https://edtechbooks.org/-rCsZ
2. Share in a discussion board post, blog, video post, Tweet, etc. about what you learned in your exploration of the built-in accessibility features. Did you find any that you would like to use in the future?
3. Experience accessibility of digital resources. Choose a website, app, or program, and access it in a different way than you usually do. For example, you can use some of the built-in accessibility tools from Activity #1, such as trying to do research through an online library website using a screen reader and voice-input (such as VoiceOver and Dictation on MacOS). You could also try navigating around a course site using keyboard-only (no mouse, touchscreen, or touchpad). Or, you could try using a web application on a mobile device that you usually access via laptop/desktop computer. Spend about a half hour accessing the digital resource in one or more different ways and then reflect on your experience. How accessible was the resource for the means that you accessed it? What did this experience prompt you to think about in regards to your own design of digital educational resources? Create and share a summary of your experience and related thoughts as an audio clip, discussion board posting, graphic (could include screenshots or sound clips), etc.

4. Observe universal design. Spend 30-60 minutes observing people using universally designed features in different contexts, such as the automatic door openers, ramps, buses, playgrounds, water fountains, food service centers, libraries, etc. What do you notice about who is using them and how? Collect pictures of examples and non-examples of universally designed features around campus. How might these impact people with different needs?
5. Using technology to implement UDL. Choose a guideline (see http://udlguidelines.cast.org/) associated with one of the UDL principles and find a technology tool that supports the implementation of the guideline. For example, you may find a tool that supports the guideline "recruiting interest" under the principle of engagement. How would the tool optimize individual choice and autonomy, optimize relevance, value and authenticity, and minimize threats and distractions?

Resources

- Accessibility Resource List from Designers for Learning based on “POUR” - Perceivable, Operable, Understandable, Robust recommendations related to website accessibility.
- Culturally Responsive Teaching & the Brain by Zaretta Hammond offers tools and recommendations for applying CRT into instruction.
- Dive Into UDL by Kendra Grant and Luis Pérez provides a UDL self-assessment and a variety of resources to explore UDL more deeply.
- Global Accessibility Awareness Day (GAAD) is an annual event in May that focuses on the design, development, and usability of technology for users around the world.
- Inclusive Learning Network of ISTE (International Society for Technology in Education) provides professional learning opportunities and resources on inclusive design and

technology.

- National Center on Accessibility Education Materials (AEM) provides resources and technical assistance on producing learning materials that meet accessibility standards.
- Techniques for Empathy Interviews in Design Thinking is a resource with ideas for how to set up and conduct exploratory interviews with potential learners.
- The UDL Toolkit is a collection of UDL resources for teachers, coaches, and instructional leaders.
- UDL-IRN (The Universal Design for Learning Implementation and Research Network) provides resources and professional learning opportunities to connect with other educators and designers regarding implementation of UDL.
- UDL Progression Rubric by Katie Novak and Kristan Rodriguez provides specific examples of UDL practices across the three principles of providing multiple means of engagement, representation, and action and expression.

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4

Problem Framing

Vanessa Svihla

Is design a problem solving process? To answer "No" suggests that designers do not produce solutions to design problems. However, in order to produce such solutions, designers must first frame—and typically reframe—the problem. Understanding this can help newcomers recognize the need for a different approach, rather than jumping straight to solutions. What does it mean to frame a problem? In this chapter, detailed below, I define it as follows:

Problem framing: To take ownership of and iteratively define what the problem really is, decide what should be included and excluded, and decide how to proceed in solving it.

To understand what problem framing looks like in practice, this chapter introduces and illustrates key terms that help us speak consistently about design problems and how they differ from other problems. Vignettes highlight how designers direct their problem framing process. The chapter concludes with tools for framing problems and diagnostics for common pitfalls.

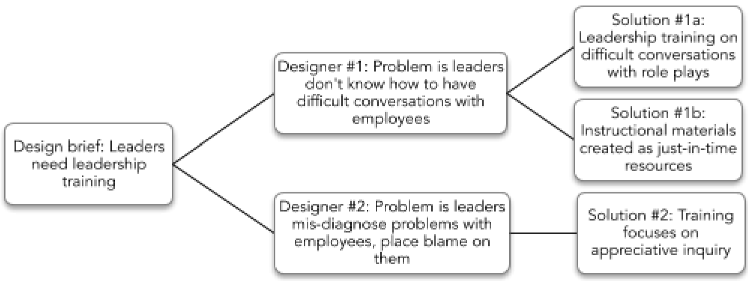
The Problem of the Problem: What Makes Design Problems Different from Other Problems?

Most of us have had abundant opportunities to solve problems, beginning in elementary school. But these problems were predominantly well-structured (Jonassen, 2000), meaning there was a single correct answer and the instructor knew what that answer was. Repeated experiences with such problems can lead us to privilege accuracy and efficiency over spending time dwelling with the problem. And surely getting to the right answer quickly is valuable in many situations. But design problems differ—there is not a single right answer or even a best way to come to a solution.

As a result, when tackling these ill-structured problems we must first frame them (Jonassen, 2000). Framing a problem involves defining the problem and bounding it, then deciding what to include and exclude and how to proceed (Dorst & Cross, 2001; Schön, 1983). This, in turn, relies on activities described in other chapters in this text, including the following: (a) gathering information about the task, learners, and context; (b) generating tentative ideas about the problem and solution; (c) making and revising decisions about the problem (often influenced by precedent); and (d) evaluating tentative ideas in light of design requirements and learner needs. Some therefore treat problem framing as a higher-level category that includes all of these activities. Others treat problem framing as an activity threaded through the design process. Regardless, problem framing is the process by which designers take ownership of a problem. This means that two designers, given identical design briefs, would not only produce different solutions, but would have solved different problems (see Figure 1.; cf., Dorst, 2003; Harfield, 2007).

Figure 1

An Example of How the Same Initial Problem may be Framed and Solved Differently



To see how this might play out, try finding multiple problems in the scenarios below (Table 1). Can you frame the problem as an instructional design problem? Can you also frame the problem not as an instructional problem?

Once you have framed possible problems in the scenarios, consider the ill-structuredness, complexity, and domain specificity of each problem (Jonassen, 2000). Each problem you framed may differ in these dimensions (Figure 2):

- Structure refers to the degree to which a problem has a single solution and most-efficient solution path (well-structured) or many possible solutions and solution paths (ill-structured). Problems are sometimes presented to instructional designers as well-structured, but design problems are ill-structured by definition.
- Complexity refers to the number of variables involved and how interrelated they are. Most—but not all—design problems are complex. This characteristic can be tricky to assess simply because we use the term informally as a synonym for "difficult."
- Domain specificity refers to whether domain general strategies would suffice; Jonassen (2000) described domain specific

problems in terms of both “abstract” and “situated,” knowledge, generally placing such knowledge in formal domains. Almost all ID problems are domain specific.

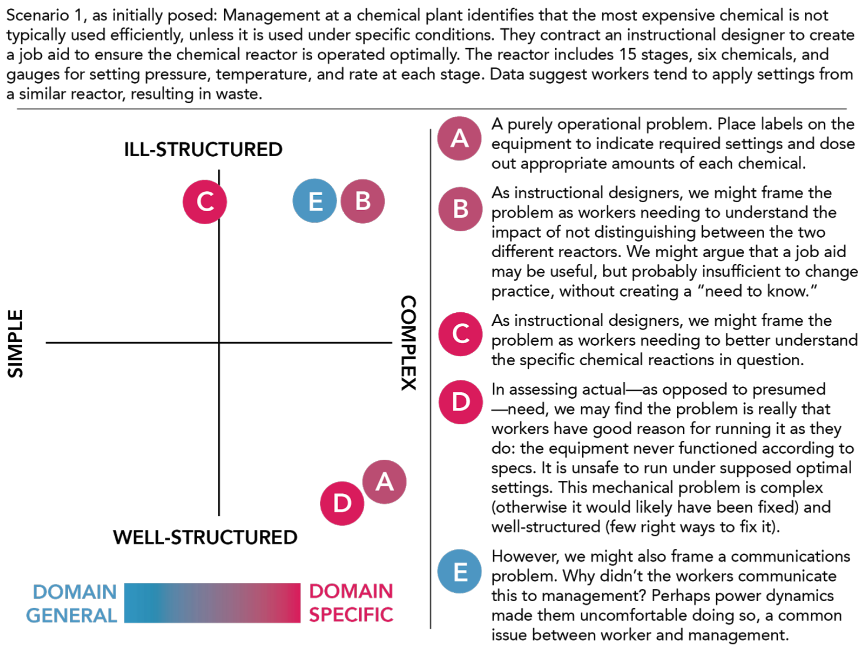
Table 1

Framing both Instructional Design and Other Problems

Scenario 1	**Management at a chemical plant identifies that the most expensive chemical is not typically used efficiently, unless it is used under specific conditions. They contract an instructional designer to create a job aid to ensure the chemical reactor is operated optimally. The reactor includes 15 stages, six chemicals, and gauges for setting pressure, temperature, and rate at each stage. Data suggest workers tend to apply settings from a similar reactor, resulting in waste.**
Scenario 2	Beth is hired by a dietician to create instructional materials—printed handouts—for parents/guardians of children with special dietary needs based on a specific disability. The dietician provides published, effective dietary standards based on the specific disability and shares that some of the terms in the standards are hard for families to understand. The production budget is small and timeline tight. The organization provides a set of images they previously created and want used in the handouts.
Scenario 3	A university’s instructional technologies committee selects and implements a learning management system (LMS), heavily guided by their own expertise, along with issues related to copyright law, tight institutional budget concerns, and interfacing with systems for registration and grading. As a consequence, instructional designers are hired primarily based on their capacity to provide technical support for the cumbersome, difficult to use LMS. To ensure they can support the faculty, they create a highly structured course shell.
Scenario 4	A district purchases science kits and curricula for teachers in Phoenix, AZ. While the resources seem useful, the teachers realize there are issues. For instance, the curriculum teaches "Fall is when the leaves change colors," but the teachers know their students have never seen leaves change color. They meet during a cross-school professional development session to address these issues, guided by curriculum leads who graduated from an instructional design program.
Scenario 5	An instructional designer is tasked with migrating courses from a decommissioned LMS to a newly adopted one. None of the content or sequencing is to be changed. The two LMSs differ greatly in many ways (e.g., how objects are connected to courses, the order in which settings must be selected, and the number of features available).

Figure 2

Problem Structure, Complexity, and Domain Specificity Differentiate Between Problem Types



Note. Design problems are always ill-structured, and usually complex and domain specific. The letters refer to the problems above related to scenario 1 in Table 1.

How Do Designers Frame Problems?

Problem framing can occur through both overt and covert activities. Some activities and deliverables make the problem visible, but other problem framing work happens through talk or individual thinking. Covert framing activities involve abductive reasoning—filling in gaps in knowledge (e.g., Kolko, 2010). This kind of thinking is heavily influenced by past precedent, and designers contend with the salience and limitations of their own experience.

From their first contact with the problem, designers consider whether the problem seems like one encountered previously and how the current problem seems to differ from past precedent.

How might you convey to a client why framing the problem is important?

Their framing of the problem is visible in the project objectives and learning goals they set. As they seek to understand and explore, researching the task, context, learners, and possibly other precedents, they reframe the problem and consider whether the client will accept their reframing, which is made visible in learning objectives and problem statements. Prototypes may likewise reveal their problem framing. Evaluation of a prototype’s feasibility, desirability, and ability to meet identified learning needs may lead to further reframing.

Clients often undervalue and underestimate the time and effort needed to frame the problem. Clients may request a specific deliverable or solution, yet may not have a deep understanding of the actual needs. Making a value proposition can sometimes help. This means communicating clearly about what problem framing is and why it can benefit the organization by preventing ineffective training.

What Does It Mean to Have Agency to Frame a Design Problem?

Experienced designers—regardless of discipline—know to direct their framing of the problem. They make consequential decisions that lead them to new understandings and reframings of the problem. This “framing agency” is a hallmark of design in which designers rely on information they gather and on their past precedent—as described in other chapters of this volume. What does framing agency look like in practice?

In the case below (Figure 3) a team faces some challenges in part because not all members understand that they need to frame the problem; this is visible in their expectations about their roles and in their talk. In the vignettes, words are highlighted to draw attention to ways the team members are talking that help us notice whether they are framing the problem or not. Designers often share framing agency with other designers, with envisioned stakeholders, and sometimes even with the materials in their designs. In ID, this happens when they reference the learning and transfer contexts, and the modes of learning (e.g., face-to-face, online, etc.) to justify decisions. Another indicator of framing agency is staying tentative, staying with the problem. Using verbs that show possible actions (e.g., could, might, etc.) and hedge words (e.g., maybe, kind of, etc.) invites both the designer and others to revise their thinking about the problem. In contrast, using verbs that show a lack of control (have to, need to, etc.) over the situation tends to shut down problem framing, unless the verb refers to a design requirement (like Yen’s use on “need to” in vignette 2).

Read through the vignettes in figure 3 and answer the following questions:

- Who treats the problem as not needing to be framed?
- How does the instructional designer encourage them to frame the problem?
- Who else shows framing agency?

Figure 3

Vignettes From a Design Team: Who Shows Framing Agency? Who Does Not?

A research organization that addresses sociotechnical challenges recently faced harsh public critique when a number of cases of sexual harassment came to light. Management fears they are endangering their many government and public contracts and wish to send a clear message that such behaviors will not be tolerated. They form a team—subject matter experts in research (Dr. K) and human resources (Yen), an instructional designer (Paul), and a web developer (Miguel)—to develop an online training.

Vignette 1: Early team meeting

Dr. K: We have to make the training short and simple. Our researchers are busy with their real work. They don't have time for extra trainings. There has to be a brief training out there.
Yen: I am not, really, uh, sure that is realistic though, you know?
Miguel: No, that is no problem. And it is great because it is easy to generate reports on who completes it, which we need.
Paul: I think, um, she was referring to whether it would be effective.
Yen: Yeah! I mean, I attended a webinar on best practices for preventing sexual harrassment, and it turns out, even those detailed, um, scenarios, like cases, they don't work, and can even make things worse. Some people feel threatened when they feel blamed, and then they act out.
Paul: So, we know, from recent unfortunate events, that there're folks who'll be like that. And we know the organization sees this as important right now, which means we have a bit of leverage in terms of resources to do this right. And, yes, we know that the pressure is on, to act fast and to not waste people's time.
Miguel: So what are you saying it needs to be?
Paul: I don't actually think we really know yet. I think we can review more of what is out there, do some research, and then explore some ways to make it meaningful for our employees, and make a real difference. A compliance training model won't do that.

Vignette 2: two weeks later

Yen: I found a study that suggests we might want to focus on a training for managers, not employees. They found that managers need to be able to recognize and respond to issues.
Dr. K: I like that idea 'cause it means the researchers won't complain about another useless training. I think we can make a strong case for this.
Miguel: In that case, does an online training still make sense?
Dr. K: Well, it depends. Managers are busy people. They might appreciate being able to complete their training as their schedules allow, so online. But we could also look at different ways to do this, maybe even during their monthly meeting.

Shared agency marker. First person plural pronoun (we, we're, we've, we'll)

Tentative agency marker. Speaker modifies statement with diminishing hedge terms (like, actually, perhaps, maybe, kind of, possibly, might, apparently, just, sometimes, etc.)

Tentative agency marker. Verbs that show potential control (could, might, should, can, going to, would, want to, etc.)

Low agency marker. Verbs that indicate a lack of control (told to, have to, need to, must, required, supposed to, etc.)

If you are on a team that is resisting framing the problem, how will you communicate with your team? Using the key in Figure 3, how can you use tentative language to invite them to frame the problem with you? How will you help them understand the importance of framing the problem?

Learning to notice how you talk with your team may help you diagnose whether or not you are framing the problem. When someone sounds tentative, consider it an invitation to engage in framing with them. Try to avoid no-control talk that shuts down problem framing.

What Tools Help Designers Frame Problems?

Mapping unknowns, assumptions, and conjectures can help clarify the work needed to frame problems. In addition to the tools that other chapters in this text have offered, I have found the following tools help make problem frames explicit yet open to revision:

- Problem statements
- Storyboarding
- KWL charting
- Design conjecture maps
- Root cause + sphere of influence analysis

It is important to remain tentative in using these tools. Just as we saw with design talk, staying open to revision is key. For this reason, I typically use pencil and paper or whiteboards for these kinds of activities. Rather than polishing and perfecting them, staying in draft mode can help you stay open.

Problem Statements

Problem statements are concise and provide clarity about the problem frame. Your problem statement should begin with one or two sentences describing a vision of what is possible if the problem is solved. Next, describe—in one to two sentences—what the specific issues are. This should include who, what, when, where and why. Finally, in one to two sentences, describe the primary symptoms of and evidence for the problem. You should not include a solution! Expect to write your problem statement multiple times to capture changes in your understanding of the problem.

[Problem Statement Worksheet]

Storyboarding

Vividly depict the problem—not the solution—as a sequence of events from a particular point of view. You may hand draw this, use photos, use a graphics program, or try out one of the many free storyboard/comic strip creation websites (see Additional readings and resources). When depicting the problem, consider other points of view, and represent these in another storyboard, with thought bubbles, or as a branching storyline. Avoid depicting the solution!

KWL Charting

KWL charting is adapted from tools commonly used in project-based learning classrooms and supports learners to identify what they do and do not know, as well as what they still need to know (Ogle, 1989). This tool is useful for designers as they manage the ambiguity of the design problem. Using it frequently as a means to track progress can help teams direct their own progress in bringing information into the problem.

Table 2

Example of KWL Charting

Date	What do we know about the design problem, learner needs, and other requirements or constraints?	What precedent do we want to (or not want to) bring into the problem?	What do we want to learn about the problem and how will we learn it?

Design Conjecture Maps

Design conjecture maps are based in tools like logic models and design-based research conjecture maps (Sandoval, 2014). They help designers coherently link the task to learning objectives and to their design ideas. First, place the learning objectives on the same page as the task analysis, then make links between them. Second, after generating tentative ideas, try connecting these to the task analysis and learning objectives using yarn or string. Third, as you begin to develop more solid designs, try connecting these back to the task analysis and learning objectives.

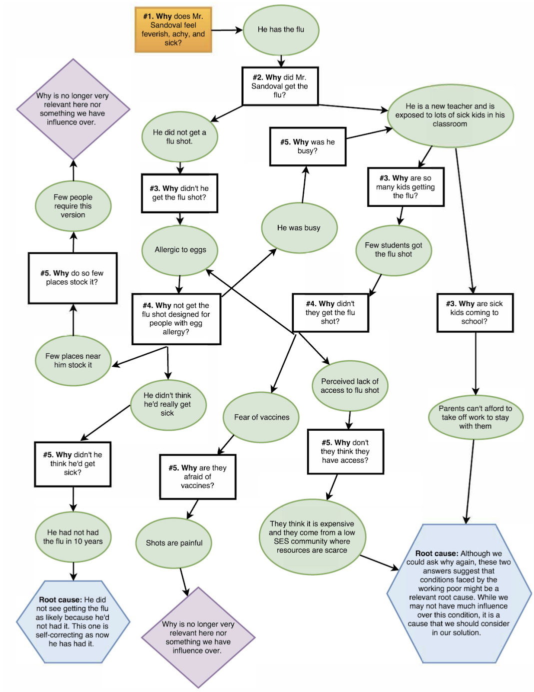
[Design Conjecture Mapping]

Root Cause Analysis

Root cause analysis techniques, like the five whys (Ohno, 1978; Serrat, 2017), can help designers identify underlying causes rather than treating symptoms. While some use this approach to craft a linear set of causes and effects, creating a network of whys is more effective for framing problems from multiple points of view. In this way, for each problem, you should ask “Why does this happen?” and “Why else does this happen?” This results in a network of possible root causes. Pairing this analysis with sphere of influence analysis—meaning, deliberately analyzing whether each cause is within your capacity to influence the problem through instructional design—provides an opportunity to consider the feasibility and impact for any particular cause. To do this, for each cause you should consider whether it is a problem you can influence and whether it is an instructional design problem (Figure 4). Which of these causes suggest an instructional design problem?

Figure 4

Example of the Five Whys as a Network



Do-It-Yourself

Now that we have learned about several tools, here are some specific ways you can apply these. First, you can try out the tools in the previous section using the scenarios above in Table 1. Second, if you are in a class that includes developing an instructional design, you can use these tools for your class. When teaching instructional design, I always require students to work for clients on real design projects because I have observed issues that come up without clients. Students spend as much or more time inventing fake clients as they would learning how to assess needs. Without a real client and context, it can be hard to learn to frame problems authentically, to really understand that even though you are designing something for others, by framing the problem, you are taking ownership of it. That is challenging to do if it is a problem of your own invention. Likewise, without a client, the reasons for reframing are likelier to stem from challenges you encounter than new understanding of the problem space. Of course, working with real clients can be challenging in other ways. Make sure your client understands that you have course deadlines and are just learning to design. Agree on the scope of work beforehand using a formal design brief.

Conclusion

While problem framing is typically treated as something that happens at the beginning of a design project, it is important to remember that it is a process that continues until the design is finalized. You may revisit and revise along the way, especially for short deliverables like problem statements and KWL charting. Prototypes, especially low fidelity prototypes, and evaluation often reveal the need for reframing. And, as contexts and needs change by location or over time, a solution may no longer function, and the problem can pop back open. In considering the iterative nature of problem framing, how will you use these tools to guide and document reframings of the problem?

Finally, my advice to you as new designers is this: Dwell with the problem. Wallow in some uncertainty. Stay tentative!

Additional Readings and Resources

Problem Framing Resources

- Gause, D. C., & Weinberg, G. M. (1990). Are your lights on? Dorset House.
- ISIXSIGMA
- Atlassian

Root Cause Tools

- Google Drawings
- Draw.io
- MindMeister
- Mindomo
- Coggle.it
- Edrawsoft
- MindMup
- LucidChart

Storyboarding Tools

- Storyboard That
- Pixton
- Witty Comics
- Strip Generator
- Make Beliefs Comix

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5

Task and Content Analysis

Levi Posadas

Editor's Note

This is a condensed version of a larger chapter on Task Analysis that can be found at the Philosophies of Instructional Design website. It is printed here by permission of the author.

Task and/or content analysis is a set of activities that help instructional designers understand the domain (knowledge, skills, etc.) to be taught. It is a critical part of the instructional design process, solving at least three problems for the designer:

1. It defines the knowledge and skills required to solve the performance problem or alleviate a performance need. This step is crucial because most designers are working with an unfamiliar domain.
2. Because the process forces subject-matter experts to work through each individual step of what is required to solve a problem, subtle details of the knowledge and skills to be taught can be more easily identified.
3. During the process, the designer has the opportunity to view material from the learner’s perspective. Using this perspective,

> the designer can often gain insight into appropriate instructional strategies for the materials they will ultimately create.

Task/content analysis does not begin in a vacuum. It begins with the needs or goals derived from the definition of the instructional problem. Designers should also consider what they uncovered during their learner analysis. An understanding of the learner's knowledge and background related to the instructional domain helps designers determine the beginning point for the analysis as well as the depth and breadth of analysis. The output of a task/content analysis is documentation of the content that could possibly be included in the instructional materials. This output then serves as input for developing detailed instructional objectives.

Preparing to Conduct a Task or Content Analysis

A task/content analysis can take many different forms. Designers most often work with one or more subject-matter experts (SMEs), individuals who are experts in the content area. The SME is our link to the instructional domain; we rely on this individual (or individuals) to provide accurate, detailed information for use in developing the instructional unit. Our task as designers is to help the SME elaborate on the content and tasks in a meaningful, logical manner.

In this chapter, we describe the different kinds of content structures designers might encounter in their work, and how each can require different types of strategies to analyze (and later teach) effectively. We then describe three specific techniques for analyzing these knowledge and skill structures: (a) a topic analysis well suited for defining cognitive knowledge; (b) a procedural analysis for use with psychomotor tasks, job tasks, or cognitive sequences involving a series of steps; and (c) a critical incident method, which is useful for analyzing interpersonal skills.

Content Structures

Six structures are often associated with a task/content analysis: facts, concepts, principles and rules, procedures, and interpersonal skills.

Facts

A fact is an arbitrary association between two things. For example, ‘‘The chemical symbol for potassium is K’’ is a fact that describes a relationship between potassium and K. Most topics include many facts because they are the building blocks or tools of any subject—the ‘‘vocabulary’’ the learner must master for understanding. But unless facts are arranged in structured patterns, they will be of limited use to a learner and are often quickly forgotten.

Concepts

Concepts are categories used for grouping similar or related ideas, events, or objects. For example, we might use the concept of soft drinks to categorize the aisle in the grocery store that contains colas, orange drink, root beer, and so forth. The concept of fruit would include apples, oranges, bananas, and dates, but not potatoes. We use concepts to simplify information by grouping similar ideas or objects together and assigning the grouping a name (e.g., fruit, islands, or democracies). Some concepts, such as fruit, are considered concrete concepts because we can easily show an example. Concepts such as safety, liberty, peace, and justice are abstract concepts because they are difficult to represent or illustrate.

Principles and Rules

Principles and rules describe a relationship between two concepts. In microeconomics, we can derive several principles from a supply-and-demand curve. For example, ‘‘as price increases, the supply increases’’ is a principle that describes a direct relationship between two concepts (i.e., price and supply) that increase and decrease together. ‘‘As price decreases, demand increases’’ describes a different relationship between price and demand that causes one to increase as the other decreases.

Procedures

A procedure is an ordered sequence of steps a learner must execute to complete a task. A recipe for making a cake or casserole is a procedure. Similarly, a procedure could be a series of steps needed to plant a rosebush, or it could be a complex series of cognitive processes required to debug a computer program or diagnose the flu.

Interpersonal Skills

This broad category includes behaviors and objectives related to interpersonal communication, for example the development of interviewing skills, solving group conflict, leading a group, or how to sit (e.g., appropriate body language) when being interviewed on television.

Topic Analysis

A topic analysis is used to define connections and relationships between the facts, concepts, principles, and rules that make up a knowledge domain. Such an analysis is typically done in layers, much like what an archaeologist finds when excavating a site. First, the top layer of soil is scraped away. Then layers of earth are removed, and each artifact’s identity and location are recorded. Similarly, a designer working with the SME carefully reveals the first layer of information while looking for indicators of knowledge structures (i.e., facts, concept, and principles). Once the structure is revealed, additional detail is gathered for each structure, and new information appears as the designer digs deeper into the content.

A topic analysis thus provides two types of information. First, it identifies the content that will be the focus of the intended instruction. Second, it identifies the structure of the components. We should note that during a topic analysis, the designer might also identify one or more procedures that require analysis. While the topic analysis is not suited for analyzing procedures, our next methodology, procedural analysis, would be appropriate. As you conduct a topic analysis, then, you should remain focused on identifying the facts, concepts, and principles that make up the domain.

Analyzing a Topic

Let’s examine a topic analysis example. Imagine we are designing a beginning carpentry course. The course includes an introductory module on different types of wood fasteners. To begin, we can ask an SME to describe the different fasteners. Our question prompts the following outline:

I. Nails
II. Screws
III. Bolts

The SME considered these three major categories adequate to describe the various types of fasteners. So we might next ask the SME to further define each category. He expanded our outline as we asked additional questions. To get started, we might ask from what material fasteners are made, how they are sized, and how they are used.

I. Nails
    A. Generally made from wire
    B. Range in size from 2-penny to 60-penny

        1. Length of nails 10-penny or less is determined by dividing size by 4 and adding 0.5 inch
            a. Example: 7-penny nail is 2.25 inches long
    C. Typically driven into one or more pieces of wood with a hammer or nail gun
II. Screws
    A. Made from steel
    B. Size determined by the gauge (thickness) and length
        1. Length varies from 0.25 to 6 inches
    C. Usually twisted into a hole with screwdriver
    D. Provide a more secure joint than nails
III. Bolts
    A. Made from steel
    B. Measured by length and diameter
        1. Available in fine or coarse threads
    C. Placed through a hole and then a nut is tightened from opposite side

Let’s examine the content structure identified in the outline. Some of the facts identified in the outline are as follows:

a. Nails are generally made from wire
b. Bolts are made of steel
c. Bolts are measured by length and diameter
d. Screw length varies from .25 to 6 inches

The concepts identified in the topic analysis are:

a. Nail
b. Screw
c. Bolt

One procedure was identified in the task analysis:

Length of nails 10-penny or less is determined by dividing size by 4 and adding 0.5 inch.

Our SME helped us identify one principle in the content:

Screws provide a more secure joint than nails.

Next, we can ask the SME to provide detailed information on each fastener category, starting with nails. Once he finishes, we can organize the content using the following steps:

1. Identify the different content structures (facts, concepts, and principles; we might have also identified procedures, and interpersonal skills that we will also need to analyze using other procedures).
2. Group related facts, concepts, principles, and interpersonal skills. For example, in our full outline of wood fasteners, we would group all the information about nails, then the information about screws, and so forth.
3. Arrange the various components into a logical, sequential order.
4. Prepare the final outline to represent your task analysis.

A completed topic analysis on nails, then, could look like this:

I. Nails
   A. Generally made from wire
   B. Range in size from 2-penny to 60-penny
      1. Length of nails 10-penny or less is determined by dividing size by 4 and adding 0.5 inch
      2. Example: 7-penny nail is 2.25 inches long
   C. Size is written as 2d for ''2-penny''
   D. Typically driven into one or more pieces of wood with a hammer
   E. Types of nails
      1. Common nails

    a. Most commonly used nail
    b. Available in sizes from 2d to 60d
        i. 8d size is most common
    c. Identified by flat head
    d. Used for general purposes
2. Box nails
    a. Smaller in diameter than common nails
    b. Available in sizes ranging from 2d to 40d
    c. Also identified by its flat head
    d. Used in lumber that may split easily
    e. Often used for nailing siding
3. Finishing nails
    a. Have a very small head that will not show
        i. Head can be sunk into wood and hole filled
    b. Available in sizes 2d to 20d
    c. Used primarily for finishing work and cabinetry
4. Common brads
    a. Similar to finishing nails but much smaller
    b. Available in various lengths
        i. Length expressed in inches or parts of an inch
    c. Used for finishing work
5. Roofing nails
    a. Similar to common nails but with a larger head
    b. Available in lengths from 0.75 inch to 2 inches
        i. Available in various diameters
    c. Used for roofing

How detailed should a topic analysis be? There is no strict guideline, but as a rule of thumb you can use your learner analysis as a guide, since this should describe the learners' prior knowledge of the content area. A course on home repair for apprentice carpenters, for example, will require a different amount of detail than a course for homeowners.

Topic Analysis Template

Procedural Analysis

A procedural analysis is used to analyze tasks by identifying the steps required to complete them. This technique can be used for both observable and unobservable procedures. You conduct a procedural analysis by asking an SME to walk through the steps of a process, preferably with the same equipment and in the same environment in which the task is performed. For example, if you are conducting a procedural analysis for repairing an electric meter, the SME should have an electric meter and the necessary tools to refer to during your interview.

Each step of a procedure analysis includes three questions:

1. What does the learner do?
    a. Identify the action in each step that the learner must perform.
    b. These actions are either physical (e.g., loosening a bolt) or mental (e.g., adding two numbers).
2. What does the learner need to know to do this step?
    a. What knowledge (e.g., temperature, pressure, orientation) is necessary?
    b. What does the learner need to know about the location or orientation of the components that are a part of this step (e.g., how to position a wrench to remove a hidden nut)?
3. What cues (tactile, smell, visual, etc.) inform the learner that there is a problem, the step is done correctly, or a different step is needed (e.g., a blinking light indicates you can release

the starter switch)?

In the following procedural analysis, a designer visited a cabinetmaker and asked him how to prepare a piece of woodwork for the final finish. During the analysis, the designer asked him variations of the three questions described in the previous paragraphs to identify the steps, knowledge, and cues. As part of the analysis, the cabinetmaker informed him that someone who finishes furniture would already know the basics of sanding and using a paint sprayer. The designer's analysis produced the following steps:

1. Inspect all surfaces for defects.
    a. Tactile cue: Feel for dents, scratches, and other surface defects.
    b. Visual cue: Splits or cracks are normally visible.
2. Repair defects in surface.
    a. Use sand and glue to fill minor defects.
    b. Reject pieces that you cannot repair for rework.
3. Spray two coats of lacquer sanding sealer on all surfaces.
    a. Visual cue: Dry, misty appearance indicates too-light application.
    b. Visual cue: Runs or sags indicate too-heavy application.
4. Prepare for final finish.
    a. Allow a 20-minute minimum drying time for sealer coat.
    b. After drying, rub out all parts with #400 grit silicon carbide abrasive paper.
    c. Remove dust from all surfaces with air gun, then wipe with clean, lint-free cloth.
5. Complete the final finish.
    a. Spray two coats of finishing lacquer on all parts.
    b. Visual cue: Dry, misty finish indicates too-light application.
    c. Visual cue: Runs or sags indicate too-heavy application.
    d. Allow a minimum of four hours for second coat to dry.
6. Inspect final finish.

a. Tactile cue: Feel for grit or runs that may not be visible.
b. Rub out all surfaces with #000 steel wool.
c. Remove dust from all finished surfaces with air gun and lint-free cloth.
d. Apply a thin coat of wax to all finished surfaces.
e. Buff all surfaces to high gloss.
f. Visual cue: Wax becomes dull prior to buffing.

Procedure Analysis Template

The Critical Incident Method

The two methods we have described—topic and procedural analyses—work well with concrete content and highly structured tasks. Analyzing other processes, however, such as how to conduct an interview, resolve an interpersonal conflict, or close a sales opportunity, are more difficult because they vary from instance to instance. Although the instances share certain elements, typically a breadth of skills and techniques actually accounts for one's success. A procedural analysis works quite well for analyzing how to apply the final finish to a wooden table, for instance, because the basic process is repeated time after time, with variations due to size and type of wood. But closing a sale, however, depends on several conditions (e.g., personality of the buyer, financial status of the buyer) that change with each sale. There are also complex tasks that an SME might consider an ''art,'' for example, determining where to drill an oil well, predicting successful stocks or mutual funds to purchase, or determining which type of psychotherapy to use with a patient.

To define content for these types of instruction we need an analysis method that provides different points of view on the skills/processes involved. For example, we might interview a salesperson who uses a very calm approach and another who uses high-pressure tactics. This is what we call a *critical incident analysis*, or an interview technique where the designer interviews several individuals to provide a rich source of data about possibilities.

There are two, key questions to ask as part of a critical incident analysis: First, ask an SME to identify three instances when he or she was successful in achieving a goal. Second, ask the SME to identify three instances when he or she was not successful in achieving the same goal.

Next, ask additional questions to gather three types of information:

1. What were the conditions before, during, and after the incident?
   a. Where did the incident occur?
   b. When did it occur?
   c. Who was involved?
   d. What equipment was used, and what was its condition?
2. What did you do?
   a. What did you do physically?
   b. What did you say and to whom?
   c. What were you thinking?
3. How did this incident help you reach or prevent you from reaching your goal?

(Ideally, this process should then be repeated with other SMEs.)

An analysis of critical incident interviews will identify knowledge and techniques the SMEs use to accomplish their goals. But note that although the critical incident analysis provides a list of topics and procedures that experts used, it does not include a list of the steps or details for topics. But using the information from this analysis you can perform a topic and/or procedural analysis to further define the content for the instruction.

Critical Incident Analysis Template

Conclusion

Task/content analysis is a critical step of the instructional design process. It can be easy to neglect, or to carry out superficially, especially given the time it takes to capture the detail required to do it right. But skipping this analysis will likely cause problems in future phases of the design process, particularly when it is time to design instructional activities. If designers only have superficial understanding of the content, or only rely on their subject matter experts' tacit understanding of the content, they are unlikely to design instructional materials that support learners in actually mastering the desired learning outcomes. Instructional designers should ensure they reserve enough time in their design process to carry out their task/content analysis in an adequate manner.

Application Exercises

Like any other skill, becoming proficient at task/content analysis requires practice. If you don’t have a current instructional design project you can practice on your own by:

1. Identifying a topic area you personally wish you knew more about and interviewing an expert to create a diagram of the knowledge structure.
    a. You may consider interviewing more than one expert to see what kind of unique structures emerge from their different point of views.
2. Identifying a simple skill and interviewing/observing an expert to create a diagram of how the skill is completed.
    a. If you interview another expert about the same skill, is there more or less variability in the results than you found with your topic analysis?
3. Identifying a complex interpersonal skill and conducting a critical incident analysis with an expert.
    a. If you interview another expert about the same skill, is there more or less variability in the results than you found with your topic or procedure analysis?

6

Documenting Instructional Design Decisions

Jill Stefaniak

Instructional designers are tasked with making countless decisions in every project they complete. Questions ranging from “Who is my learning audience?” to “How will this project be evaluated for effectiveness upon implementation?” all require the instructional designer to make a variety of questions to ensure that their instructional design efforts are contributing to efficiency, effectiveness, and ease of learning (Morrison, Ross, Kalman, & Kemp, 2013). As the utility of instructional design continues to be recognized across industries, the complexities of design will continue to grow. With more options available in terms of how instructional solutions are to be designed and disseminated to a range of different learning audiences, the complexities of design decisions facing instructional designers are insurmountable.

There is a large body of literature in other design disciplines that outline strategies for engaging in decision-making and documenting design decisions. Many of these strategies lend themselves to the ID field, particularly with working on complex, ill-structured design problems. Marston and Mistree (1997) argue the importance of decision-making in design practices stating that decisions serve as markers to identify the progress that is made on designing a solution.

The purpose of this chapter is to help instructional designers differentiate between the different types of decisions they may be responsible for during a project. Various approaches for engaging in decision-making will be discussed and tools will be provided to assist the instructional designer with documenting their design decisions.

Types of Decisions

Instructional design problems can be classified as well-structured (Jonassen, 2000). Well-structured problems typically have one possible solution, whereas ill-structured problems may have multiple solutions. Instructional designers will often find themselves tasked with designing instructional solutions for problems of an ill-structured nature. While some problems may require a quick decision by the designer, other problems may be more complex; thus, requiring several interrelated decisions (Jonassen, 2011).

Decisions can be categorized according to types such as choices, acceptances/rejections, evaluation, and constructions (Yates & Tschirhart, 2006). Choices consist of selecting an option from a large set of options. Acceptance/rejection decisions consist of a binary decision where the option (or solution) is accepted or not. Evaluative decisions involve an individual assigning worth to a possible option and determining their level of commitment if they were to proceed with that option (Fitzpatrick, Sanders, & Worthen, 2011; Guerra-Lopez, 2008). Decisions of a more constructive nature involve trying to “identify ideal solutions given available resources (Jonassen, 2012, p. 343).

Table 1 provides an overview of their typology along with the types of decisions an instructional designer may encounter during a project.

Table 1

Decision Typologies as they Relate to Instructional Design

Type	Example of Instructional Design Decisions
Choices	An instructional designer has been asked to help a local museum with developing learning materials for their patrons. During their brainstorming meeting with the museum staff, they discuss the possibility of using audio headsets, mobile learning, QR codes, online learning modules, and face-to-face training programs as training options.
Acceptances/Rejections	An instructional designer submits a proposal to present their project at a national instructional design conference. Reviewers responsible for reading the proposal must decide to accept or reject the conference proposal.
Evaluation	An instructional design firm in a metropolitan city meets with a not-for-profit organization to discuss their training needs. During a few of the initial conversations, the firm realizes that their client would not be able to pay the typical fees they charge for their instructional design services. The CEO of the instructional design firm sees the impact that the not-for-profit has made in the local community and decides that they can offer a few of their services pro bono.
Constructions	An instructional design program discusses the options for offering two special topics courses to their students in the upcoming year. Program faculty discuss possible topics and discuss which ones might be of the most interest to their students. During their discussions, they identify potential instructors for the courses and look to see how this might impact regular course offerings and instructor assignments.

Jonassen (2012) suggests that decisions fall under two models of decision-making: normative and naturalistic. Normative models involve an individual evaluating the situation and considering several options before deciding on a solution that yields the optimal solution given any constraints or resources related to the situation. He further categorizes normative models of decision-making as falling into three categories (rational choice, cost-benefit, and risk assessment).

Rational choice models involve the instructional designer evaluating alternative options for addressing a problem and weighing the option to determine what is the most viable of the solutions. Oftentimes, the instructional designer will evaluate the strengths and weaknesses of each solution using decision-making tools such as SWOT or force field analyses. A cost-benefit analysis seeks to select solutions based on the potential for their return-on-investment. There may be instances where it is worth foregoing training if an organization cannot justify incurring the costs associated with training. A risk assessment model is when an instructional designer will evaluate the risks associated with not proceeding with a particular solution.

Naturalistic models are suggested to assist in the decision-making process when decisions are more contextually-embedded. These models "stress the role of identity and unconscious emotions in decision-making" (Jonassen, 2012, p. 348). Narrative-based models place value on the explanations that accompany the various decision options. More emphasis is placed on the explanation rather than the cost-benefit analysis associated with a particular solution. Identify-based decisions are centered around how any individual relates to solutions on a personal level. Table 2 provides examples of instructional design decisions that may fall under normative or naturalistic decision-making models.

Table 2

Examples of Normative and Naturalistic Instructional Design

Decisions

Type of Decision-Making	Model	Examples in Relation to Instructional Design
Normative Decision-Making	Rational choice	A manufacturing company is looking to conduct Kaizen events as a means to create a lean manufacturing environment. To date, there have been many issues reported and logged by employees related to inefficiencies related to production. The manufacturing supervisors and the director of continuous improvement meet to rank the performance issues. They will begin by developing training and Kaizen events around the top three issues that have been prioritized by the team.
	Cost-benefit analysis	A call center is interested in investing in the development of new training modules to assist their call attendants on strategies to troubleshoot common calls they have been receiving about new products. Investing in training has the potential to reduce each customer call by five minutes.
	Risk assessment	A local hospital has sought input from its training department to explore whether training is needed regarding patient safety for their volunteers. The organization is looking at what the cost would be to host training sessions every month with incoming volunteers versus the risks of not training them on patient safety practices.
Naturalistic Decision-Making	Narrative-based	A sociology department at a research-intensive university is meeting to discuss if there is a need to modify and update their curriculum for their graduate programs. A faculty member has mentioned to the group that they do not believe the existing curriculum places enough emphasis on vulnerable populations. As they talk during the meeting, they keep referring to some existing students and asking the program faculty to consider what they would do if they were these students.
	Identity-based	The curriculum committee at a medical school is discussing options for offering graduate certificates in Patient Safety and Quality or Global Health in addition to their medical degree programs. Three of the members on the curriculum committee participated in global health trips during their medical training and recall it being a very engaging experience. They are more inclined to support the certificate in global health because they identify with that program on a personal level.

Normative Decision-Making Example: An Accident Occurs on the Plant Floor

Mike is an instructional designer who works in the Department of Employee Development for an automotive aftermarket manufacturer. Over the weekend, an employee had a fatal accident operating a piece of machinery during the night shift. Mike and his supervisor have been included in meetings to explore whether modifications are needed to the company's existing health and safety modules.

It is most likely that Mike and his supervisor will employ a normative approach to decision-making by conducting a risk assessment to determine the need for updating existing modules or developing new courses. The following are examples of some questions that Mike may ask during his meeting with the organizational leadership:

- How many accidents have occurred on the plant floor in the past year?
- How many of these accidents were related to the particular machine?
- What training had the injured employee received before operating the machinery?
- Are safety practices related to the machine covered in the existing health and safety training modules?

Application Exercises

Make a list of all of the potential options you might consider if you were to assist Mike with the project.

Naturalistic Decision-Making Example: Transitioning Human Resource Mandatory Training

Angela has recently been hired as an instructional designer and trainer in support of employee development initiatives for a local hospital. In a recent meeting that was held with managers in human resources, there was a discussion about whether mandatory training courses should be offered in an online format. At her previous organization, Angela remembers that there were a lot of issues with transferring courses to an online format and she wonders if the employee development team has the necessary manpower and resources to support these modules.

Application Exercises

How might Angela’s previous employment experience influence her position during this discussion about offering online training modules?

Fostering the Development of Instructional Design Decision-Making

Several studies have been conducted exploring the development of instructional designers' design judgment (Demiral-Uzan, 2015; Gray et al., 2015; Honebein, 2017; Korkmaz & Boling, 2014). These studies have explored how instructional designers engage in making decisions based on resources available in real-world settings. The results of these studies have supported the idea that instructional design is not limited to a linear approach for designing and developing instructional solutions; it is complex, and heavily influenced by contextual factors that are uniquely situated in relation to the project goals.

Other studies have sought to explore the role of experience and instructional designers’ abilities to make decisions. There are several differences inherent in terms of how novice instructional designers engage in decision-making compared to experts (Ertmer et al., 2008, 2009; Hoard, Stefaniak, Baaki, & Draper, 2019; Perez & Emery, 1995; Stefaniak, Baaki, Hoard, & Stapleton, 2018). Novice instructional designers are more apt to rely on instructional design models to guide their design process in a linear fashion whereas expert designers design in a more recursive manner. Several of the abovementioned studies also reported that novices tend to revert back to instructional design solutions they have used in previous projects; experts are more prone to customize solutions to meet the unique needs of their learning audience.

Several researchers in the instructional design field have suggested that an apprentice model can be beneficial to novice instructional design students as they are acquiring and developing design skills. The use of a cognitive apprenticeship provides a framework for instructors and expert instructional designers to model behavior and design practices in addition to providing the necessary instructional scaffolding to support instructional designers as they engage in design decision-making (Bannan-Ritland, 2001; Ertmer & Cennamo, 1995, Moallem, 1998; Shambaugh & Magliaro, 2001; Stefaniak, 2017)

Tools to Facilitate and Log Decision-Making During the Design Phase of Instruction

Instructional design is an iterative and recursive process that requires the instructional designer to continuously monitor and revisit their designs to ensure alignment between instructional components from conception to implementation. Table 3 provides an overview of various tools that an instructional designer can utilize throughout their design process to log and reflect upon their instructional design decisions. Also, examples of studies and resources that discuss the use of these tools in detail are included in the table.

Table 3

Overview of Tools to Assist Instructional Designers with Logging Decisions

Tool	Description	Examples of Studies and Uses
Design documents	A document that serves as a blueprint for the entire instructional project. This document typically includes information related to course goals, learning objectives, instructional strategies, assessments, project timelines, and budgets.	Boot, Nelson, van Merrienboer, and Gibbons (2007) Martin (2011) Piskurich (2015)
External representations	The knowledge and structure in the environment, as physical symbols, objects, or dimensions (e.g., written symbols, beads of abacuses, dimensions of a graph, etc.), and as external rules, constraints, or relations embedded in physical configurations (e.g., spatial relations of written digits, visual and spatial layouts of diagrams, physical constraints in abacuses, etc.)" (Zhang, 1997, p. 180).	Baaki and Luo (2019) Boling and Gray (2015) Fischer and Mandl (2005) Huybrechts, Schoffelen, Schepers, and Braspenning (2012) Luo and Baaki (2019) Verschaffel, de Corte, de Jong, and Elen (2010) Yanchar, South, Williams, Allen, and Wilson (2010)
Group repositories	Space where an instructional design team can track the progress of a project and share notes. This space is typically housed by an online platform.	Gustafson (2002) Spector (2002) Stefaniak, Maddrell, Earnshaw, and Hale (2018) Van Rooij (2010)
Rapid Prototyping	An instructional design approach that is used to create a sample of an instructional design product that is scalable according to the needs of the project. Rapid prototyping allows instructional designs to combine multiple phases of the instructional design process to facilitate discussions and decisions about results.	Roytek (2010) Tripp & Bichelmeyer (1990) York and Ertmer (2011)
Reflection journals	A journal where an instructional designer can log any ideas they might help, reactions to different phases of the instructional design process, or notes that might be beneficial for a future project. The use of a journal helps an instructional designer keep track of their thoughts and ideas that might not be suitable to be documented in a design document while still promoting a reflection-in-action mindset (Schon, 1983).	Baaki, Tracey, and Hutchinson (2017) Bannan-Ritland (2001) Gray et al. (2015) Luppicini (2003) Moallem (1998) Tracey and Hutchinson (2013) Young (2008)

Conclusion

While decision-making is recognized as a common form of problem-solving in instructional design practices, Jonassen (2012) contends that there is a need for empirical research to assess decision-making in our field. To date, there is a growing body of literature exploring the decision-making practices of instructional designers; however, we, as a field, have just begun to skim the surface. More studies are needed to explore the types and quality of decisions made by instructional designers of all levels in a variety of contexts. We know that contextual factors contribute to or hinder the effectiveness of instructional designers' final designs (Morrison et al., 2013; Smith & Ragan, 2005). Researchers have criticized that the role of context continues to be an aspect of design that still warrants further explanation and understanding (Tessmer, 1990; Tessmer & Wedman, 1995). This continues to be an issue facing our field. Additional studies on factors influencing instructional designers' abilities to engage in decision-making will better equip our field to prepare the future of instructional design (Ertmer et al., 2009; Jonassen, 2008; Stefaniak et al., 2018; Tracey & Boling, 2014).

In the meantime, instructional designers can continue to focus on cultivating their designer identity (Tracey & Hutchinson, 2016, 2018) by documenting their thoughts and making use of the tools mentioned in this chapter to track their design decisions during projects. Over time, the aspiring instructional designer will begin to identify patterns in terms of how they approach various types of design problems, identify and utilize design resources and space, and articulate their rationale to fellow designers and clients. This continual practice of design documentation will serve the field well by informing both theory and practice.

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7

Generating Ideas

Vanessa Svihla

Brainstorming, ideation, generating ideas. These terms and the kinds of practices they refer to are familiar to many, even outside of design fields. As instructional designers, we use such techniques to come up with more ideas—and more creative ideas. But how do these techniques help designers develop ideas? And when and why should we use them?

In this chapter, I first discuss the typical purposes and desired outcomes for ideation. I review some common as well as new techniques and briefly discuss evidence of their effectiveness, in part to draw attention to the kinds of challenges designers face when using such techniques. Finally, I re-center the purpose of generating ideas as reframing the problem.

What Is Ideation? When and Why Do We Typically Generate Ideas?

Designers commonly generate ideas about possible solutions after the problem is initially framed. Or at least, typical texts on design suggest this is when designers should generate ideas. We will reconsider that later in this chapter.

Many ideation techniques focus on generating many ideas, going on the assumption that if you generate many ideas, some of them will surely be creative. This probabilistic reasoning is not always accurate, however. This is because even if we generate many ideas, they may still be similar to each other. Researchers who study ideation techniques argue that novelty comes from having dissimilar ideas. This means that variety is more important than quantity. But coming up with dissimilar ideas can be challenging because of *fixation*—the experience of getting stuck on previous ideas. Compared to designers who are not shown an existing solution, designers who are given an example tend to reproduce features from the example (Jansson & Smith, 1991), even when the example is known to be flawed (Purcell & Gero, 1996). Often, designers are unaware they have incorporated such features, and this is why overcoming fixation can be so challenging—it is often a covert process.

Research suggests that designers who have less diverse precedent to consider may be more prone to fixation (Purcell & Gero, 1996). Who has a less diverse precedent? Some may think this would be novice designers because they have not been exposed to the concepts and materials with which they are designing. But in some fields, like mechanical engineering and instructional design, we commonly encounter designs, but many of us do not encounter much diversity in those designs (e.g., a lot of sedans look like one another, and many school lessons look like one another). Repeated exposure to a limited set of ideas covertly shapes our vision of what could be. And, without deliberate engagement with diverse precedent, we might not be very influenced by that precedent.

New designers also tend to commit to design ideas prematurely (Rowland, 1992; Shum, 1991), and once committed, can feel invested and unwilling to change, a phenomenon referred to as *sunk cost* (Kahneman & Tversky, 1979). In my own teaching of design, I require messy, hand-drafted first versions of ideation and prototypes and impose a -10% penalty to any such assignment that looks to have been tidied up. This appears to help, but it is still very easy to fall in love with a first idea. Consider the following vignettes in Tables 1 and 2, in which a supervisor (Sunil) requests fire extinguisher training to comply with regulations and the design team (newcomer Noel, experienced Eli, and subject matter expert Marley) considers their options.

Vignette 1. Meeting With Supervisor

Sunil

Of course, we want to make sure our employees are exposed to proper fire extinguisher use. We have to comply with these new regulations ASAP.

Marley

Some units, like mine, have already been certifying employees because we really have to know how to use an extinguisher. But we rely on an external provider.

Eli

It seems like that won't scale to the entire organization, given the cost you shared with us earlier.

Noel

We can just put together a short online training using the PASS model, with a quiz to certify them. I think the pass score should be rather high, though, right? Like 100%. I know we sometimes go with 80%.

Sunil

What is the difference between a pass model and pass score?

Noel

Oh! Sorry. The PASS model—I googled it before the meeting—is a mnemonic to use the fire extinguisher. It means pull the pin, um, aim, and sweep. I forget what the other S stands for, give me a sec—

Sunil

How long would it take you to put that together?

Eli

Before we get to that, I think we need to consider options.

In the vignette, who shows fixation? Premature commitment? What precedent might shape how the design team and supervisor evaluate design ideas? How might they overcome fixation and premature commitment? To answer that, let's look first at the origins of idea generation.

What Are Some Tools for Ideation?

In 1939, Osborn began developing techniques for more creative advertising. He devised classic brainstorming and published techniques based on years of practice (Osborn, 1957). He advocated for the following techniques as part of brainstorming:

- suspending critique
- considering wild ideas
- coming up with as many ideas as possible
- combining ideas, and
- working in a large group of designers.

Several of these ideas were later empirically challenged, especially group size (Mongeau & Morr, 1999). Generally, support has been found for more structured ideation methods (Crilly & Cardoso, 2017; Runco et al., 2011; Santanen, Briggs, & Vreede, 2004; Sosa & Gero, 2013; Yilmaz, Seifert, & Gonzalez, 2010). For instance, an early, somewhat more-structured approach was lateral thinking, meaning thinking in generative ways (as opposed to analytical “vertical thinking”) (De Bono & Zimbalist, 1970). De Bono described general methods for lateral thinking, such as:

- generating alternatives with a pre-set quota (number of ideas),
- challenging assumptions by repeatedly asking why,
- suspending or delaying judgement, and
- restructuring or reorganizing elements.

In the vignette below, what techniques (from the bulleted lists above) do they use? Where do they stray from the guidelines for brainstorming and lateral thinking?

Vignette 2. Design Team Meeting: Classic Brainstorming in a Group

Eli

I am a little worried that if we just deliver a compliance training, Sunil will consider that sufficient, even for units like Marley’s, because the cost savings will be so appealing. So, I think we should generate some ideas before we commit. So, let’s come up with at least 20 ideas. Let’s not evaluate them yet, just list any ideas that pop in.

Noel

Well, I think we should do the PASS model, followed by a quiz.

Marley

That makes me think about job aids. Like we could have a sign, maybe next to or on fire extinguishers?

Noel

Nice. And we should make the job aid similar to the training, so the instructional and transfer contexts are similar.

Marley

That’s a good idea. We can use the same font and pictures even.

Eli

Sometimes asking “why” helps. Like, why do all employees need this training? Why don’t they know how to use a fire extinguisher already?

Marley

In the certification course we take in my unit, people think they should aim at the top of the flames, but it’s the base. So, we could focus on that aspect.

Noel

And that is also part of the PASS model. And they need it because of compliance though, right?

Eli

Let’s really try to get some other ideas on the table.

Noel

We could make our own model. SAPS? APSS?

Marley

Or it could be just like a handout they get.

In this vignette, you may have noticed that although Eli encouraged them not to evaluate ideas, Noel and Marley reacted in evaluative ways to each other's ideas. Although they did not critique ideas, even providing positive evaluation can shape how others respond because it signals that poor ideas are unwelcome. This in turn can impinge on creative thinking.

Noel's suggestion to make their own model by rearranging the steps is something those of us who teach design see often. Coming up with flawed versions of existing ideas accomplishes two things well—it gets you toward whatever preset quota you need, and it guarantees your favorite idea won't be ruled out—but it does not lead to more creative ideas. Yet, this approach is common when ideation feels forced or artificial, as can happen when one designer prompts ideation that others do not see a need for (or when ideation is assigned, such as in an ID class!). Knowing when to deploy ideation techniques is critical, but this is learned through experience. For practicing designers, ideation is not always a formal step; they often generate ideas ad hoc. Experienced designers do not always find benefit from typical ideation techniques (Laakso & Liikkanen, 2012; Linsey et al., 2010; Sio, Kotovsky, & Cagan, 2015; Tauber, 1972; Vasconcelos & Crilly, 2016), but research suggests these may hold benefit for newcomers.

Below, I have summarized some common structured ideation techniques. I have included a couple that are not common in instructional design because methods developed in other design fields, like engineering and creativity, are transferrable outside of product design fields (Moreno, Yang, Hernández, & Wood, 2014). This is important in part because our most prominent design approach—ADDIE—has relatively little to say about ideation, and even newer models like SAM do not provide clarity about where new ideas might come from (Allen, 2012).

Take the fire extinguisher training problem described in the vignettes, and try out two of the techniques in Table 1 below.

Table 1

Common Structured Ideation Techniques

Technique	Outcomes	Use in ID
	SCAMPER	
An elaboration of traditional brainstorming, this technique structures ideation by providing questions tied to actions that form the SCAMPER acronym: substitute, combine, adapt, modify/magnify/minimize, put to other uses, eliminate, and reverse/rearrange (Eberle, 1972). For instance, ask “What can I substitute?”	Studies suggest that SCAMPER may result in more high-quality novel ideas compared to unguided methods (Moreno, Yang, et al., 2014).	SCAMPER has been commonly used with elementary students. It is a particularly promising technique for making incremental changes to typical instructional settings, where major changes may be viewed as threatening or problematic.
	Design Heuristics	
Based on expert performance in product and engineering design (Yilmaz, Daly, Seifert, & Gonzalez, 2015, 2016) this is a well-studied set of 77 strategy cards—such as add levels, adjust functions for specific users, repeat, compartmentalize, contextualize, build user community, change flexibility, scale up or down, and incorporate environment—for designers to use as inspiration as they generate ideas.	Design heuristics can support newcomer designers to develop more elaborated and practical ideas (Daly, Seifert, Yilmaz, & Gonzalez, 2016).	While many of the strategies are specific to engineering or product design, many are salient to instructional design, especially if we change “user” to “learner.” For instance, several focus on user agency, which we could frame as learner agency—allow the learner to customize, reconfigure, reorient. What other heuristics might we identify from expert ID practice? The list of ID heuristics could be a place to start (York & Ertmer, 2011).
	Design-by-Analogy	
These methods include various forms—Synectics (Gordon, 1961), biomimicry—and include techniques like mapping related words in a network like a concept map or exposure to near or far examples. The latter mirrors intuitive as well as professional design practice in which designers rely on precedent. However it involves deliberately considering ideas that may be similar or wildly different as sources of inspiration. Common to engineering design, the TRIZ (Altshuller, 1996) approach involves first identifying “contradictions” then looking at ways others have resolved the same kind of contradiction.	Design-by-analogy methods can help designers produce more novel ideas (Moreno, Hernandez, et al., 2014) especially if the designers use far analogies (Chan et al., 2011) which can help them think more broadly about a problem (S. M. Smith & Linsey, 2011). TRIZ has led to more varied ideas (Belski, Hourani, Valentine, & Belski, 2014).	Although not commonly used in ID, this is a promising technique to overcome exposure to traditional precedent. Developing clarity about tensions is also promising. Common contradictions salient in instructional design are breadth versus depth, efficiency versus understanding, and convenience versus learning.
	Nominal group	
In a group, individuals silently generate ideas. Each member shares ideas. After all have been shared, members clarify and evaluate ideas collectively then vote individually.	Compared to an unstructured group, nominal groups generate more ideas (Ven & Delbecq, 1974).	Nominal group techniques are beneficial when generating ideas with stakeholders or in groups with power imbalances because it opens space for all members to participate.
	Bodystorming	
Rather than attempting to generate ideas removed from context, bodystorming involves acting out the problem and possible solutions in situ (Oulasvirta, Kurvinen, & Kankainen, 2003).	Bodystorming has been helpful when designing with new or unfamiliar learning technologies (B. K. Smith, 2014).	Although not commonly used (in ID or other fields), bodystorming can be particularly generative when considering the configuration of learning spaces, ways to arrange collaborating learners, and mobile learning.

Contrast the two techniques you tried out:

- Which did you prefer and why?
- Which led you to produce more ideas?
- Which do you think led you to generate more novel ideas?
- Which do you think led you to generate higher quality ideas?

If you found answering the last two questions more difficult, you are not alone. Researchers have long debated the best ways to measure novelty and quality of ideas. While counting the number of ideas generated is straightforward, as mentioned earlier, this does not necessarily result in better ideas. Novelty is often characterized by the variety or breadth of ideas of a single designer as well as the frequency of their ideas compared to other designers (Hernandez, Okudan, & Schmidt, 2012). Quality is sometimes measured as feasibility, usability (Kudrowitz & Wallace, 2013) or the degree to which needs are met without violating constraints.

Others have also considered characteristics such as ethics and empathy. This means evaluating the just distribution of risks and benefits for multiple and especially marginalized groups (Beever & Brightman, 2016). Although not commonly used, techniques that sensitize the instructional designer to the experiences of marginalized groups and connect this to their own experiences prior to generating ideas has potential for addressing persistent inequities and structural oppression (Kouprie & Visser, 2009; Visser & Kouprie, 2008). Such approaches also tend to more clearly change the problem space.

How Can Ideation Reshape the Problem Space?

So far, we have mostly focused on the solution space, but due to the ill-structured nature of design problems, ideation also changes the problem space (Cardoso, Badke-Schaub, & Eris, 2016) as designers reframe the problem during ideation (Daly, Yilmaz, Christian, Seifert, & Gonzalez, 2012). Designers sometimes relax constraints and this can reshape the problem space (Chan, Dang, Kremer, Guo, & Dow, 2014; Silk, Daly, Jablokow, Yilmaz, & Rosenberg, 2014). By temporarily ignoring a key constraint, sometimes we can notice something new about the problem space.

Similarly, my own approach—the Wrong Theory Protocol (WTP, https://edtechbooks.org/-IAVb)—likewise tends to reshape the problem space. In this approach, we ask designers to first come up with ideas that would cause harm and humiliation prior to generating beneficial ideas. I was inspired by a magazine article on artists and designers deliberately creating displeasing and wrong works (Dadich, 2014). When we first incorporated it into an ideation session, we noticed that the most humiliating ideas led to more empathetic insights and changed problem frames. Consider the vignette below to understand why this might be.

Vignette 3. Design Team Meeting: Wrong Theory Protocol

After individually generating harmful and humiliating ideas, the team discusses their insights:

Eli

I think my worst idea was locking the learner in a room with a small fire burning and a sort of Rube Goldberg fire extinguisher with terribly complex instructions. They first can't get it started, and once set in motion, the extinguisher has too many steps to get through and the fire grows and grows.

Noel

Wow. That's terrible. Mine was giving them a depleted extinguisher with no instructions and putting them on one of those weird game shows, where if they can't make the extinguisher go, they have to eat spiders.

Marley

Ew! You both had much worse ideas than me. I think mine was just lazy. I said just give them no instructions and wait for a fire, then put up a list in the hall of those who messed up. Eli, your wrong design makes me think of how—in some of our units, it could go really wrong if someone who got basic training used the wrong kind of extinguisher. Some of our labs have two or three kinds for different situations.

Noel

You know, at first, I thought, we just need to make sure everyone knows how to use a basic model, but now I wonder if that could actually lead to accidents. If we tackle this just as a compliance problem, we could make it worse.

In this vignette, how did the problem change as a result of insight gained from generating wrong ideas? Why do you think it changed?

In our work on WTP, designers' beneficial ideas, though not numerous, tend to be both creative and empathetic. We have several reasons for why WTP might work. Perhaps designers feel beholden to stakeholders after coming up with harmful and humiliating ideas? Or perhaps they simply gain empathy? Maybe they notice something new about the problem situation? Or, perhaps in absence of the pressure to be right, they are able to be more creative? Afterall, research on suspending judgment suggests that it is difficult to accomplish.

Conclusion

Instead of treating ideation as the tipping point between being problem- and solution-focused, try generating ideas across the depth and duration of your design process to help you frame the problem with empathy and design learning experiences that meet needs without unintentionally widening gaps. By depth, I mean that it can help to drill down and ideate on a particular aspect.

While this chapter introduced a few techniques, there are many more available.

Additional Readings and Resources

There are many texts that illustrate additional ideation/creativity techniques. I always recommend keeping an eye out for one that appeals to you.

Kelley, T., & Littman, J. (2006). The ten faces of innovation: IDEO's strategies for defeating the devil's advocate and driving creativity throughout your organization: Crown Business.

Michalko, M. (2011). Cracking creativity: The secrets of creative genius: Ten Speed Press.

Michalko, M. (2010). Thinkertoys: A handbook of creative-thinking techniques: Ten Speed Press.

Sawyer, K. (2013). Zig Zag: the surprising path to greater creativity: John Wiley & Sons.

Finally, ideation can be an effective tool when employed at any sticking point. Low fidelity prototypes, use-cases and early storyboards often reveal issues that can be dealt with through ideation. Even in pilot implementation, having ideation techniques ready-to-hand can avert disaster when issues come up. This kind of generative thinking—How can it work? How else could it work?—serves designers well throughout their design work.

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9

Design Critique

Brad Hokanson

Central to design and design education is the critique (Dannels, 2005; Gray, 2013). The methodology and practice of critique is how designs are improved and how design skills are developed in workplaces and within studio education around the world. It is where work is presented by a designer, criticized by others, its virtues and limitations debated, and the work improved.

By itself, designing is a challenge to any individual's abilities. Information must be gathered and analyzed and a guiding principle or idea must be developed and communicated to others. Designers must expose their work to the criticism of others and answer critiques with the quality of their arguments and improvement in the design. Critique looks at an idea—created through analysis and an inventive process, which is shared by the learner/designer—and advances its quality.

The design critique can provide instructional design with a means for intensifying the learning process as well as improving the design project itself. As a process, critique benefits the learner, other members of a class, and the critic.

Defining Critique

Used throughout the design and creative fields, "critique" is a formative, conversational method of interaction and assessment. It is the systematic and objective examination of an idea, phenomenon, or artifact. Critique is a semi-structured method of sharing work for evaluation and commentary by others; it is a discussion with a project focus. While there are a number of different forms and terms for the process, critique is used here to refer to formal and informal discussions involving design disclosure and criticism.

This writing focuses on the formative aspects of critique, and does not address final critiques or formal reviews, processes meant to conclude and evaluate a design project (see Figure 4). For less formal and individual scaled interactions, the terms "crit" and "desk crit" are commonly used. Here the focus is on critiques which happen during the design process.

Design critique can be compared with user testing. Both allow the evaluation of design projects and provide important feedback to the designer. Here the focus is on critiques which happen during the design process. In contrast, in user testing, most of the understanding of the quality of design work comes from observation of appropriate test users. Comments from the test users can be helpful, but often are limited by their experience with design or the project at hand. On the other hand, critique generally deals with peers or mentors with experience in designs of this project type.

In the first major studies of these interactions in the design studio, Donald Schön (1983, 1985, 1987) directly observed architectural education. His writing described the individual consultations between studio instructors and individual students. The intensity and focus of this type of learning event is the essence of an effective studio education, it is not didactic. At its most positive, a critique is meant to “coach” or “guide” the learner to a more effective answer, develop judgment, and model tacit design/problem setting and solving skills. Per Schön, “The student cannot be taught what he needs to know, but he can be coached” (1987, p. 17).

Forms of Critique

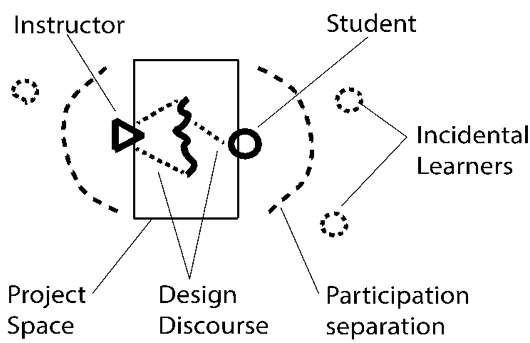
There are a number of different structures for critique. Blythman et al. (2007) describe a variety of critique forms which range from final reviews to industry presentations to individual critiques. In this writing three of these forms are described as central to design and education: desk critiques, peer crits, and group critiques. Each of these types is formative, designed to encourage and direct design progress, and are qualitatively the most effective.

Within a studio learning experience, the development of design skills is commonly sought through a form of informal critique or desk crit (see Figure 1). A desk crit is “… an extended and loosely structured interaction between designer and critic (expert or peer) involving discussion and collaborative work on a design in progress” (Shaffer, 2003, p. 5). In general, most of the activity during scheduled class time in a design studio will be individual students receiving criticism of their work from instructors or visitors.

Figure 1

Desk Critique (illustration by the author, photo courtesy of University of Minnesota College of Design)

Desk Crit


Instructor
Student
Incidental
Learners
Project
Space
Design
Discourse
Participation
separation

"During a crit, a student describes his or her work to the professor…As students present possible solutions, the professor explores the implications of various design choices, suggesting alternative possibilities, or offering ways for the student to proceed in his or her exploration of the problem" (Shaffer, 2000, pp. 251–252).

The desk crit is a personal conversation between a designer and a critic (who may be a visiting professional, expert, or professor). The length varies with the discussion. "This model of social interaction between student and instructor involves a critical conversation about the student's design, and usually involves both people working towards solving a problem" (Conanan et al., 1997, p. 2). It is inherently formative, guiding the work toward a more successful conclusion. It is also subjective, and when successful, provides not only objective answers but directions focused on developing the designer's ideas and thought process.

An important concept in effective critiques is the focus of the criticism on the work itself and not on the designer. A positive, formative atmosphere is essential to an effective critique; grading and evaluation occur elsewhere. Shaffer described this nature:

“The tone of desk crits was almost always supportive and nonjudgmental. On the other hand, pinups and reviews, although constructive, were quite blunt and sometimes extremely critical—particularly in the case of formal reviews. Judgment was, in effect, off-loaded from the more private desk crits to the more public presentations” (Shaffer, 2003, p. 2).

Non-participants also can benefit from the individual desk critique both through direct observation and through incidental listening to the process. While not as formalized as a lecture, within a studio space, frequently there are informal observers who gain from hearing another's desk critique.

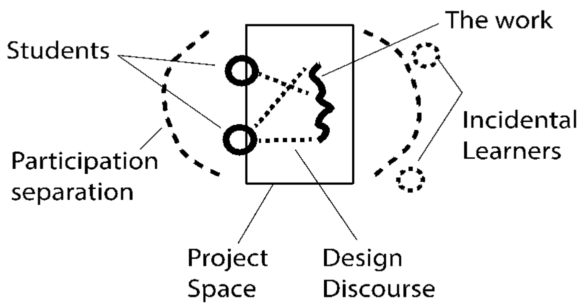
Talking to two student designers at a time may be more effective as it allows designs to be compared and more designers to be critiqued in a given time period. It does, however, lack the focus and attention found through the individual critique.

While access to instructors is limited, other members of a class or team are available at any time to provide opinions, clarifications, and evaluations through a peer critique, inside or outside of formal meeting hours. This is the simplest form of critique in design, the "peer crit", where design work and ideas are discussed between colleagues (see Figure 2).

Figure 2

Peer Critique (illustration by the author, photo courtesy of University of Minnesota College of Design)

Peer Crititque



Any critique develops both the critic and designer. While they can provide an external review of one’s design decisions, peer crits also provide the critic with the opportunity to extend their own skills. Peer critics review the validity and logic of a particular design idea or set of design choices. While peer crits may be the least formal format, they are the basis for an extended professional understanding of the use of critique. This practice occurs in a range of fields from graphic design to architecture to user-experience design.

An individual working session with a single student can change learners' minds and their thinking process, providing, as Shaffer describes it involves social scaffolding of learning the design process. At its core, critique as part of an educational experience is constructivist. While the focus is on an external project, the overall goal of the critique is to develop the designs skills of the learner.

"He [sic] has to see on his own behalf … Nobody else can see for him, and he can’t see just by being “told,” although the right kind of telling may guide his seeing and thus help him see what he needs to see." (Dewey 1974, p. 151)

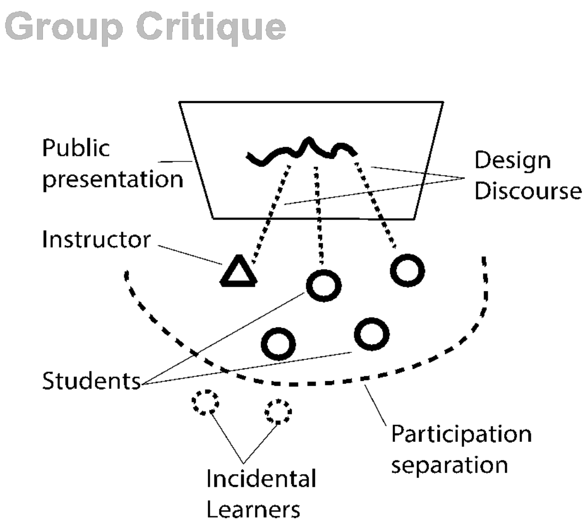
The importance of the informal critique in the development of learners in the studio classroom is clear. Frequent engagement and discussion of ideas scaffold the experience, while the designer tacitly recognizes the value of engagement and collaboration with other professionals by seeking criticism from others.

Designers who participate in critique may do so as a critic or as one being critiqued. Both roles have cognitive benefits to the individual designer and to their broader understanding of design. Designs are developed conversationally, building from the initial ideas of the designer, but tested and improved through the argumentation like process of a critique. Criticism of the work can help improve the quality of the end-product. Over time, exposure to critique can also help develop thinking skills of the designer building their capability to analyze, anticipate, and respond. For a beginning designer, a first critique may be challenging and helpful comments may be rejected. Often the criticism of the work is conflated with criticism of the designer themselves, when they should be separated. Discussions must focus on the work, and not on the designer.

Small groups can also observe and participate in formative group critique as well, with selected projects serving to trigger discussion and interaction with all present. In studio format learning, intermediate group critiques can have much of the same coaching or generative functions as individual critiques. Whether as a group crit or pin-up, these can highlight specific milestones in a project development. While similar in form to final reviews or "juries", the distinguishing quality is one of development and advancing the work of the individual designer and benefiting the group from generalizable comments. It is inherently formative and positive.

Figure 3

Group Critique (illustration by the author, photo courtesy of University of Minnesota College of Design)

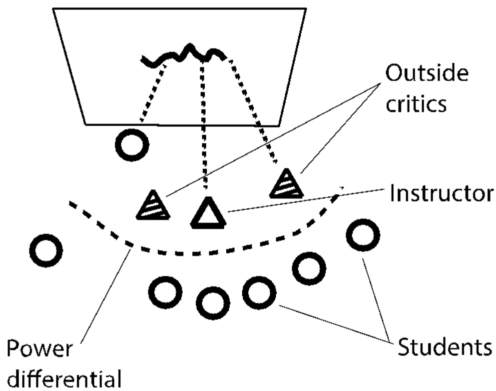


A general, but often tacit goal of design education is to instill a habit of critique, and an ongoing practice of generative evaluation of creative work. Critique supports reflection and engagement among designers of all types.

Figure 4

Final Review (illustration by the author, photo courtesy of University of Minnesota College of Design)

Final Review / Jury



Use of Critique in Studio

Studio-based education is learning by designing, a rich and complex process. Designers in all fields examine problems, advance possible exploratory resolutions, and iteratively evaluate their own work as a regular part of the design process. This process occurs through personal reflection and evaluation, but it can also be improved through the interaction with others through as Shaffer calls "…a variety of structured conversations…" (2003, p. 5). An important aspect of learning design is developing the professional practice of seeking and giving critique; the formal and informal evaluation of the work. It is one of the consistent aspects across design programs and schools worldwide, and importantly, in design culture. As a generative format, the critique process focuses on the improvement and development of the design project.

The use of the studio model in instructional design has become increasingly common over the past ten years (Clinton and Rieber, 2010). Studios are based on the ideas of project-based learning and modeled directly from pedagogical methods in the creative fields such as studio art, architecture, and product design. “The originators of the studio curriculum [at the University of Georgia] … envisioned the learning of educational multimedia design to that of an art or architectural studio in which a group of people learn skills and develop expertise while working on authentic projects in a public space comprised of tools and work areas” (Clinton and Rieber, 2010).

Application in Instructional Design

Instructional design education can benefit from the models presented in studio-format classes. Instructional designers also can utilize the general concept of critique in various ways in design products of their own. However, not everyone is experienced with critique or even studio-based learning in an educational environment. Design schools have the advantage of a well-developed and expected critique model; the scaffolding is explicit and the instructors are well versed in the process.

It is valuable to start using and employing critique as a method as a learner, as an instructor, and as an instructional designer. The suggestions below intersperse these roles, describing critique from these three different orientations.

Designers, even those without experience in studio-based learning, can start by opening themselves to critique as an educational method. Beginning can be as simple as developing a habit of asking peers or friends for informal feedback on a project. The author's own second year architecture critic began the year by saying "You have to expose yourself.", encouraging our own sharing and interaction regarding design ideas. (Stageberg, 1973).

Peer critiques can be done at any time, whether during scheduled class time or at off-hours, exposing project ideas to others' opinions and assessments. Critique can also be done between designers, developing their skills of synthesis and evaluation, and expands the learning process…and importantly as a way to improve the design work itself. [An application exercise is included at the conclusion of this writing.]

Designers seeking input on their work can begin by specifically focusing the critique on areas for improvement. A peer critique should start with briefly describing the problem or design and outlining the objectives of the project. Present is an understanding of the immediate goal of the critique being improvement of the design solution (Gibbons, 2016). As with writing, the goal is to seek a larger understanding of the logic and tone as opposed to a copy edit.

While a critique is in progress, designers can help steer the direction of discussion to more important issues by focusing on discourse within the design work, and by seeking evidence and the reasoning behind any criticisms.

Critiquing a colleague, peer, or student helps in developing one's own reflective ability to analyze and criticize design work. Critiquing the work of others can help make one a better designer in the long term, and improve design projects in the present.

While giving a critique involves evaluating the work for errors and problems, it can also delve into the more philosophical and theoretical aspects of the project. For example, an instructional design could begin from a behavioral basis or a constructivist basis, which is a place for philosophical advocacy.

For instructors, individual critiques can be described as a regular system of tutoring individual learners, driven by attention and engagement. Critique is contemporary and formative feedback, engaging, and scaffolds the design process. The skills of critique should be consciously developed in learners both as recipients and for their role as critic. The critique model is extendable, as individuals can be paired or grouped as need be, building collaborative learning events. A formative critique is comparable to reviewing a written article draft for a colleague, building on their ideas and their thinking.

Critics or instructors themselves will need to begin by modeling a positive and formative approach to a constructive conversation. Faculty will need to have a consistent pattern of using critique for helping learners develop their ideas as well as their thinking process. Explicit standards for both the interaction and the quality of the work are helpful. Individual "desk" crits can be either private or public, and faculty can encourage other students to informally listen in. As individual critiques can be face-to-face or online, they can continue to allow others to participate or view. Establishing individual critiques as an educational practice in a course can build to conducting small group critiques as well.

Instructional designers have the opportunity to build into their designs open frameworks for critique. A framework can, for example, support student peer critiques, user testing of interactive designs, verbal critique of visual layouts, or a shared review of a colleague's writing. In most cases it would be important to develop critique skills in learners to help improve responses. The goal of any particular critique is progress toward improvement of the finished design, with the overarching goal of improving learner thinking. It is valuable for a learner or critic to review over all ideas and evaluate their validity and consistency, and to be present, positive, and engaged. Critique is a structure that can be built into instructional designs.

While critique is valuable for both face-to-face and online learning, there are challenges that exist with the increasing use of technology-enhanced learning. The fluidity of conversation, whether online or in-person adds much to a critique, even if done through sharing screens and talking synchronously, which is now possible with some course management systems. Critiques should be done in a manner providing the highest fidelity of communication possible; while face-to-face is valuable, most synchronous critique can be done through video conference software. A current example would be online music lessons connecting, say, a violin player in Japan with an instructor in Finland (Furui et.al., 2015; Nishimura, 2017).

Asynchronous critique may be less effective, but can still provide direction and formative assessment through mark-up and annotation. Unfortunately, there isn't the same interaction with a "Track Changes" review or with software such as VoiceThread as with a face-to-face conversation, but with investigation, structuring of the conversation could be improved. Online written texts can be combined with synchronous audio for editing sessions as well.

Conclusion

As with any educational practice, there are limits to the use of critique in education. More commonly, the limits on the use of critique are due to time and the one-on-one nature of an instructor critique. Modern economics necessarily constrains the amount of time spent reviewing, analyzing, and being involved with individual critiques. Lecture classes and objective evaluations are simpler and much more financially viable in 'presenting' a large class than is a single design instructor working with individuals in a smaller studio class. This is a continuing source of pressure on design departments. Pragmatically, class size and time limit the availability of critique as an educational method.

Critiques do vary in quality as well as scale. Some critiques are helpful and advance the work, others challenge the designer's thoughts, leading to new insight for future work. Other critiques, of course, are less successful, perhaps focusing on the traits of the designer and not on the design itself. Critiques which focus primarily on minor details, facts or factual error are often distracted from larger, more important issues. Critiques which are simplistic and present criticism without evidence are not helpful, nor are those which are overwhelmingly negative or positive. The goal of a good critique is to make the design and designer better, and not to express a power relationship.

The skills of the reviewer, whether educator or peer, are also important—recognizing the social and formative nature of the interaction. However, it is within the systemic role of instructional designers to extend a valued and effective model to the technology-enhanced learning of today.

Critique can be integrated into instructional design models and education. It can be the way instructional designers learn, and an important aspect of how they practice.

Application Exercises

As a concluding exercise for this writing, try the following process. At some point in a design project, whether with early sketches or more developed ideas, contact a peer who is working at a comparable scale. It might be the same type of project or one that has similar requirements and standards. Ask if they would be willing to critique your work, and offer the same input on theirs. Review the following process and set a reasonable time scale for the critique, with enough for discussion of both efforts.

For the critique itself, first give your colleague a brief outline of the current progress of your work and focus the critique on areas of concern you may have. Solicit a comparable set of information from your partner. Spend a reasonable amount of time examining the project, depending on the scope of the project and on your agreed upon time commitment. Take notes, and try to synthesize your understanding and experience with their work. With of goal of seeking to improve the work, discuss your findings with them, and in turn, learn of their findings. Restate what you heard in your own words to them for confirmation and clarification.

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11

Instructional Design Evaluation

Cheryl Calhoun, Shilpa Sahay, & Matthew Wilson

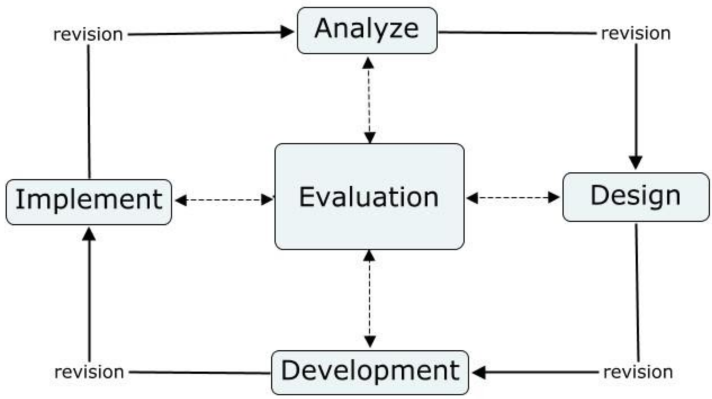
Editor's Note

This is a remixed version of an earlier chapter on evaluation in instructional design that can be found at the ADDIE Explained website, and is printed here under the same license as the original.

Evaluation sits at the center of the instructional design model. It provides feedback to all other stages of the design process to continually inform and improve our instructional designs. In this chapter we will discuss the Why, What, When, and How of evaluation. We will explore several of the most cited evaluation models and frameworks for conducting formative, summative, and confirmative evaluations. It is important to note that instruction can occur in formal instructional settings or through the development of instructional products such as digital learning tools. Throughout this chapter we will discuss interchangeably instructional programs and/or products. Effective evaluation applies to all of these forms of instructional design.

Figure 1

ADDIE Model of Design (Fav203, 2012)



Why Do We Evaluate?

Evaluation ensures that the instruction being designed both meets the identified need for instruction and is effective in achieving the intended learning outcomes for participants. It helps to answer questions such as:

- Are our instructional goals aligned with the requirements of the instructional program?
- Are our lesson plans, instructional materials, media, and assessments, aligned with learning needs?
- Do we need to make any changes to our design to improve the effectiveness and overall satisfaction with the instruction?
- Does the implementation provide effective instruction and carry out the intended lesson plan and instructional objectives?
- Have the learners obtained the knowledge and skills that are needed?
- Are our learners able to transfer their learning into the desired contextual setting?

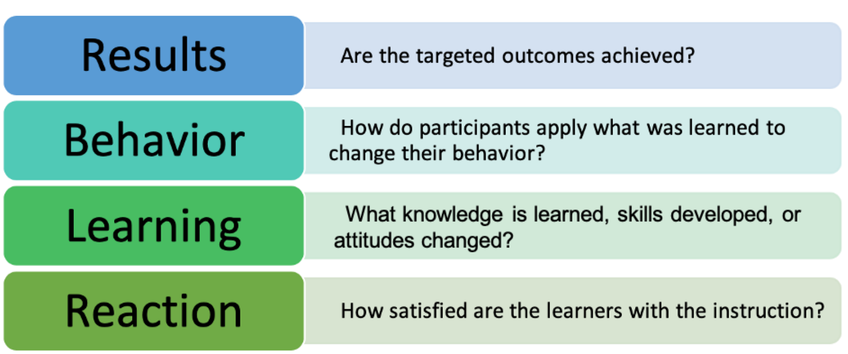
These questions help shape the instructional design, confirm what and to what extent the learner is learning, and validates the learning over time to support the choices made regarding the design—as well as how the program holds up over time.

What Is Evaluation?

Evaluation is the process of reviewing both the instructional components and the resulting outcomes of instruction to determine whether instruction achieves the desired outcomes. Kirkpatrick’s model of evaluation proposes four levels of evaluation: reaction, learning, behavior, and results (Kirkpatrick & Kirkpatrick, 2016). While this is a fairly simplistic model, it provides a framework for understanding evaluation and has provided a significant model of evaluation to the field of instructional design.

Figure 2

Kirkpatrick's Model of Evaluation



Reaction

In order to have effective instruction, one requires frequent feedback from the learners to check learning progress and monitor efficacy of the pedagogical process selected for instruction (Heritage, 2007). An instructional designer can evaluate both the teacher and the learner's reaction to a new pedagogical instruction. Once it is determined that there is engagement by the learners, one may assume that learners will not drop out due to their reaction to the quality or applicability of instruction. It also helps the evaluator to control the pace of the program as one moves ahead in the training phase. It leaves less frustration and vagueness in the evaluator's mind if one knows that all the learners are positively oriented towards undertaking the training.

Learning

Evaluating learning is an ongoing process in instructional development. It is important to evaluate whether materials developed solve the problems that were identified. When learners master the content of the training or exhibit proper learning through assessment, one can assume the effectiveness of the program and identify what did not work if the learning outcomes show adverse results. Several studies in the field of educational measurement have suggested that assessments and evaluations lead to higher quality learning. Popham (2008) called this new aspect of assessment in the evaluation process as "Transformative Assessment" where an evaluator identifies learning progression of the learners by analyzing the sequence of skills learned over the period of study program. This also helps the evaluator or the instructional designer to develop methods to assess how much the learners mastered the learning material.

Behavior

Attitudes and behavior are important indicators towards the acceptance and success of an instructional program. Dick, Carey, and

Carey (2015) mentioned that an evaluator needs to write directions to guide the learner's activities and construct a rubric (e.g. a checklist or a rating scale) in order to evaluate and measure performance, products, and attitudes. A learner develops several intellectual and behavioral skills, and an evaluation can uncover what changes have been brought in the attitude and behavior of the learners.

Results

With every instructional product, evaluating results is the most significant task by an evaluator, and is done to determine how closely one has been able to achieve success in the implementation of the program. An evaluator conducts an evaluation in order to test the effectiveness of the instruction to create the desired learning outcome (Morrison et al., 2019). Morrison et al. (2019) suggested evaluators measure the efficiency of learning by comparing the skills mastered with the time taken; cost of program development; continuing expenses; reactions towards the program; and long-term benefits of the program.

When Do We Evaluate?

Three commonly used types of evaluation for instruction are formative, summative, and confirmative (Morrison et al., 2019; Ross & Morrison, 2010). Formative evaluation is conducted during the design process to provide feedback that informs the design process. Summative evaluation is conducted at the end of the design process to determine if the instructional product achieves the intended outcomes. Confirmative evaluation is conducted over time to determine the lasting effects of instruction. Each of these stages of evaluation is examined in detail here, both through the definition of the form itself and through a discussion of some of the key tools within each.

“When the cook tastes the soup that’s formative; when the guests taste the soup, that’s summative.” – Robert E. Stake (M. Scriven, 1991, p. 169)

Formative

Formative evaluation occurs during instructional design. It is the process of evaluating instruction and instructional materials to obtain feedback that in turn drives revisions to make instruction more efficient and effective. One way to think about this is to liken it to a chef tasting his food before he sends it out to the customer. Morrison et al. (2019) explained that the formative evaluation process utilizes data from media, instruction, and learner engagement to formulate a picture of learning from which the designer can make changes to the product before the final implementation.

Boston (2002, p. 2) stated the purpose of formative evaluation as “all activities that teachers and students undertake to get information that can be used diagnostically to alter teaching and learning.” Formative evaluation results in the improvement of instructional processes for the betterment of the learner. While making formative changes are best conducted during earlier stages of the design process, these changes may come later if the situation dictates it. According to Morrison et al., (2019), when summative and confirmative evaluations demonstrate undesirable effects, then the results may be used as a formative evaluation tool to make improvements.

Instructional designers should consider a variety of data sources to create a full picture of the effectiveness of their design. Morrison et al. (2019) proposed that connoisseur-based, decision-oriented, objective-based, and constructivist evaluations are each appropriate methodologies within the formative process. More recently Patton (2016) introduced developmental evaluation which introduces innovation and adaptation in dynamic environments.

Types of Formative Evaluation

Connoisseur-Based

Employs subject matter experts (SMEs) in the review of performance objectives, instruction, and assessments to verify learning, instructional analysis, context accuracy, material appropriateness, test item validity, and sequencing. Each of these items allow the designer to improve the organization and flow of instruction, accuracy of content, readability of materials, instructional practices, and total effectiveness (Morrison et al., 2019).

Decision-Oriented

Questions asked may develop out of the professional knowledge of an instructional designer or design team. These questions subsequently require the designer to develop further tools to assess the question, and as such should be completed at a time when change is still an option and financially prudent (Morrison et al., 2019).

Objective-Based

Through an examination of the goals of a course of instruction, the success of a learner's performance may be analyzed.

Constructivist

Takes into account the skills students learned during the learning process as well as how they have assimilated what is learned into their real lives.

Developmental

Responsive to context and more agile, allowing for quicker response and support of innovative designs (Patton, 2011).

Summative

Dick et al. (2015, p. 320) claimed the ultimate summative evaluation question is “Did it solve the problem?" That is the essence of summative evaluation. Continuing with the chef analogy from above, one asks, “Did the customer enjoy the food?" (M. Scriven, 1991). The parties involved in the evaluation take the data and draw a conclusion about the effectiveness of the designed instruction. However, over time, summative evaluation has developed into a process that is more complex than the initial question may let on. In modern instructional design, practitioners investigate multiple questions through assessment to determine learning effectiveness, learning efficiency, and cost effectiveness, as well as attitudes and reactions to learning (Morrison et al., 2019).

Learning Effectiveness

Learning effectiveness can be evaluated in many ways. Here we are trying to understand:

- How well did the student learn?
- Are the students motivated to change behavior?
- Did we engage the intended population of learners?
- Even, did we teach the learner the right thing?

Measurement of learning effectiveness can be ascertained from assessments, ratings of projects and performance, observations of learners’ behavior, end of course surveys, focus groups, and interviews. Dick et al. (2015) outlined a comprehensive plan for summative evaluation throughout the design process, including collecting data from SMEs and during field trials for feedback.

Learning Efficiency and Cost-Effectiveness

While learning efficiency and cost-effectiveness of instruction are certainly distinct constructs, the successfulness of the former impacts the latter. Learning efficiency is a matter of resources (e.g., time, instructors, facilities, etc.), and how those resources are used within the instruction to reach the goal of successful instruction (Morrison et al., 2019). Dick et al. (2015) recommended comparing the materials against an organization's needs, target group, and resources. The result is the analysis of the data to make a final conclusion about the cost effectiveness based on any number of prescribed formulas.

Attitudes and Reactions to Learning

The attitudes and reactions to the learning, while integral to formative evaluation, can be summatively evaluated as well. Morrison et al. (2019) explained there are two uses for attitudinal evaluation: evaluating the instruction and evaluating outcomes within the learning. While most objectives within learning are cognitive, psychomotor and affective objectives may also be goals of learning. Summative evaluations often center on measuring achievement of objectives. As a result, there is a natural connection between attitudes and the assessment of affective objectives. Conversely, designers may utilize summative assessments that collect data on the final versions of their learning product. This summative assessment measures the reactions to the learning.

Confirmative

The purpose of a confirmative evaluation is to determine if instruction is effective and if it met the organization's defined instructional needs. In effect, did it solve the problem? The customer ate the food and enjoyed it. But, did they come back? Confirmative evaluation goes beyond the scope of formative and summative evaluation and looks at whether the long-term effects of instruction is what the organization was hoping to achieve. Is instruction affecting behavior or providing learners with the skills needed as determined by the original goals of the instruction? Confirmative evaluation methods may not differ much from formative and summative outside of the fact that it occurs after implementation of a design. Moseley and Solomon (1997) described confirmative evaluation as maintaining focus on what is important to your stakeholders and ensuring the expectations for learning continue to be met.

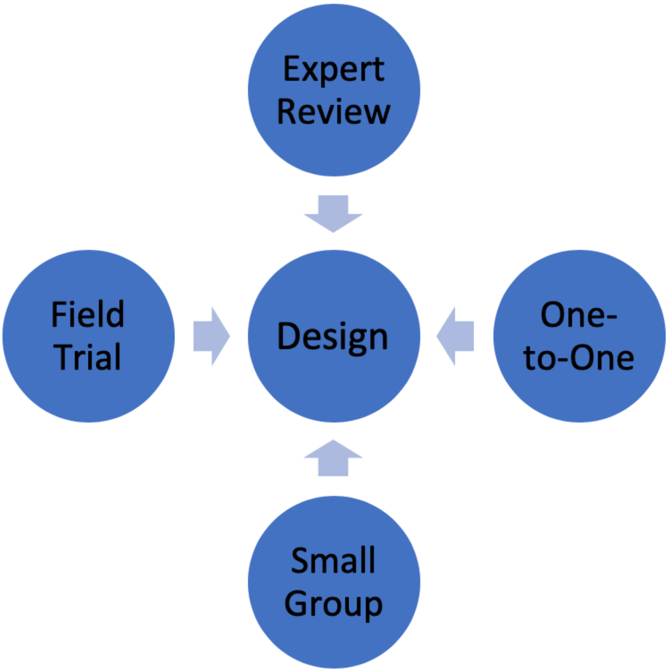
How Do We Evaluate?

Formative Evaluation

Formative evaluation is an iterative process that requires the involvement of instructional designers, subject matter experts, learners, and instructors. Tessmer (2013) identified four stages of formative evaluation including expert review, one-to-one, small group, and field test evaluation. Results from each phase of evaluation are fed back to the instructional designers to be used in the process of improving design. In all stages of evaluation, it is important that learners are selected that will closely match the characteristics of the target learner population.

Figure 3

The Cycle of Formative Evaluation

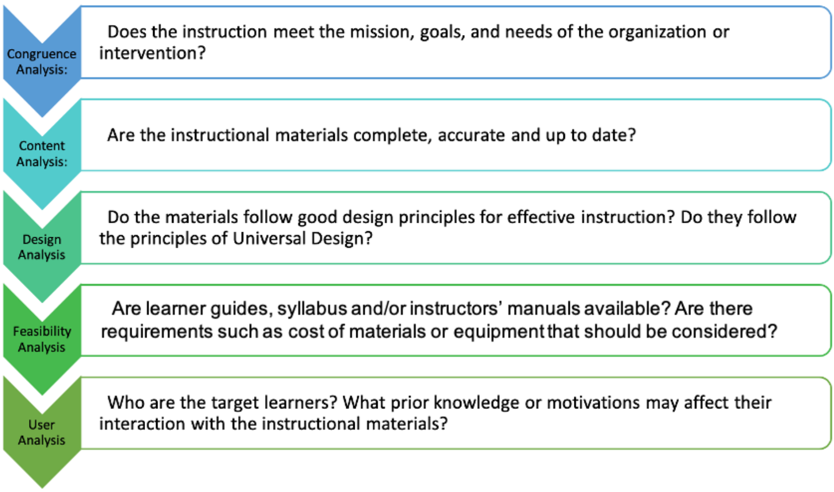


Expert Review

The purpose of the expert review is to identify and remove the most obvious errors and to obtain feedback on the effectiveness of the instruction. The expert judgment phase can include congruence analysis, content analysis, design analysis, feasibility analysis, and user analysis. Results from expert review can be used to improve instructional components and materials before a pilot implementation. This phase is conducted with the instructional designer, the subject matter experts, and often an external reviewer. Target learners are not involved in this stage of evaluation.

Figure 4

The Expert Judgment Phase (Dick et al., 2015)



One-to-One

The one-to-one evaluation is much like a usability study. During this evaluation, IDs should be looking for clarity, impact, and feasibility (Dick et al., 2015, p. 262; Earnshaw, Tawfik, & Schmidt, 2017). The learner is presented with the instructional materials that will be provided during the instruction. The evaluator should encourage the learner to discuss what they see, write on materials as appropriate, and note any errors. The ID can engage the learner in dialog to solicit feedback on the materials and clarity of instruction. There are many technological tools that can facilitate a one-on-one evaluation. The principles of Human Computer Interaction and User Center Design can inform the instructional design review (Earnshaw et al., 2017). In *Don't Make Me Think*, Krug (2014) described a process of performing a usability study for website development. The steps he provided are a good guide for performing a one-to-one evaluation. Krug recommended video recording the session for later analysis. If instruction is computer based, there are tools available that can record the learner interaction as well as the learner's responses.

Morae from Techsmith (https://edtechbooks.org/-oPnH) is a tool that allows you to record user interactions and efficiently analyze the results.

Small Group

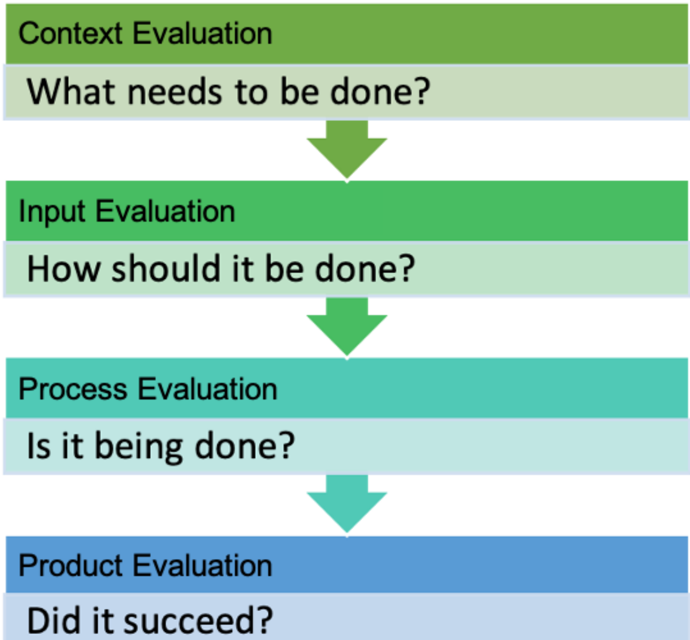
Small group evaluation is used to determine the effectiveness of changes made to the instruction following the one-to-one evaluation and to identify any additional problems learners may be experiencing. The focus is on consideration of whether learners can use the instruction without interaction from the instructor. In a small group evaluation, the instructor administers the instruction and materials in the way they are designed. The small-group participants complete the lesson(s) as described. The instructional designer observes but does not intervene. After the instructional lesson is complete, participants should be asked to complete a post-assessment designed to provide feedback about the instruction.

Field Trial

After the recommendations from the small group evaluation have been implemented, it is time for a field trial. The selected instruction should be delivered as close as possible to the way the design is meant to be implemented in the final instructional setting, and instruction should occur in a setting as close to the targeted setting as possible. Learners should be selected that closely match the characteristics of the intended learners. All instructional materials for the selected instructional section, including the instructor manual, should be complete and ready to use. Data should be gathered on learner performance and attitudes, time required to use the materials in the instructional context, and the effectiveness of the instructional management plan. During the field trial the ID does not participate in delivery of instruction. The ID and the review team will observe the process and record data about their observations.

Figure 5

Field Trial



Summative Evaluation

The purpose of a summative evaluation is to evaluate instruction and/or instructional materials after they are finalized. It is conducted during or immediately after implementation. This evaluation can be used to document the strengths and weaknesses in instruction or instructional materials, to decide whether to continue instruction, or whether to adopt instruction. External evaluators for decision makers often conduct or participate in summative evaluation. Subject matter experts may be needed to ensure integrity of the instruction and/or instructional materials. There are several models we can consider for summative evaluation including the CIPP Model, Stake's Model, and

Scriven’s Model.

CIPP Model

The CIPP evaluation model by Stufflebeam (1971) describes a framework for proactive evaluation to serve decision making and retroactive evaluation to serve accountability. The model defines evaluation as the process of delineating, obtaining, and providing useful information for judging decision alternatives. It includes four kinds of evaluation: context, input, process, and product. The first letters of the names of these four kinds of evaluation gave the acronym - CIPP. The model provides guidelines for how the steps in evaluation process interact with these different kinds of evaluation.

The CIPP Model of Evaluation by Mallory Buzun-Miller

[Watch on YouTube https://edtechbooks.org/-rTn](https://edtechbooks.org/-rTn)

Stake’s Model

Stake in 1969 created an evaluation framework to assist an evaluator in collecting, organizing, and interpreting data for the two major operations of evaluation (Stake, 1967; Wood, 2001). These include (a) complete description and (b) judgment of the program. W. J. Popham (1993) defined that Stake's schemes draw attention towards the differences between the descriptive and judgmental acts according to their phase in an educational program, and these phases can be antecedent, transaction, and outcome. This is a comprehensive model for an evaluator to completely think through the procedures of an evaluation.

Dr. Robert Stake by Education at Illinois

Watch on YouTube https://edtechbooks.org/-UpSY

Scriven's Goal-Free Model

Scriven provides a transdisciplinary model of evaluation in which one draws from an objectivist view of evaluation (Michael Scriven, 1991a, 1991b). Scriven defined three characteristics to this model: epistemological, political, and disciplinary. Some of the important features of Scriven's goal free evaluation stress on validity, reliability, objectivity/credibility, importance/timeliness, relevance, scope, and efficiency in the whole process of teaching and learning. Youker (2013) expanded on the model to create general principles for guiding the goal-free evaluator. Younker proposed the following principles:

1. Identify relevant effects to examine without referencing goals and objectives.
2. Identify what occurred without the prompting of goals and objectives.
3. Determine if what occurred can logically be attributed to the program or intervention.
4. Determine the degree to which the effects are positive, negative, or neutral.

The main purpose of the goal-free evaluation is to determine what change has occurred that can be attributed to the instructional program. By conducting the evaluation without prior knowledge of learning outcomes or goals, the evaluator serves as a check to see if the program produced the outcome desired by the instructional designer(s).

The Past, Present, and Future of Evaluation: Possible Roles for the University of Melbourne, by The University of Melbourne

Watch on YouTube https://edtechbooks.org/-ycH

Confirmative Evaluation

The focus of confirmative evaluation should be on the transfer of knowledge or skill into a long-term context. To conduct a confirmative evaluation, you may want to use observations with verification by expert review. You may also develop or use checklists, interviews, observations, rating scales, assessments, and a review of organizational productivity data. Confirmative evaluation should be conducted on a regular basis. The interval of evaluation should be based on the needs of the organization and the instructional context.

Conclusion

Evaluation is the process of determining whether the designed instruction meets its intended goals. In addition, evaluation helps us to determine whether learners can transfer the skills and knowledge learned back into long-term changes in behavior and skills required for the target context. Evaluation provides the opportunity for instructional designers to ensure all stakeholders agree that the developed instruction is meeting the organizational goals.

In this chapter we reviewed what evaluation looks like and its relationship within the instructional design process. We looked at several models of evaluation including Kirkpatrick's Model and the four levels of evaluation: Evaluating Reaction, Evaluating Learning, Evaluating Behavior, and Evaluating Results. We also looked at the three phases of evaluation including formative, summative, and confirmative evaluation, and introduced several different models and methods for conducting evaluation from many leading evaluation scholars.

Discussion

- Where does evaluation stand in the instructional design model? How will your flow chart look when you describe evaluation in relation to the other stages of instructional design?
- Describe the three stages of evaluation. Give an example to explain how an instructional designer will use these three stages in a specific case of a learning product.
- Which are the five types of formative evaluation methods mentioned in the chapter that assist in collecting data points for the initial evaluation? Which two of these methods will be your preferred choice for your formative evaluation and why?
- What will be the parameters to evaluate the success of the instructional training?
- What are some of the techniques to conduct formative and summative evaluation?
- Several models of evaluation have been discussed in the chapter. Discuss any two of these models in detail and explain how you will apply these models in your evaluation process.

Application Exercises

For the following exercises, you may use an instructional module that you are familiar with from early childhood, k-12, higher ed, career and technical, corporate, or other implementation where instructional design is needed. Be creative and use something from an educational setting that you are interested in. Be sure to describe your selected instructional module as it relates to each of these exercises. You may need to do some additional online research to answer these questions. Be sure to include your references in your responses.

1. Describe how you would conduct the three phases of the formative evaluation. Define your strategies, populations, and methodologies for each stage within the process.
2. Draw a diagram of the iterative formative evaluation process. What specific pieces of the instructional intervention are considered within each stage of the process? How is the data gathered during this process employed to improve the design of instruction?
3. Describe the context and learner selection process you would use for setting up a formative evaluation field trial. What special considerations need to be made to conduct this stage of evaluation effectively?
4. What materials should the designer include in a field trial? How do the materials used for field trials contrast with the one-to-one and small group evaluations?

You have been asked to serve as an external evaluator on a summative evaluation of a training model designed by one of your colleagues. Explain the phases of the summative evaluation that you may be asked to participate in as an external reviewer. Imagine you have created a rubric to help you evaluate the instructional intervention. What items might that rubric contain to help you effectively and efficiently conduct a review?

Group Assignment

Conduct an evaluation study to understand how successful an instructional intervention has been in achieving the goals of the designed instruction. Keep in mind the group project conducted in the previous development and implementation chapters and conduct an evaluation study to assess the success of achieving the goals and objectives of the instruction. To achieve these goals, you should conduct several rounds of evaluation:

- Conduct a one-on-one evaluation with a student from the target population. Make observations of the student’s actions within the instruction and reactions to the materials, content, and overall design. Propose changes to the instructional intervention based on the sample student’s feedback.
- Conduct a small group evaluation with a group of 3 to 5 learners. This evaluation should reflect the changes you made after the one-to-one stage and evaluate nearly operational materials and instruction. You must recruit an instructor to deliver instruction. Make observations and have the instructor administer a summative assessment after instruction. Analyze the data gathered and create a one-page report on the results.
- Implement a field test with an instructor and a student population of at least 15 people. Instructional materials, including the instructor manual, should be complete and ready to use. Gather data on learner performance and attitudes, as well as time required for instruction and the effectiveness of the instructional management plan. Observe the process and record data, and create a final report detailing the full evaluation cycle.

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12

Continuous Improvement of Instructional Materials

David Wiley, Ross Strader, & Robert Bodily

From time to time new technologies provide us with a qualitatively different ability to engage in previously possible activities. For example, 20 years ago it was already possible to publish an essay online. You simply used the command line program Telnet to login to a remote server, navigated into the directory from which your webserver made html files available to the public, launched the pico editor from the command line, wrote your essay, and manually added all the necessary html tags. Today, open source blogging software like Wordpress makes publishing an essay online as easy as using a word processor. Yes, it was possible to publish essays online before, but the modern experience is qualitatively different.

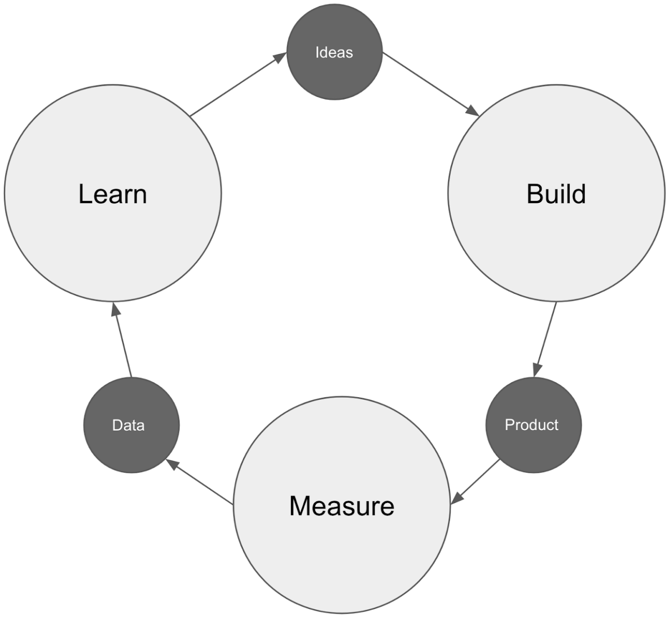
"Evaluate" is the final step in the traditional ADDIE meta-model of instructional design, and it has always been possible—if, at times, expensive and difficult—to evaluate the effectiveness of instructional materials. Modern technology has made the process of measuring the effectiveness of instructional materials a qualitatively different experience. Gathering data in the online context is orders of magnitude less expensive than gathering data in classrooms, and open source analysis tools have greatly simplified the process of analyzing these data.

Historically, any needed improvements discovered during the evaluation process would take a significant amount of time to reach learners, as they could only be accessed once new editions of a book were printed or new DVDs were pressed. Again, modern technology makes the delivery of improvements a qualitatively different exercise. When instructional materials are delivered online, instructional designers can engage in continuous delivery practices, where improvements are made available to learners immediately, as often as multiple times per day.

The modern approach to continuous improvement designed for use in the context of online services described by Ries (2011), called the "build - measure - learn cycle," is illustrated in Figure 1.

Figure 1

The Build - Measure - Learn Cycle



In this chapter we adapt the build - measure - learn cycle for use by instructional designers who want to engage in continuous improvement. Because our focus is on the improvement of instructional materials, our discussion below does not include a discussion of the creation of the first version of the materials. (The first version of the materials could be open educational resources created by someone else or a first version that you created previously.)

The chapter will proceed as follows:

- Conceptual Framework: We argue that all instructional materials are hypotheses, or our best guesses, informed by research, about what instructional design approach will support

student learning in a specific context. Thinking this way will naturally lead us to collect and analyze data to test the effectiveness of our instructional materials.
- Build: We describe the implications of designing for data collection, together with the instrumentation and tooling that must be built in order to collect the data necessary for continuous improvement.
- Measure: We describe the process of analyzing data in order to identify portions of the instructional materials that are not effectively supporting student learning.
- Learn: We discuss methods to use when reviewing less effective portions of the instructional materials and deciding what improvements to make before beginning the cycle again.
- Technical Note: We briefly pause to discuss the role of copyright, licensing, and file formats in continuous improvement.
- Worked Example: We demonstrate one trip through the cycle with a worked example.
- Conclusion: We end with some thoughts about the imperative implied for instructional designers by the existence and relative ease of use of continuous improvement approaches like the build - measure - learn cycle.

Conceptual Framework

Instructional Materials Are Hypotheses

People who design instructional materials (who we will refer to as instructional designers throughout) make hundreds of decisions about how to best support student learning. Each decision is a hypothesis of the form “in the context of these learners and this topic, applying this instructional design approach in this manner will maximize students’ likelihood of learning.” The ways in which these individual decisions are interwoven together creates a network of hypotheses about how best to support student learning.

Hypotheses Need to Be Tested

It reveals a fatal lack of curiosity for an instructional designer to simply say "these materials were designed in accordance with current research on learning" without following through to measure their actual effectiveness with actual learners in the actual world. While designing instructional materials in accordance with research is a positive first step, to our minds the most important measure of the quality of instructional materials is the degree to which they actually support student learning. Questions of whether or not the materials are informed by research, are finished on schedule and on budget, are stunningly beautiful, render correctly on a mobile device, or were authored by a famous academic become meaningless if students who use the materials do not learn what the designers intended.

Initial Hypotheses Are Seldom Correct

Hypotheses need to be refined in an ongoing cycle of improvement. Data collected during student use of content and from assessments of learning can be used to identify specific portions of the instructional materials (i.e., specific instructional design hypotheses) that are not successfully supporting student learning. Once these underperforming designs (hypotheses) are identified, they can be redesigned, improved, and incorporated into a new version of the instructional materials. The updated collection of instructional design hypotheses can then be deployed for student use, and the cycle of continuous improvement can begin again.

Build: Designing for Data, Instrumentation, and Tools for Data Collection

In order to be able to engage in continuous improvement, instructional materials must be designed for data collection. There must be a unifying design framework that will allow data from a wide range of sources to be aggregated meaningfully. The method we will describe throughout this chapter organizes instructional materials around a network of learning outcomes. In this method of designing for data collection, all instructional materials (e.g., readings, simulations, videos, practice opportunities) are aligned with one or more learning outcomes. All forms of assessment, both formative or summative, are also aligned with one or more learning outcomes (this alignment must be done at the individual assessment item level.)

Once instructional materials have been designed for data collection, tools and instrumentation must be created so that the data can actually be collected and managed. The system that mediates student use of the instructional materials (e.g., a learning management system) must be capable of (a) expressing the relationships between learning outcomes, instructional materials, and assessments, (b) capturing data about student engagement with these instructional materials, and (c) capturing item-level data about student engagement with, and performance on, assessments. The data collected by the system should be able to answer questions such as, for any given learning outcome, what instructional materials in the system are aligned with that outcome? (If instructional activities are "aligned with" a learning outcome, student engagement with the instructional activities should support mastery of the outcome.) For any given learning outcome, what assessment items in the system are aligned with that outcome? (If assessments are "aligned with" a learning outcome, student success on these assessments should provide evidence that they have mastered the outcome).

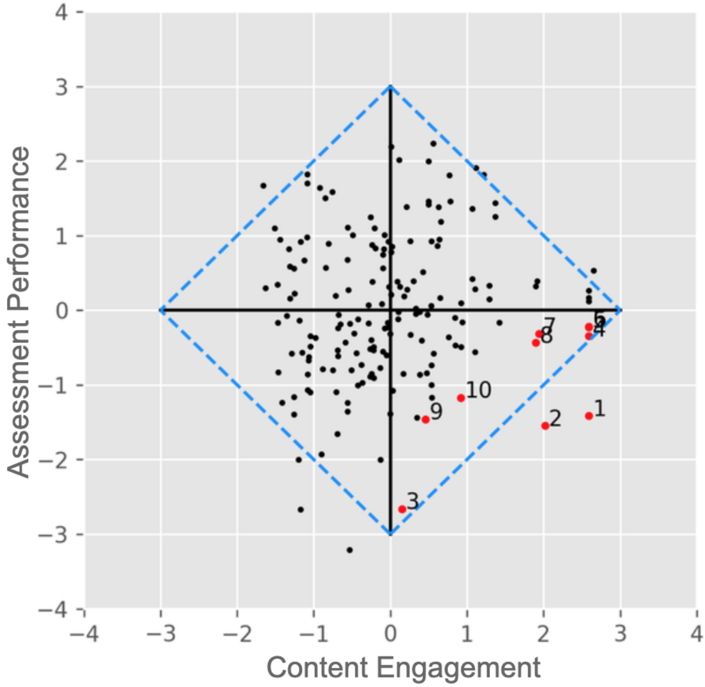
Measure: Using RISE Analysis to Identify Less Effective Learning Materials

As described in Bodily, Nyland, and Wiley (2017), activity engagement data and assessment performance data can be analyzed together to identify learning outcomes whose aligned instructional materials are not sufficiently supporting student mastery (as demonstrated by performance on aligned assessments). The purpose of Resource Inspection, Selection, and Enhancement (RISE) analysis is to identify learning outcomes where students were highly engaged with aligned instructional materials, but simultaneously performed poorly on aligned assessments.

Each point in Figure 2 represents a learning outcome. The x-axis is engagement with instructional materials and the y-axis is assessment performance, both converted to z-scores. The bottom-right quadrant (high engagement, low performance) indicates which outcomes should be targeted for improvement and are numbered to indicate the order in which they should be addressed.

Figure 2

A RISE Analysis Plot



An open source software implementation of RISE analysis is described in Wiley (2018). This greatly simplifies the process of running RISE analyses, as long as appropriate data on learning outcome names, content engagement, and assessment performance are available.

Learn: Understanding Why Learning Outcomes End up in the Bottom Right Quadrant

Once learning outcomes are identified as being in the bottom right quadrant of a RISE analysis plot, the cause of the problem can be isolated. For brevity, we will refer to learning outcomes in the bottom right quadrant of a RISE analysis plot as "underperforming learning outcomes” below. The root of the problem can generally be identified in two steps.

The first step in isolating the problem with an underperforming learning outcome is evaluating assessments aligned with each learning outcome. Are the assessments accurately measuring student learning? Questions to ask at this stage include: are there technical problems with the assessment? Are items miskeyed? Are other sources of spurious or construct-irrelevant difficulty present? Are measures of reliability, validity, or discrimination unacceptably low? If the answer to any of these questions is yes, improvements should be made to problematic assessments, after which the instructional designer can stop working on this learning outcome and move onto the next. There is likely no need to make improvements to instructional materials aligned with this learning outcome.

If the aligned assessments are functioning as intended, the instructional designer can move on to the second step—reviewing the instructional materials to determine why they aren’t sufficiently supporting student learning. This process is highly subjective and brings the full expertise of the instructional designer to bear. The instructional designer reviews the instructional materials aligned with the learning outcome and asks questions about why students might be struggling here. For example:

- Is there a mismatch between the type of information being taught and the instructional design approach originally selected? For example, if students are learning a classification task, are examples and non-examples provided without a specific discussion of the critical attributes that separate instances from non-instances?
- Is there a mismatch in Bloom’s Taxonomy level between the learning outcome, the instructional materials, and the assessment? (For example, are the learning outcome and instructional materials primarily the *Remember* level, while the

assessments require students to *Apply*?)
- Have the instructional materials failed to provide learners with an opportunity to practice in a no/low-stakes setting and receive feedback on the current state of their understanding?

We cannot list every question an instructional designer might ask, but we hope these examples are illustrative. Talking with students can also be incredibly helpful at this stage. These conversations are an effective way for the instructional designer to zero in on root causes of students' misunderstandings.

Once the instructional designer believes they have identified the problems (i.e., they have a new hypothesis about how to better support student learning), new or existing instructional materials and assessments can be created, adapted, or modified. Students can also be powerful partners and collaborators in creating improvements to the instructional materials (e.g., OER-enabled pedagogy as described by Wiley and Hilton (2018)).

When this (Build) process is completed, the new or improved materials can be released to students immediately. Once students are using the new version of the materials, this use will result in the creation of new data which the instructional designer can examine using RISE analysis (Measure). These analyses support the instructional designer in forming new hypotheses about why students aren't succeeding (Learn). When this continuous improvement process is followed, instructional materials should become more effective at supporting student learning with each trip through the cycle.

Technical Note: The Role of Copyright and File Formats

Before adaptations or modifications can be made, instructional designers must have legal permission to make changes to the instructional materials. Because copyright prohibits the creation of derivative works that are often the result of the improvement of instructional materials, one of two conditions must hold. In the first condition, the instructional designer (or their employer) must hold the copyright to the instructional materials, making the creation and distribution of improved versions legal. In the second condition, the instructional materials must be licensed under an open license (like a Creative Commons license) that grants the instructional designer permission to create derivative works (aka improved versions of the instructional materials).

Legal permission to create derivative works can be rendered ineffective if the instructional materials are not available in a technical format amenable to editing (e.g., HTML). ALMS analysis as described in Hilton, Wiley, Stein, and Johnson (2010) includes four factors to consider regarding the "improvability" of instructional materials. The first factor is *Access to editing tools*—is the software needed to make changes commonly available (e.g., MS Word) or obscure (e.g., Blender)? The second factor is the *Level of expertise required* to make changes—is the content easy to change (e.g., Powerpoint) or difficult to change (e.g., an interactive simulation written in Javascript)? The third factor is whether or not the instructional materials are *Meaningfully editable*—is the document a scanned image of handwritten notes (this text is not easily editable) or an HTML file (easily editable)? The final factor is *Source file access*—is the file format preferred for using the resource also the format preferred for editing the resource (e.g., an HTML file) or are the preferred formats preferred for using and editing the files different (e.g., PSD versus JPG)?

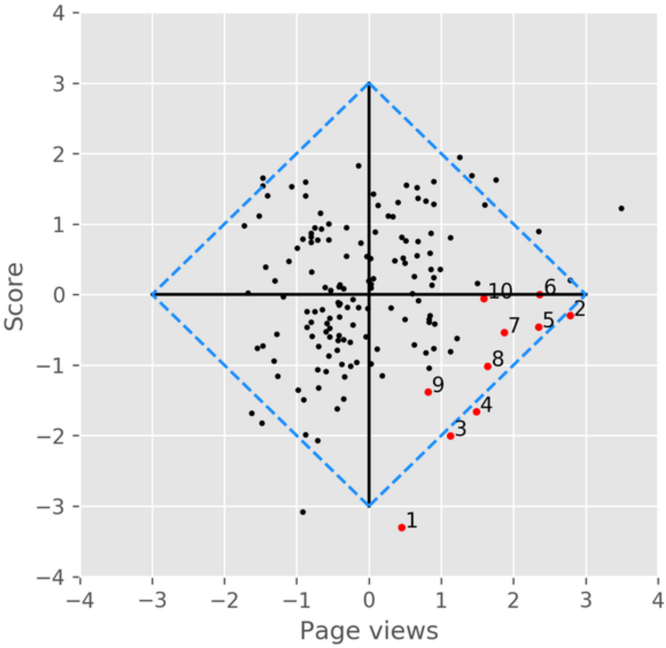
If the instructional materials you are working with do not belong to you or your employer, are not openly licensed, or are available only in file formats that are not conducive to adaptation and modification, you may not be able to engage in continuous improvement.

A Worked Example

Lumen Learning, a company that offers instructional materials for college classes that can be adopted in place of traditional textbooks, offers a Biology for Non-majors course in its Waymaker platform. This platform allows instructional designers to enter learning outcomes and align all instructional materials and assessment items with the learning outcomes. A RISE analysis was conducted using the content engagement data and assessment performance data for all students who took the Biology for Non-majors course during a semester. Among the top 10 underperforming learning outcomes it identified, the RISE analysis revealed that students were performing poorly on assessments aligned with the learning outcome “compare inductive reasoning with deductive reasoning” despite the fact that students were engaging with the aligned instructional materials at an above average rate (see outcome 1 in Figure 3 below). This learning outcome was selected for continuous improvement work.

Figure 3

Biology for Non-Majors RISE Analysis Plot



A review of the aligned assessment items by an instructional designer revealed that the items appeared to be keyed correctly and free from other problems. Following this review of the aligned assessments, the instructional designer reviewed the aligned instructional materials guided by the question, "why are students who use these instructional materials not mastering the outcome?" The analysis revealed that the instructional materials for this outcome were comprised of two paragraphs of text content, each of which defined one of the terms. No other instructional materials were provided in support of mastery of this learning outcome and students appeared to be unable to remember which of these similar sounding terms was which.

The instructional designer decided to make minor edits to the existing paragraphs to improve their clarity and also to create an online interactive practice activity (Koedinger et al., 2017) in support of this learning outcome. This activity provided students with mnemonic tools to help them remember which term is which, and combined these mnemonics with practice exercises in which students classify examples as either inductive or deductive and receive immediate, targeted feedback on their performance. The online interactive practice activitity can be viewed in context at https://edtechbooks.org/-QwUE.

These new and updated instructional materials are now integrated into the existing materials and are being used by faculty and students across the United States. After another semester is over, the RISE analysis will be rerun. This new analysis will either confirm that the improvements to the instructional materials have improved student learning, in which case other underperforming learning outcomes will be selected for continuous improvement, or they will confirm that there is still work to do to better support student learning of this outcome.

Conclusion

Modern technologies, including the internet and open source software, have radically decreased the cost and difficulty of collecting and analyzing learning data. Where evaluation alone was once prohibitively difficult and expensive, today the entire continuous improvement process is within reach of those who design instructional materials for use in online classes and other technology-mediated teaching and learning settings. While Ries (2011) described the build - measure - learn cycle as a way to rapidly increase a company’s revenue, we see a clear analog in which similar approaches can be used to rapidly increase student learning. We now live in a world where it is completely reasonable to expect instructional materials to be more effective at supporting student learning each and every term.

We invite the reader to help us make this possible state of affairs the actual state of affairs by engaging in continuous improvement activities in their own instructional design practice. And in the spirit of continuous improvement, we further invite the reader to join us in developing and refining the processes described in this chapter—in part by completing the survey at the end of this chapter and providing us feedback on how the chapter can be improved.

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Part II

Instructional Design Knowledge

13

Learning Theories

Beth Oyarzun & Sheri Conklin

Learning theories are the foundation for designing instructional solutions to achieve desired learning outcomes. Analogies can assist in understanding new concepts, so imagine that you have purchased a new home and are considering the best options for furniture placement in the living room. Your desired outcome is a furniture arrangement that is aesthetically pleasing yet also functional. Many factors can play into the decision depending on how you view the problem, and there can also be more than one solution that meets the desired outcomes.

Similarly, theories and models provide a foundation and framework for any instructional design project. Theories serve as lenses to view the problem from different perspectives, much like interior design styles and preferences may affect decisions about which furniture to purchase for your new home based on your overall aesthetic. Models then provide guidance about how to build the solution or where to place the furniture in the home. Depending on the theory and model used, the solution might look different, much like a living room would look very different using modern vs. western-style decor with various arrangements. However, the desired outcomes can still be achieved. It is essential to conduct a thorough analysis to ensure the theory and/or selected strategy will support the desired outcomes and the targeted learners.

Learning theories help instructional designers understand how people retain and recall information and stay motivated and engaged in learning. There are three main families of learning theories and an emerging fourth: behaviorism, cognitivism, constructivism, and connectivism. Referring back to the house analogy, these could be different decorative styles (lenses) used to view a room in the house or to view an instructional problem and how to address it. Much like decorative styles have evolved and changed over time, so have learning theories. This chapter will define the four main families of learning and then explore some additional social and motivational learning theories that have derived from some of the families of learning.

Behaviorism

Behaviorism grew from the work of many psychologists in the early 20th Century, such as Watson (1913), Thorndike (1898), and Skinner (1953), who hypothesized that learning occurs through interaction with the environment. Hence, observable behaviors resulting from a response to a stimulus followed by a reward or punishment based on the behavior is how a behaviorist would condition learners to elicit the desired outcome. Conversely, if the stimulus is removed, then the behavior will stop over time. This phenomenon is called extinction.

This type of behavior modification can be considered conditioning. Two types of conditioning were defined by Pavlov (1960) and Skinner (1953): classical and operant respectively. An example of classical conditioning is Pavlov’s dog in which he trained the dog to salivate with a bell ringing by providing food every time a bell rang. Extinction occurred when the food was not delivered when the bell rang over time. Operant conditioning relies on positive and negative consequences occurring to shape behavior. This method is focused on changing the learner's external behavior using stimuli (an event that evokes a specific functional reaction) with positive and negative reinforcement. Reinforcements (positive or negative) are environmental responses that increase the probability of a behavior being repeated. Punishment, on the other hand, decreases the likelihood of a behavior being repeated, yet weakens the behavior. As an illustration, a simple way to shape student behavior is to provide feedback on learner performance. Through positive feedback (e.g., praise, compliments, encouragement), students are reinforced on learning a new behavior. Over time, as the performance improves, the feedback occurs less frequently until only exceptional outcomes are reinforced. Over time the behavior changes given the response to or removal of the stimulus. In the elementary school environment, operant conditioning methods are often used for behavior modification. Behavior charts in which learners earn stickers for displaying good behavior and have stickers removed for displaying bad behavior during the week is an example. A reward or punishment is delivered at the end of the week based upon the number of stars accumulated or removed. The rewards for learners might be a class party, or the punishment might be taking away privileges.

Behaviorist theory informs key aspects of the instructional design process such as the task analysis. The task analysis involves identifying observable behaviors or steps learners need to take to achieve the desired learning outcome. A designer often observes learners from various expertise levels completing the task to create a thorough task analysis to inform the design of instruction. Behaviorism has been criticized due to the emphasis on external behaviors only, which led to the development of a new learning theory in the mid-1900s.

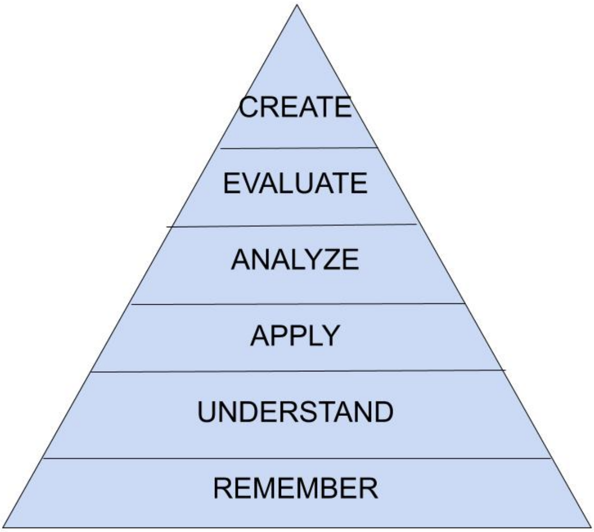
Cognitivism

A contrast to the external nature of behaviorism is the internal natured cognitivism learning theory. Cognitivism focuses on how the brain internally processes, retains, and recalls information based upon how the learner organizes information into existing knowledge schemas. Schemas are structures of existing information in the learner's mind. To ensure new information is retained for recall, instruction can be designed to enhance the probability that the new information will be added to the learner's existing schema. For instance, if the desired learning outcome is to explain the water cycle, then the instructor may use questions to have learners recall information in their existing schemas about water and weather by having them tell stories about storms, clouds, lakes, and oceans. Once they have activated those schemas, the instructor could then relate the new information about the water cycle to the stories they told, in order to help learners integrate this new information into their existing knowledge about water.

A common tool used by cognitivist learning theorists are taxonomies of learning outcomes that specify what mental processes are relied upon for various types of learning. Perhaps one of the more well-known and used taxonomies is Bloom's taxonomy (1956), which was later revised (Anderson & Krathwohl, 2001). The revised taxonomy has six levels: remember, understand, apply, analyze, evaluate, and create (see Figure 1). Using this taxonomy to identify the level of desired learning can assist in writing learning objectives, selecting appropriate instructional methods, and designing assessments to increase the probability that the desired learning outcome is achieved. The taxonomy relies on the use of action verbs to ensure learning outcomes are measurable. Many resources such as this one from the University of Nebraska-Lincoln provide a variety of verbs to use for each level of the taxonomy (Anderson & Krathwohl, 2001, available at https://edtechbooks.org/-nhUI).

Figure 1

Bloom's Revised Taxonomy



For example, if the desired learning outcome were for a student to solve a simple algebraic equation, that would fall under the application level of Bloom's revised taxonomy because the learners will apply previously learned concepts to solve the problem. The instructor may use the suggested verbs (eLearning Heroes, 2020, available at https://edtechbooks.org/-Ftt) to write a clear instructional objective such as "given an algebraic equation, the learner will solve the equation by selecting the appropriate method, showing work, and checking the solution." Next, the instructor would design assessment items that measure the attainment of that objective. In this case several equations would serve as assessment items (i.e. x + 5 = 7, x - 8 = 12, 7 + x = 9). Lastly, the instructional methods would be designed to align with the objective and assessment. Here, presenting examples with and without manipulatives, and practice problems with and without manipulatives, would be appropriate.

Cognitivism also brought about the shift from learning theory to instructional theory, which focused on the design of instruction instead of how learners process information or learners' behavior. This is an important shift that provided the foundation for the instructional design field. In 1971, a revolutionary project entitled TICCIT, an acronym for Time-shared, Interactive, Computer-Controlled Information/Instructional Television, was funded by the National Science Foundation and MIT research corporation to test computer-assisted delivery of instruction using a cognitive approach. This project produced learner-controlled instruction that was adaptive to learner choices (Gibbons & O’Neil, 2014). Other projects followed that similarly sought to apply new cognitive theories to emerging educational technologies, leading to the explosion of computer-assisted instruction applications.

Constructivism

Cognitivism added a new perspective based upon research of brain functionality during the learning process. However, another learning theory gained attention in the mid-1990s, which combined learner’s interactions with the external environment and their internal learning process: constructivism. Constructivism is divided into two major schools of thought: cognitive constructivism and social constructivism.

Cognitive constructivism is based upon the work of Dewey (1938), Bruner (1966), and Piaget (1972). This theory revolves around the concept that learners construct their knowledge through individual personal experiences. For example, when learners are exploring complex concepts through project-based learning, some learners may grasp the concepts quickly while others may struggle. Facilitating knowledge development through probing questions to help learners identify where they are having difficulty is part of an inquiry method to alleviate misinterpretation. It can also help learners reflect on their knowledge, misconceptions, and progress. Anchored instruction is an example of a cognitive constructivist theory that incorporates instructional technology such as video (Bradsford et al., 1990). Anchored instruction suggests that learning is anchored in a realistic, evolving context with guiding resources available to help the learners solve the instructional problem presented. The Adventures of Jasper Woodbury is a mathematics video series that was designed using the anchored instruction theory (Cognition and Technology Group at Vanderbuilt, 1992, available at http://jasper.vueinnovations.com/).

Social exchange and collaboration are foci of the social constructivist theory grounded in the work of Vygotsky (1978). A major theme of social constructivist theory is that social interaction plays a fundamental role in the development of cognition. Vygotsky postulated that cultural development happens twice, first on the social level (between people), then later on the individual level (inside the mind). One example of social constructivist theory is the development of language. If you are building a house, you may have basic language skills but may be unaware of terms associated with construction. As you continue to work with your peers, you begin to learn various tools and terms associated with construction through your interactions with them. Think about learning another language. Language mobile applications now offer the ability to have conversations with a native speaker electronically. This social interaction allows learners to first hear and engage with correct grammar and pronunciation. Over time, the learner can begin to process and think in another language, using proper grammar and pronunciation.

This perspective deepens our experiences in the world and aids our construction of new knowledge through the exchange of ideas with others. Often group activities such as projects, experimentation, and discussions are utilized. Learners engage with the content and then decompress with one another to develop or construct meaning from various activities. The teacher acts as a guide or translator by setting up the instruction to allow the learners to explore concepts. As the learners explore the concepts, the teacher then assists the learners in translating what they have found into the learner's current state of understanding.

Quest Atlantis is an example of an instructional design and technology product based on social constructivist theory (Barab et al., 2005). The goal of Quest Atlantis was to provide an immersive learning environment that combined academics and play with interdisciplinary cultural quests that supports learning, development, and social transformation. Players created a persona and by completing quests they engaged in educational activities while interacting with other users and mentors. The authors described the design as socially responsive because the quests adapted to the decisions of the players.

Connectivism

Early in the 21st Century, a new learning theory emerged from the digital age: connectivism. Connectivism is based on the work of Siemens (2004) and is the first theory that defines learning as more than an internal and individual process (see https://edtechbooks.org/-oCyT for a republishing of this article). The connectivist theory posits that learning takes place when learners make connections between ideas located throughout personal learning networks (e.g., other individuals, databases, social media, Internet, learning management systems). The connection of the right individuals to the right resources can enhance the learning for all within the network.

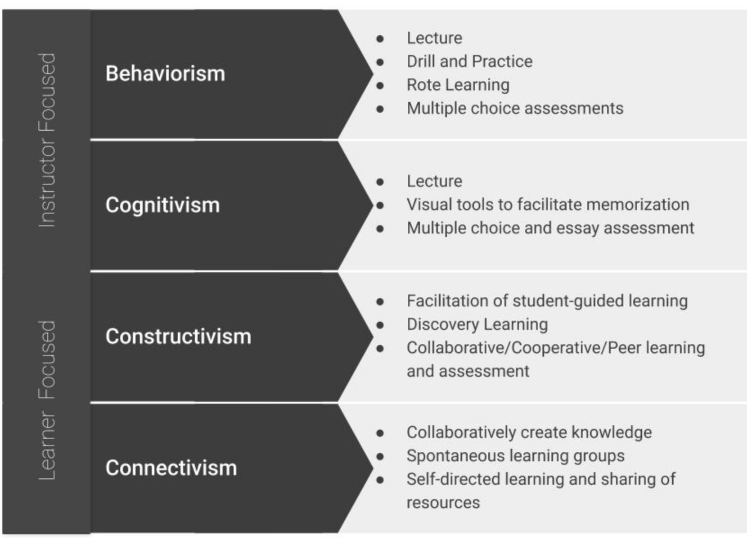
Technology increases learners' access to information and their ability to be a part of a greater learning community (Siemens, 2004). There are premises around connectivism. One premise is that learners need to distinguish between important and unimportant information, as well as valid information, since there is a continuous flow of new information. If we go back to the house example, you are working on building your house, and you want to install a fireplace. You can go to the Internet and join a builder's community on YouTube or a Do-It-

Yourself (DIY) forum. You may also be able to access reviews for various types of fireplaces and what has worked and what has not. Once you have built the fireplace, you can share your experience with these communities to enhance the experiences of others.

To summarize the four families of thought on learning theories, Figure 2 identifies some possible instructional methods for each learning theory presented so far.

Figure 2

Methods Used for Learning Theories Adapted from Morrison (2013)



Additional Readings and Resources

1. Foundations of Learning and Instructional Design Technology Book - Chapters 9, 10, 11 and 19. (West, 2018)
2. Learning Theory and Instructional Design (Mcleod, 2003)
3. Understanding the practices of Instructional Designers through the lens of different Learning Theories (Yeo, 2013)
4. How People Learn I (National Research Council, 2000)

Social Learning Theories

As noted above, interaction with both individuals and the environment is embedded in learning theories. From these types of interactions, multiple social learning theories emerged during the late 1990s that enhanced or deepened some of the ideas from the major families of thought around learning at that time. We will discuss the following social learning theories: social cognitive theory, social development theory, collaborative learning, and cooperative learning.

Social Cognitive Theory

Social cognitive theory teaches that people learn by observing others and is based upon the work of Bandura (1986). He believed that people construct knowledge from learning from others' experiences. By observing others' behavior, learners derive conceptions regarding the behavior being modeled. This observation can happen directly or through the media. Reflection is a crucial component of this theory as once the learner observes the action, they reflect and determine whether this is something they want to incorporate or use. Four processes coincide with observational learning techniques: attention, retention, reproduction, and motivation. Within the social cognitive theory, motivation is seen as depending upon one's self-efficacy and agency. In order to proceed through all four processes, the learner must have the confidence to exhibit control over a desired behavior or self-efficacy. Social cognitive theory is rooted in the view of human agency in which individuals are agents proactively engaged in their development and can make things happen through individual actions. For example, if a learner struggles with learning a particular behavior or task, allowing the learner to work with another person that has mastered the behavior or task will allow the learner to view how the ideal behavior or task is performed successfully.

Collaborative Learning

Instructors and designers sometimes want learners to work together to construct new knowledge deliberately. Collaborative learning is a social learning theory that involves learners grouping themselves together to explore a concept or to work on a project collectively. Collaborative learning is a loosely structured, discovery learning approach in which learners have much control. It is an “umbrella” term that encompasses a variety of educational approaches involving joint efforts by learners working together. Group members capitalize on the skills of one another through the sharing of information and ideas that build towards a common group goal.

Cooperative Learning

Cooperative learning is a carefully structured type of collaborative learning. In both of these social learning theories, the instructor's role is that of facilitator, and the tasks for the groups should be open-ended and complex. Cooperative learning is rooted in social interdependence theories (Deutsch, 1949; Lewin, 1935). Johnson and Johnson (1989) conducted extensive research on defining the parameters of cooperative learning, which requires these five components: interaction, positive interdependence, group processing, individual accountability, and social skills. In other words, groups need to interact, depend on one another, monitor their progress, be responsible for their work, and be able to work together. For example, a team research project could require each team member to find several resources, and an annotated bibliography of those resources could be submitted individually (individual accountability). The team could then co-write and edit the research paper with all of the resources (interaction, social skills, and positive interdependence). The group could use a cloud-based text editor to ensure all team members are contributing in a timely fashion (group processing). Cooperative learning requires intentional planning by the instructor or the designer to ensure all five components are present.

Additional Readings and Resources

1. Collaborative vs. cooperative learning video (wufei87, 2018)
2. Social Cognitive Theory video (Bandura, 2010)

Motivational Theories

Keeping learners motivated and engaged is just as important as understanding how they learn best. Therefore, motivation and engagement theories are essential to include when discussing learning theory. We will discuss three motivation theories (self-determination, hierarchy of needs, ARCS), and one engagement theory (flow).

Self-Determination Theory

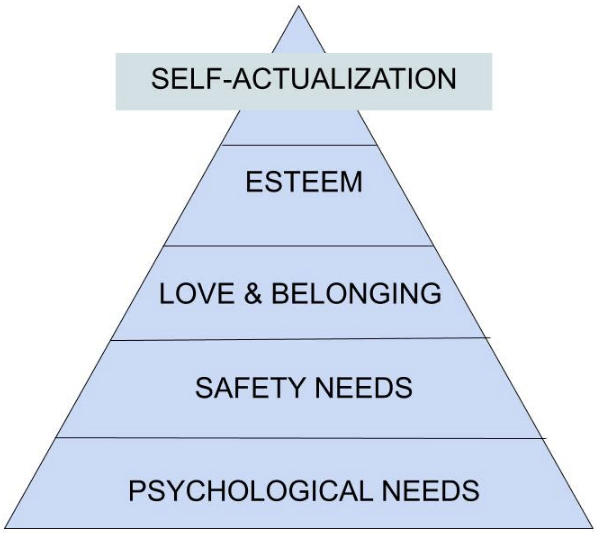
Self-determination theory is a motivational theory that suggests learners can become self-determined when their needs for competence, connection, and autonomy are satisfied (Deci & Ryan, 1985). Self-determination theory views internalization as a process for transforming external regulations into internal regulations and thereby integrating them into one’s self (Deci, Eghrari, Patrick, & Leone, 1994). Social support, along with intrinsic and extrinsic motivators are important factors for developing self-determination. Extrinsic motivators can hinder self-determination, whereas intrinsic motivators can enhance self-determination. Intrinsic motivators such as joy and self-fulfillment allow learners to be autonomous and engage with learning. When learners complete their work or a challenge, they feel competent. Both competence and autonomy are components necessary to maintain intrinsic motivation. Extrinsic motivators can hinder self-determination, whereas intrinsic motivators can enhance self-determination. External motivators, such as being rewarded for making an A on a test, can hinder learning. Social support should be considered over extrinsic rewards to foster self-determination. For example, ensuring every member of a team can play a role and understand their contributions are valuable. Methods to complete that could be establishing roles based on team member talents and providing positive feedback. Allowing individual learners and teams to set their own learning goals can also be beneficial. Another example of utilizing intrinsic motivators is giving learners an assignment where learners teach the concepts to other learners (internal) rather than teaching the learners to take a test on the concepts (external). This type of motivation is fostered and encouraged by fostering autonomous support for the learners rather than controlling.

Maslow's Hierarchy of Needs

Creating an autonomous environment may not always motivate learners as there are basic needs that need to be in place before learners can begin to move in the direction of self-fulfillment. Maslow's hierarchy of needs (Maslow, 1943) is a second motivational theory. Maslow stated that some needs take precedence over others, such as basic needs for survival. Maslow developed a hierarchy stating the needs at the bottom should be met first and then move their way up (see Figure 3).

Figure 3

Maslow's Hierarchy of Needs



At the bottom of the pyramid are the physiological needs such as air, food, shelter. Next is safety needs, such as protection from the elements, order, and freedom from fear, followed by love and belongingness. Next, are esteem needs, which are achievement, mastery, and the desire for reputation or respect from others. Finally, the self-actualization needs are realizing personal potential or the ability or desire to become capable. Although the order of the needs seems rigid, they are flexible, depending on the external circumstances or individual differences. For example, if a learner is concerned about where they are going to sleep or eat that night, they will not be as inclined to learn new concepts as their basic needs are not met. However, if a learner who is well-fed and is loved and has a sense of belonging, whether it is part of a social group or family, they are more inclined to strive to learn new concepts.

Keller's ARCS Model

Within the motivational theories, there are models that provide guidance to assist designers in planning to ensure learners' motivation. For example, Keller's Attention, Relevance, Confidence, and Satisfaction (ARCS) is a motivational model that can be used to guide instructional planning to be intentionally motivational for learners (Keller, 1987). This model focuses on promoting and sustaining motivation throughout the learning process. First, gain the attention of the learner by piquing their curiosity. Games, roleplay, humor, or the use of inquiry are all techniques to gain learner attention, particularly when introducing a new concept. Next, to increase the learner's motivation, relevance needs to be established. To establish relevance, you need to present the worth of knowledge gained, what does it mean to the learner? How will this knowledge directly affect the learner? Next, provide confidence and give the learners control over their learning while providing feedback. The instructor can achieve this by providing the learner's opportunities for short term wins and small steps of growth during the learning process. Finally, the learning needs to be rewarding or satisfying in some way, either from a sense of achievement or external means; however, without patronizing the learner through over-rewarding easy tasks.

Flow

Once a learner's attention is gained, the instructor or designer's focus should turn to keep the learner engaged. Flow is an engagement theory that is sometimes described as "being in the zone." Flow was defined by Csíkszentmihályi (1990), who was inspired by watching artists, athletes, chess players, and others who become immersed in completing tasks. Flow tends to happen when someone is engaged in an activity they enjoy, either due to their skill level or other intrinsic stimuli. Csíkszentmihályi defined 10 components of flow, but not all 10 have to happen for flow to occur. These 10 components are: (1)

clear and challenging goals, (2) strong concentration, (3) intrinsic motivation, (4) serenity feeling, (5) timelessness, (6) immediate feedback, (7) a balance between challenge and skill level, (8) feeling of control, (9) loss of awareness of other needs, and (10) complete focus. To create flow for learners, designers should allow some choice of activity to build on the learner's strengths and interests and strive to match and personalize the challenge level of the learning to the learner's abilities. "Genius Hour" (West & Roberts, 2016) is an example of applying Flow theory to education. In this approach, learners are given an hour each day, or every other day, to be "geniuses" in whatever topic they are excited about. They work for an extended period of time to complete a major project in their area before sharing their ideas with the class or families. These types of projects often produce substantial learning benefits by encouraging conditions where learners are more likely to be in flow.

Conclusion

Learning theories and models are tools that help to shape and guide learning. Like decorating a living room in a new house, various tools can be employed to move an empty room to one with a functional design and a pleasing look and feel to the designer and client. Instructional designers can rely on learning theories and models to design learning solutions that meet the needs of their clients. The theories and models also give designers language and structure to communicate their designs and research to give evidence that their designs will be effective. Consider if you were the client that bought the house and received several proposals from interior designers for the living room decorations. Proposal 1 was a diagram and a budget. Proposal 2 had a narrative description that justified the attached diagram and budget. The justification was based on their interior design philosophy and detailed how the diagram would prove to be functional for the client. Provided the design philosophies match, you would probably select proposal 2. Using instructional design theories and models helps guide your design or learning solution and helps justify your design solution as an effective one for potential clients.

Additional Readings and Resources

1. Foundations of Learning and Instructional Design Technology Book - Chapters 12, 13, 14 and 16. (West, 2018)
2. Development and use of the ARCS model in instructional design article (Keller, 1987)
3. Flow TED talk (Csikszentmihalyi, n.d.)
4. Edward Deci—Self-determination theory (Deci, 2017)

Application Exercises

1. Create a reference guide or chart of theories, characteristics, methodologies, and how you may best apply them to your own design context and situation.
2. Create a timeline of the evolution of learning theories.

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16

The Nature and Use of Precedent in Designing

Elizabeth Boling

As a student, or as a practicing designer, you may have noticed that moment when, even if you are following a detailed model, you have to figure out what is this material, this experience, this system I am designing actually going to be? Whether you have consciously done so or not, you have turned to your own memories, your store of precedent knowledge, in order to tackle these questions. Precedent knowledge is a form of knowledge specific to the activities and goals of design—and you do have some, whether you realize it consciously or not. When you do understand what precedent is and think about how you obtain it and use it, you have increased both the discipline and the imagination that you bring to the act of designing.

Precedent as a Form of Design Knowledge

One of the fundamental elements of design knowledge is precedent (Lawson, 2004; Lawson, 2019). Unlike in law, where the term precedent refers to the accretion of decisions made over time and constraining future decisions, in design precedent refers to the store of experiential (episodic) memories each designer accumulates over time—expanding their future possibilities for actions or decisions. And unlike in science, where past discoveries or established facts form a solid foundation of knowledge which must be accepted or definitively proven incorrect, precedent knowledge in design is gathered by individual designers through their experiences of the world. Each designers' store of experiences is unique to that designer. Even when multiple designers share the same experiences, they do not necessarily pay attention to the same aspects of those experiences, or recall them later in the same way. Some designers possess more experience and some less; no single designer's store of experiences is comprehensive or the same as any other one, and none can be transferred in an abstract way to another designer. Consider something you have experienced yourself, something that left a vivid memory with you. If you want to share this memory with someone else, you will likely use concrete means to do so—photos, video, audio—providing you have those means. If you do not, it can be difficult to transmit to another person the quality of what you have experienced. Now think about how you might share a career full of design experiences with another designer. You might summarize your memories as principles, or as lessons learned, but this would not reproduce for that other designer what you know. Some design knowledge, like principles, can be stated in abstract form for the benefit of others. But precedent knowledge, a designer's store of experiences, cannot be communicated easily or completely to someone else.

In architecture education, building precedent knowledge has long been a highly structured activity, overtly and rigorously pursued by means of memorization (Lawson, 2019), and of the requirement to refer to celebrated structures from the past in support of, or in contrast to, decisions made in the present (Eastman, 2001). Conflict persists over the canon, the body of works deemed worthy of this intensive study. Some argue that the canon is narrow and discriminatory (Gürel & Anthony, 2006), while others bemoan moves in architecture education to eliminate the canon because they argue that the benefits of this form of education outweigh the drawbacks (Breitschmid, 2010).

Although fields like instructional design do not maintain a canon, less formal means of noting, storing, and applying precedent knowledge in architecture also exist. Reviewing publications across multiple fields in which design is the primary practice, it is possible to see that building and using precedent knowledge is common across all of them (Boling et al., 2019), although the term precedent is not always the term used and sometimes the references are just brief glimpses of how precedent is actually used. For example, Rowe (1987) talks about architects and other designers using literal analogies, “borrowing known or found forms” either in canonic form (“‘ideal’ proportional systems” as in the architectural canon), or iconic form (“objects from the natural world … imagery from some scene, painterly conception, or narrative account of real or imagined circumstances”) (p. 80-83).

In the canonic form of precedent use, an architect may use forms (columns, arches, proportions) from classic structures in a current design. Without an existing canon in instructional design, it does not make sense to offer an example of canonic precedent use by instructional designers. Consider, however, examples of the iconic use of precedent. Madhavan (2015) quotes engineer John Shepherd-Barron, inventor of the ATM cash dispenser as saying, “I hit upon the idea of a chocolate bar dispenser, but replacing chocolate with cash” (p. 70), and Zimmerman (2003) mentions in passing that the graphics in his widely-known video game SiSSY FiGHT were “inspired by Henry Darger’s outsider art and retro game graphics” (p. 178). And as an instructional designer, a co-instructor and I used our experiences with buffet restaurants to offer multiple mini-lessons on technology to our students, letting them choose a "plateful" of learning in the multimedia production class we were developing.

How Precedent Is Collected

Goldschmidt (2014, p. 1) addresses the way informal, or iconic precedent is collected, saying the “designer possesses a ‘prepared eye’ which is able to take advantage of stimuli it encounters, randomly or intentionally, in any environment.” In other words, building precedent knowledge is a disciplined practice in which the preparation of experience allows designers to notice more that is potentially useful and relevant to them than novices or non-designers do. To picture this, imagine that an instructional designer working for an insurance company takes her children to a theme park where employees explain to guests, quickly but clearly, how to enter each ride and buckle themselves in safely. This designer is experiencing a happy day with her kids as many parents do, but because she is a designer, she is also noticing these just-in-time instructions. Without knowing when she might retrieve and use this memory, she stores it automatically; she has developed the habit of noticing and remembering experiences that may be relevant to her work.

Within the mind of each designer, precedent knowledge is structured over time into multiple schemata; “precedent stored in the form of episodic schemata is used by experts to recognize design situations for which gambits are available” (Lawson, 2004, p. 1). Lawson does not imply that precedent knowledge becomes, or should become, abstract knowledge by being transformed into generalized principles. He discusses schemata as patterns in which the original experiential elements remain intact as potential “gambits,” or design actions, recognized as possibly applicable to the immediate design situation. Considering the instructional designer who took her children to the theme park, it is likely that when she noted park employees giving instructions to guests as they boarded rides, she did not simply store that memory. This memory probably joined memories of experiences she had stored previously as part of a schema that might be thought of as, perhaps, "super-condensed instructions." It may also have joined other schema, possibly "scripted instructions easy for employees to learn," or "minimal scripts."

The Nature of Precedent Knowledge

Drawing on the discussions of precedent in the literature, and the ways in which designers refer to precedent, it is possible to consider the nature of this special form of knowledge.

Precedent Is Concrete

As noted, precedent knowledge is composed of the memory of experiences, not the abstract meaning we impose on those experiences. These experiences can be ones in which an object was held and used, a building walked through or lived in, a class taken or taught, an ocean beheld or sailed upon. They may, with equal validity, be vicarious, formed through encountering pictures, diagrams and narratives that represent designs to those who are not interacting with the designs directly. Whatever way this form of knowledge has been acquired, it is stored the same way that memories of a vacation trip or a day at school would be. It contains the details that struck the designer at the time of the experience, making it flexible in the ways that it can be used because more than one aspect of the experience can be related to a new design situation.

Precedent Is Neither Good or Bad; Its Value Is Determined When It Is Used

Precedent knowledge is neutral. The original precedent experience may have been a positive or negative one, and the designer recalling that experience may have thought at the time, “That’s a weak design,” or “That’s a great design.” We call the knowledge itself neutral, however, because later it will not be confined to use as an exemplar or as a cautionary tale. A weak, or even a failed, design can yield an affordance or an analogy that proves useful in a future design situation. In some situations, therefore, a designer might need to know whether an instructional design was proven to be effective when it was implemented. However, in many more designs its value as precedent is dependent on what it offers as part of a schema, or of multiple schemata, as inspiration for a design action or as a way to frame a new design problem.

Precedent Is Relevant When It Is Used; It May or May Not Be Relevant When It Is Collected

The relevance of any precedent memory to the work of the designer who holds that memory is determined at the time the precedent is used. As we will see in the discussion of precedent knowledge in use, designers sometimes seek examples of design intentionally to use them right away as models or inspirations for the work at hand. However, they also notice and store memories of designs continuously without knowing how they are going to use those memories later. This means that the exact relevance, even the vague relevance, of much precedent knowledge cannot be assessed in advance. In order to have precedent knowledge available when it is needed, designers who have been trained and encouraged to do so form the habit of attending to their environments with a generalized focus on potentially useful experiences, but also with a productive lack of boundaries as to which experiences they should note.

Precedent Can Be Used Repeatedly, and May Be Used Differently Each Time

As a form of knowledge that is simultaneously detailed and non-specific, precedent offers rich possibilities that can be connected by the designer to multiple design situations. Unlike case-based problem-solving-in which there is a match between the problem and the case being used to solve, or illuminate, it-design precedent does not have to be well-matched to the situation where it is being used. In some cases, there may be little to indicate that the precedent is related to the design situation at all. As we will see during the discussion of precedent in use, it is the designer who perceives the possibility that precedent knowledge affords an insight, a possibility for addressing a design problem (a gambit), or a bumper that pushes their thoughts in a new direction. Therefore, the designer's perception may be different in a precedent memory based on the current design situation than based on a previous one. Because this knowledge has not been abstracted into a fixed, declarative form, the designer is free to use it differently each time they recall it.

Precedent Knowledge in Use

In a current study of precedent knowledge across the literature in multiple fields of design, Boling et. al. (2019), have identified several primary modes of precedent use.

Linear

A linear use of precedent is one in which the bridge between precedent and a design decision or action (Lawson, 2019) is conscious, direct, and simply connected to the design. A designer might face a situation in which a particular style of design is required and look for examples of that style in order to perceive and reproduce its key elements. An instructional designer may have framed a project as one for which many precedent examples already exist and decide, appropriately, that drawing on one or more prior designs known to be effective will provide a reasonable template. Similarly, designers may seek, or draw upon, precedent knowledge to understand what a class or type of design looks like, sounds like, or how it is constructed. This happens when, for example, an inexperienced designer is preparing to develop a student workbook and collects examples of existing workbooks to learn more about how this class of design is put together. This is a kind of deliberate reverse-engineering in which the application of the precedent experience is determined in advance.

Field-Specific Sources and Validation of Judgment

Using the architectural canon, or less systematized bodies of recognized precedent (sometimes the bodies of work produced by famous designers), designers can draw on precedent knowledge that they share with many other designers and use it to guide or validate their own design decisions or actions. In this type of use, schema within the body of precedent knowledge may be less personal to an individual designer than understood across a professional community. A majority of precedent experiences for many of these designers may be vicarious-gathered through photographs and descriptions made available during their studies, found in curated collections published in books and periodicals. A product designer, for example, may be well aware of a shift toward rounded surfaces and complex "dashboards" of buttons on household appliances because designs like these appear in trade magazines and win professional design awards. They do not refer to any single prior design when they develop a dishwasher for the manufacturer employing the designer, but the widely-known schema informs their design and they refer to that schema to support their decisions. It may be difficult to picture this form of precedent use among instructional designers because the field does not now build, or disseminate, organized bodies of precedent, or acknowledge individual practitioners to the extent of making them famous.

Direct Model for Invention

Engineers in particular use precedent knowledge in a combinatory way, incorporating precedent designs directly into new ones when subsystems are required for a complex situation and existing examples can be used with minimal adaption. In what is termed *normal design*, when the requirement for invention is low, Vincenti (1990) describes a special form of precedent termed *normal* *configurations*, in which the designer's experience includes both the elements directly usable for the situation and examples of how those elements will work together. Every engineer who needs to include a pump in a design does not re-invent the pump if there is an existing pump design compatible with the larger system being created. It is easy to observe a similar form of precedent use among program designers who maintain, share and draw upon libraries of code. Instructional designers may recognize that this form of precedent use shares characteristics with reusable learning objects.

Abduction/Analogic Reasoning/Inspiration

Cross (2011) explains that abductive thought suggests "what may be," instead of figuring out what must be (deduction) or determining what is (induction) (p. 33). The abductive use of precedent involves allowing the experience of what exists to suggest possibilities for that which is still to be designed. To understand this use of precedent, consider an instructional designer who is a relay runner in their off-time. They are working on a web-based design for a high-enrollment college course in which undergraduates are supposed to be learning collaboratively. As they consider that students are not always excited about group work, it occurs to the designer that the feeling of handing off a baton during a relay race is both intense (motivating) and positive (satisfying). Without literally building the course as a relay race, the designer decides to try dividing the class into small teams and incorporating "hand-off-ness" into the process of working together. The students will set a goal for their final assignment together, then use an online collaborative writing tool that is open to each of them sequentially for additions and revisions until they complete the assignment. Still inspired by their running experience, the designer builds in some practice in sequential writing ("handing off") as part of smaller assignments during the semester.

While many fruitless forays may be conducted into one's store of precedent, or there may be only a tenuous connection between a possibility discovered there with the problem in hand, abduction is not just random exploration. Because precedent tends, with experience, to gather into schema (Lawson, 1994), analogic use of precedent is likely a key factor in the efficacy of abductive thought. Analogic reasoning “is a method of activating stored schema based on the identification of connections, parallels, or similarities between, what are typically perceived as dissimilar items” (Daugherty & Mentzer, 2008, p. 9). In the case of what we perceive as inspiration, analogic reasoning utilizing multiple schema may occur and, because these processes are not linear (not propositional or easily converted into rationalized form), they appear to be—or are experienced as—unexplainable leaps from what is known to something entirely new. Consider again the instructional designer inspired by their experiences as a relay runner. Let's suppose that in addition to being a relay runner currently, the designer also participated in improvisational theater as a high school student and performed in a short-lived jazz ensemble during college. Each of these experiences involves handing off from one participant to another (a baton, a story line, a musical theme), and by the time they begin designing this college course, the designer's use of the schema for handing off may not have been a conscious design act as described above. They may have experienced the idea of sequential authorship in this online class as something that "just came to them;" they drew on a schema for parallels between it and their design problems that are not obvious on the surface and were not deliberately sought.

Problem Framing

Dorst and Cross (2001) discuss how a “problem-solution pair is framed” (p. 435) by designers, defining the design situation by considering the insight that a possible solution can provide. Such possible solutions are drawn from, or suggested by, the designer’s store of precedent knowledge. In this use of precedent, the designer’s knowledge is not being used to guide specific design actions, but to explore, understand and define the situation overall. Many designers can bring to mind the point in a project where someone throws out an idea; "what if we put together something like a kit that the instructors in the field could use to assemble lessons on the fly? Like Ikea™ lessons!" The project may or may not follow this direction, but considering the idea can bring to light factors in the design situation that may or may not have been evident before—or suggest new information that a project team may need to gather which was not considered previously.

Design Talk

As designers work together, they engage in design talk, a specialized form of discourse described by Fleming (1989), of which a central component is discussion of the object (or system, or experience) being designed. Lawson (1994) offers a vivid description of such talk among architects in which they all used a single term derived from separate but overlapping, bodies of precedent knowledge and probably from experiential memories the team also shared. While a comparative lack of precedent dissemination in instructional design can limit this element of design talk, you may be able to recognize a discussion in which team members share an educational background and use terms like "WebQuest" or "MOOC" that carry an entire set of experiential meanings for the participants.

Design Models and Precedent

Design models are one of the most widely discussed forms of design knowledge discussed and used in the field of instructional design (Smith & Boling, 2009). These are a declarative form of knowledge, meaning that they are abstract and fixed; they can be passed from one person to another through explanation and memorization. Such models are useful (Branch, 2009), but they do not serve the same purpose for designers that precedent knowledge serves. In fact, without the judgment of designers (Archer, 1965; Holt, 1997; Merrill; Vickers, 1983; Gibbons et al. 2014; Smith and Boling, 2009) and their precedent knowledge, design models are not actually effective. Discussion of design judgment may be found elsewhere (Boling et al., 2017; Dunne, 1999; Gray et al., 2015; Nelson & Stolterman, 2014). Here we will consider the role that precedent knowledge plays within design models.

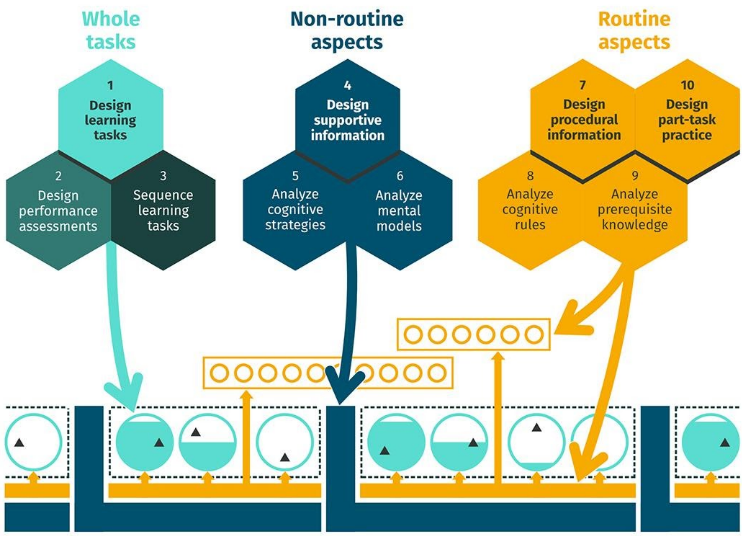
In each model of design that exists, and there are many (e.g.; Archer, 1965; Dick et al., 2000; Dubberly, 2019; Gustafsen & Branch, 2002; Lawson & Dorst, 2009; Morrison et al., 2012; Reigeluth & Carr-Chelman, 2009), close examination will uncover a point at which many aspects of a design situation may be known, but all the rational sources of knowledge and decision-making have reached the limits of their usefulness. The results of analysis, and the application of established principles or prescriptions, may have precluded some design moves, or implied fruitful directions for others (Krippendorf, 2005). But now—what to do precisely? What, exactly, will come to exist that did not exist before all the preparation was done?

Bruce Archer's (1965) early, influential, and detailed engineering design model, created at the start of high excitement regarding systematic design, was presented as a long diagram that extended for yards, and included a short text of fifteen pages explaining it. Of those fifteen pages, ten are devoted to discussing the human activity and perspective actually required to make the model function, pointing specifically to the one place in the model where nothing but the human designer can bridge from one step to the next by saying, "there is no escape for the designer from the task of getting his own creative ideas" (p. 11). And where do those ideas come from? Archer explains that looking at other people's end results (designs) "including phenomena and artefacts in … unlikely fields," and "a rich, wide and fruitful experience … as well as the capacity for flexibility and fantasy in thought" (p. 12) are required; in other words, building and using precedent knowledge.

Looking at a more recent and familiar prescriptive model for developing instruction, consider the 4C-ID Model, focused specifically on designing instruction for complex tasks, and summarized by van Merriënboer et al. (2002).

Figure 1

Ten Steps of the 4C/ID Model. Obtained From www.4cid.com



This model is quite detailed, focusing on prescriptions for breaking down complex skills, providing practice of part-tasks and whole-tasks, and providing materials for support and for just-in-time information. Explanations for using the model do not address explicitly, as Archer did, what is required from designers to carry out the steps of the model. If we examine it, though, we will see that the model can only be used when designers employ precedent knowledge.

For example, in the case example the authors provide, the complex task to be learned is literature searching. They describe a scenario in which a designer has, in step 1, broken down “literature searching” into several “task classes,” and specified that “learners receive three worked-out (good) examples of literature searches (step 4). Each example contains an elaborate search query in which Boolean operators are used” (p. 56). Guidelines are offered as to what a task class may be, and the characteristics that practice items or informational materials should have. However, neither the model nor the explanation of it acknowledge the invention required to move from knowing what kind of example is to be offered, to actually inventing this example—or to deciding the nature of the event in which the examples will be introduced and used.

The very language—“learners receive”—masks what actually has to happen; unless the appropriate worked-out example of a literature search is readily available, one must be made to exist where previously it did not. Even if the appropriate example is readily available, its relationship to this instructional event must be created. While this is not a criticism of the model, it is important that designers recognize the additional forms of knowledge they need to use such models.

Conclusion

While precedent knowledge interacts with other forms of knowledge that designers possess (like their knowledge of guidelines, theories or principles), it is different in important ways. Designers need to understand those differences so that they can build and use this knowledge effectively.

Application Exercises

The Noticing Journal

The beginning of a disciplined practice in accumulating and using precedent knowledge is to develop the simple habit of noticing. Commit to a week of noticing and challenge yourself to notice as many kinds of instruction or performance support around you as you can for that week. Jot down a note about each one, or take a photo with your phone, so that you can see how many have built up over the week.

Not sure where to begin? Consider how many things you use or see in a day that carry instructions on them -- shampoo, instant noodles, fire extinguishers, bus and subway maps, vending machines. Pay attention to digital experiences like videogame and software tutorials, or website navigation instructions. Don't limit yourself to formal instruction either. Did you overhear a parent teaching something to a child or a child showing a parent how to use a smartphone app? It all counts!

Once you have spent a week on this exercise, consider continuing with it, adding items as you come across them. While noticing precedent becomes automatic at some point, there is no harm in remaining conscious of the discipline of noticing.

Exploring Your Existing Store

Set aside 30 minutes to an hour in a quiet place where you can bring to mind past experiences. Begin with the earliest learning experiences you can remember. From the perspective of an instructional designer, call up as many as you can. Don't worry if some of them are negative. Precedent knowledge is built from all experiences, not just exemplary ones. While I recall a great experience with the SRA Reading System in 4th grade, that same year yields the painful memory of "math races" in which two students had to run to the blackboard and solve a problem written there quickly, trying to beat each other to the answer.

As you bring these memories of learning to mind, resist the urge to try to turn them into lessons learned, to diagnose what happened, or to draw conclusions about what happened. What you are doing right now is just taking stock of how many experiences you already have in your store of precedent, and recognizing that it belongs to you. You have probably been using it; you may well be conscious of that. And if you have not been, then this exercise may prove illuminating!

As with the first exercise, consider spending 30 minutes this way more than once. You probably have more than 30 minutes of learning memories!

Deconstruct Your Present

If you are studying in school now, begin to take note of the way one of your courses is structured and of the materials you are using in this class. Don't stop there, though. The experience of a course is not the same thing as a syllabus or a textbook. It is the experience that you remember and that forms part of your precedent knowledge. Write the story of this class—take several pages to do so. While this is your experience, pretend that you are an observer trying to give someone else a vicarious experience of what it is like to be in the course.

As an example, a short time ago I participated in a square dancing club as a student for a year. While the structure of the lessons was straightforward—3-4 new calls introduced each week, with several repeated each time as a refresher, and each student dancing with an experienced partner—the experience of these lessons would take more time to describe. The experienced dancers were uniformly elderly and enthusiastic. Every student was greeted warmly at the start of the session, encouraged and praised throughout each dance, and treated to homemade goodies by the members of the club. Actually, concentrating on learning and dancing at the same time is surprisingly strenuous, so the goodies were welcome. So was the encouragement! While the steps we were learning were each pretty simple, they were not called out in a set order. The caller changed the sequence constantly and more than one student stepped on more than one toe. Every so often the entire group came to a halt when one or more students swirled left instead of right. In these instances, I'm sure some of the experienced dancers were frustrated but no one complained and we all formed up to begin again. I could go on for several more pages, explaining in more detail about the sequence of the steps we learned and how the caller handled the dances, what the room was like, the "final exam." Once you get started on this exercise, you will find that you have plenty to say as well.

If you are not studying right now, you can choose a learning experience that, like mine, took place over an extended period. Or, if you teach, complete the exercise using one of your own courses, trying to keep that observer perspective. And no matter what experience you use for this exercise, once you have completed it, read it over and ask yourself what kind of schema this experience may be, or could be, part of. You are not trying to abstract this experience, but to consider what others come to mind and what patterns they might both be part of. There could be several or many.

NOTE: As you carry out these exercises, focus on the fact that you are building awareness of your design knowledge and thinking. These exercises are not intended to become part of your design process; although I have recommended repeating them for the sake of building awareness, they will not tell you what to design or how to design. They will strengthen abilities you already have and use.

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18

Standards and Competencies for Instructional Design and Technology Professionals

Florence Martin & Albert D. Ritzhaupt

Students entering the field of instructional design must possess a wide array of competencies to be successful in their future roles (Ritzhaupt & Martin, 2014). Competencies are the knowledge, skills, and abilities professionals need in their roles, while standards speak to a pre-defined level of quality or attainment of those competencies. Competencies and standards are essential aspects to advance professionals in this field. Several professional organizations guide the development of competencies and standards. They also have certification programs for instructional designers and instructional programs. In this chapter, we review the instructional design standards and competencies both from professional organizations and those proposed by researchers who guide the educational preparation of instructional designers and also support their academic and work experiences.

Competency and Standard

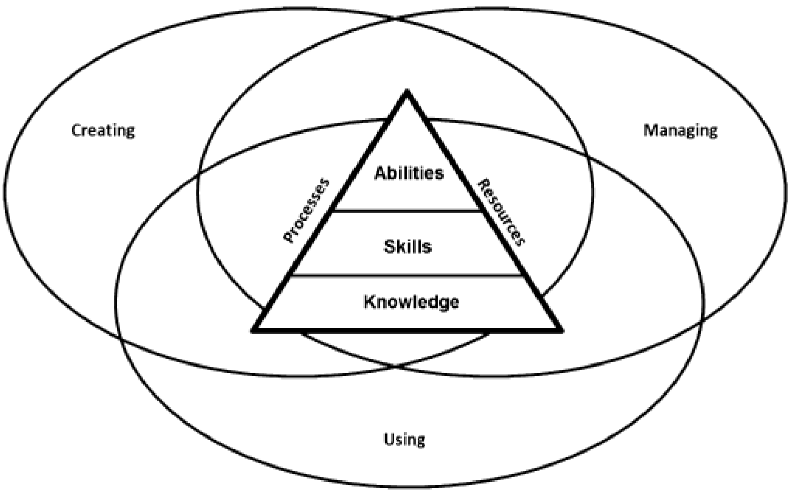
In this section, we review the term competency and standard before we introduce instructional design competencies from professional organizations and from research. Richey et al. (2001) defined competency as “a knowledge, skill or [ability] that enables one to effectively perform the activities of a given occupation or function to the standards expected in employment” (p. 26). Spector and De la Teja (2001, p. 2) refer to the term competency as “a state of being well qualified to perform an activity, task or job function” and competency refers to the “way that a state of competence can be demonstrated to the relevant community.” Thus, competencies are specific to a community of endeavor in which professionals determine the competencies valuable to the profession. As competencies are identified and developed, professionals express these competencies as standards to assist professionals, professional associations, academic programs, and the larger community to better understand the domain of interest.

The KSA framework, comprised of Knowledge, Skills, and Abilities, has been used by researchers to study competencies in the field. Ritzhaupt et al. (2010) used the KSA framework to categorize educational technology competencies into knowledge, skills and abilities statements. Figure 1 illustrates this framework in light of three domains used to characterize the field: creating, using, and managing. The KSAs represent the core processes and resources used by those practicing in the field, which are the creation of instructional materials, learning environments, and instructional products using systematic approaches and based on research to improve learning and performance. Using refers to selecting, using, and implementing educational technologies and processes to support student learning and to enhance their pedagogy. Management refers to managing people, processes, physical infrastructures, and financial resources to create diverse learning environments and provide supportive learning communities to improve learning and performance (AECT Standards

2012, 2008).

Figure 1

Knowledge, Skill, and Abilities Statements for Educational Technologists (Adapted from Ritzhaupt et al., 2010)



Standards are critically important to establish a foundation for a field. For instance, the field of project management established the well-known American National Standards Institute's (ANSI) Guide to The Project Management Body of Knowledge (PMBOK), which is used as the basis for the Project Management Professional (PMP) certification program and as the official body of knowledge for the profession.

Instructional Design and Technology Competencies and Standards From Professional Organizations

The field of instructional design is comprised of several professional organizations, several of which define competencies and standards for the profession. Table 1 provides a summary of these professional organizations and the following section provides more details about each. Each organization has a different focus and provides standards and competencies for their relevant programs. Students should be reminded that these standards and competencies serve as ideal frameworks, and should not be discouraged by their scope.

Table 1

Professional Organizations Who Publish Instructional Design and Technology Standards

Professional Organization	**Website Address**
International Board of Standards for Training, Performance and Instruction	http://ibstpi.org/
International Society for Performance Improvement	https://www.ispi.org/
Association for Talent Development	https://www.td.org/
Association for Educational Communications and Technology	https://www.aect.org/
Online Learning Consortium	https://onlinelearningconsortium.org/
International Society for Technology in Education	https://www.iste.org/
University Professional and Continuing Education Association	https://upcea.edu/

International Board of Standards for Training, Performance and Instruction (IBSTPI)

http://ibstpi.org/

Ibstpi Vision: To be the leader in setting international standards in the areas of training, instruction, learning, and performance improvement.

Ibstpi Mission: Develop, validate, and promote implementation of international standards to advance training, instruction, learning, and performance improvement for individuals and organizations.

Ibstpi has competency sets for various learning and development roles, including the instructional designer. They also have competency sets for other roles such as training manager, evaluator, instructor, and learner. For the instructional designer, Ibstpi (2012) developed 22 competencies across five domains.

1. Professional Foundations
2. Planning and Analysis
3. Design and Development
4. Evaluation and Implementation
5. Management

Each of these competencies has detailed performance statements and a level of expertise (essential, managerial and advanced) identified for each of them. Ibstpi goes through a rigorous development model to identify and validate these competencies. The steps in the model include preliminary analysis of job roles, identification of foundational research, competency drafting by directors and experts, validation study design, translation of research instruments in multiple languages and implementation worldwide with working professionals, data analysis and competency validation, publishing final competencies and performance statements and disseminating the competencies to practitioners, researchers and organizations.

International Society for Technology in Education (ISTE)

https://www.iste.org/

ISTE Vision: ISTE's vision is that all educators are empowered to harness technology to accelerate innovation in teaching and learning, and inspire learners to reach their greatest potential.

ISTE Mission: ISTE inspires educators worldwide to use technology to innovate teaching and learning, accelerate good practice, and solve tough problems in education by providing community, knowledge, and the ISTE Standards—a framework for rethinking education and empowering learners.

ISTE has developed well-adopted standards for students, teachers, administrators, coaches, and computer science educators. The ISTE standards are widely accepted in the K-12 community, and have been transformed into assessment systems (Hohlfeld et al., 2010) and a new professional credential offered by ISTE known as the ISTE Certification, which is a vendor neutral teacher certification based on the ISTE Standards for Educators. The ISTE Standards for Educators can be accessed at https://www.iste.org > standards for more information.

They include:

1. Learner: Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning.
2. Leader: Educators seek out opportunities for leadership to support student empowerment and success and to improve

teaching and learning.
3. Citizen: Educators inspire students to positively contribute to and responsibly participate in the digital world.
4. Collaborator: Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems.
5. Designer: Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability.
6. Facilitator: Educators facilitate learning with technology to support student achievement of the ISTE Standards for Students.
7. Analyst: Educators understand and use data to drive their instruction and support students in achieving their learning goals.

International Society for Performance Improvement (ISPI)

https://www.ispi.org/

ISPI Vision: Performance improvement practices are recognized globally as an essential part of every organization's competitive strategy.

ISPI Mission: ISPI and its members use evidence-based performance improvement research and practices to effect sustainable, measurable results and add value to stakeholders in the private, public, and social sectors.

ISPI has proposed 10 Human Performance Practitioner Standards for instructional designers who assume the specialized role of performance consultants. The ten standards include,

1. Focus on Results or Outcomes

2. Take a Systemic View
3. Add Value
4. Work in Partnership with Clients and Stakeholders
5. Determine Need or Opportunity
6. Determine Cause
7. Design Solutions including Implementation and Evaluation
8. Ensure Solutions' Conformity and Feasibility
9. Implement Solutions
10. Evaluate Results and Impact

In addition to the practitioner standards, ISPI also has accreditation standards for organizations and programs/courses. ISPI certifies practitioners though a rigorous peer-review process and with the opportunity for the practitioners to be re-certified every three years.

Association for Talent Development (ATD)

https://www.td.org/

ATD Vision: Create a World That Works Better

ATD Mission: Empower Professionals to Develop Talent in the Workplace

ATD certifies professionals in learning and performance (CPLP) and associate professionals in talent development. The Certified Professional in Learning and Performance (CPLP) candidates are tested on ten (10) areas of expertise and include

1. Performance improvement
2. Instructional Design
3. Training Delivery
4. Learning Technologies
5. Evaluating Learning Impact
6. Managing Learning Programs
7. Integrated Talent Management

8. Coaching
9. Knowledge Management
10. Change Management

ATD also has a competency model for learning and development through which they identify roles, areas of expertise, and foundational competencies for professionals in learning and performance.

Association for Educational Communications and Technology (AECT)

https://www.aect.org/

AECT Vision: We seek to be the premier international organization in educational technology, the organization to which others refer for research and best practices.

AECT Mission: Provide international leadership by promoting scholarship and best practices in the creation, use, and management of technologies for effective teaching and learning.

Januszewski and Molenda (2007) defined Educational Technology as "Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (p.1).

AECT has developed standards for educational technologists in five areas. These standards can be accessed from the AECT website.

1. Content Knowledge
2. Content Pedagogy
3. Learning Environments
4. Professional Knowledge and Skills
5. Research

For each of the standards, there are several indicators provided. AECT certifies graduate certificate programs in higher education who prepare educational technologists based on these standards.

University Professional and Continuing Education Association (UPCEA)

https://upcea.edu/

UPCEA is a leading association of professional, continuing and online education. Their goal is to provide high quality, professional, continuing and online education programs of practice in higher education.

UPCEA® Purposes:

- To promote quality in professional and continuing higher education.

UPCEA has seven standards identified to provide excellence in online learning leadership.

1. Internal Advocacy
2. Entrepreneurial Initiative
3. Faculty Support
4. Student Support
5. Digital Technology
6. External Advocacy
7. Professionalism

Online Learning Consortium

https://onlinelearningconsortium.org/

OLC® Vision: Setting the global standard in online and digital learning

OLC® Mission: Creating community and connections around quality online and digital learning while driving innovation

OLC's Five Pillars of Quality Online Education include

1. Learning Effectiveness
2. Scale
3. Access
4. Faculty Satisfaction
5. Student Satisfaction

Instructional Design and Technology Competencies From Research

In addition to the professional organizations, several researchers have examined instructional design competencies and standards over the years. Table 2 below provides details of researchers and the competencies and standards examined for various instructional design professionals. These articles can be used to plan professional development, academic programs, and learning experiences for our professionals and emerging professionals.

Table 2

Instructional Design and Technology Competencies From Research

Authors	Audience	Research Method	Competencies Identified
Tennyson (2001)	Instructional Technologists	Development of competency worksheet	Educational foundations, instructional systems design methodology, and instructional design process experience
Liu, Gibby, Quiros, and Demps (2002)	Instructional Designers	Interviews	Problem-solving and decision-making skills
Brown, Sugar and Daniels (2007)	Media Producers in entry-level multimedia production	Biennial Survey	Authoring applications media producers regularly use and attributes that are most important to the choice of an authoring application
Kenny, Zhang, Schwier and Campbell (2007)	Instructional Designers	Literature Review	Communication skills, knowledge of instructional design models, problem-solving/decision-making skills, and technology skills
Ritzhaupt, Martin and Daniels (2010)	Educational Technologists	Job Announcement Analysis and Survey of Professionals	Multimedia competencies for educational technologists
Lowenthal, Wilson and Dunlap (2010)	Instructional Designers	Job Announcement Analysis	Instructional design experience, communication skills and collaboration skills
Wakefield, Warren and Mills (2012)	Instructional Designers	Job Announcement Analysis	Communication and interpersonal skills, managing multiple instructional Design projects, specific traits, and collaborative skills
Ritzhaupt and Kumar (2015)	Instructional Designers in Higher Education	In-depth Interviews	Solid foundation in instructional design and learning theory, possess soft skills and technical skills, and have a willingness to learn on the job
Kang and Ritzhaupt (2015)	Educational Technologists	Job Announcement Analysis	Instructional design, project management, technical skills, and soft skills
Ritzhaupt, Martin, Pastore and Kang (2018)	Educational Technologists	Survey of Professionals	Instructional design, development, facilitation, assessment, evaluation, communication, problem-solving, and interpersonal skills

Learning theory also guides ethical decision-making when engaged in the creation of a wide-array of learning solutions. Professionals must also stay abreast in emerging learning technologies and should possess both the ability to learn independently and the commitment to lifelong learning. Other knowledge, skills, and abilities were identified in these studies, but these areas noted were frequently observed and noted.

Conclusion

Professional competencies and standards are helpful ways to communicate the value-add of our professionals to stakeholders outside of our community in various professional contexts (e.g., healthcare), to assist our professionals and emerging professionals in planning professional development and lifelong learning (e.g., which webinar to attend), and to guide our academic programs to align with the expectations of the needs in our field (e.g., selecting which topics to cover in an instructional design course). While no list of competencies and standards is complete, those enumerated in this chapter provide readers a glimpse of the status of the profession as described by our professional organizations and existing research literature. Students entering the profession should spend time on learning these competencies and standards to identify career paths and professional development opportunities. We conclude the chapter with some independent learning activities for your edification.

Application Exercises

1. How should professional competencies and standards be identified, documented, and used by professionals in our field? What forms of research methods have been used to identify and document these competencies and standards? Write a brief overview of how you think competencies and standards should be developed in our profession by reviewing the existing articles listed in Table 2.
2. Read three of the recent articles listed in Table 2. Using the competencies and standards provided in these articles, write a short list of professional learning outcomes for yourself to achieve in the next calendar year.
3. Explore one of the professional organizations discussed in this chapter to identify more detailed information about the organization, including when the professional organization hosts its annual conference, the cost of membership, the list of readings available with membership, and any of professional learning (e.g., webinars) provided by the organization for its members.
4. Some scholars, such as Ritzhaupt and Martin (2010; 2014; 2018) have expressed the competencies of professionals using knowledge, skill, and ability statements. Using this approach, search and identify 10 instructional design professional position announcements using tools like indeed.com. After identifying the announcements, code the knowledge, skill, and ability statements found in these announcements.

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20

Robert Gagné and the Systematic Design of Instruction

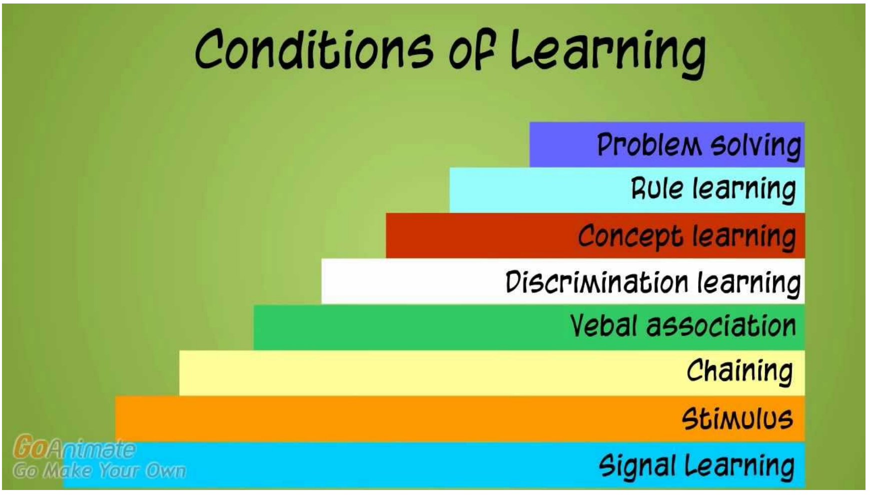
John H. Curry, Sacha Johnson, & Rebeca Peacock

To begin any study of instructional design, it is beneficial to examine the roots of the field. Where did the field originate? How did we develop into a field of study and practice? As your study continues, you can better see how the knowledge base of the field began, how it progressed, and how it was researched and when, which will help you gain a better understanding of the process and practice of instructional design as well as the field as a whole. Specifically, understanding the origins of the systematic design of instruction will give the learner a greater appreciation for today's more robust design theories and models.

As the United States entered World War II, they faced an enormous problem: How were they going to train so many troops? The numbers are staggering. The military trained over 16 million troops. In addition, the technology of the war had changed drastically from World War I, and the troops needed to be trained on all the skills necessary to complete their tasks at hand, and FAST. They did not have the luxury of time—the training needed to be done quickly, effectively, and efficiently.

After the war ended, cognitive psychologists, many of whom had served in World War II themselves, began studying how to apply the training lessons from the war to other instructional settings to help people learn better. Combining the work of those researchers, the systematic instructional design process was born.

Gagné’s Conditions of Learning



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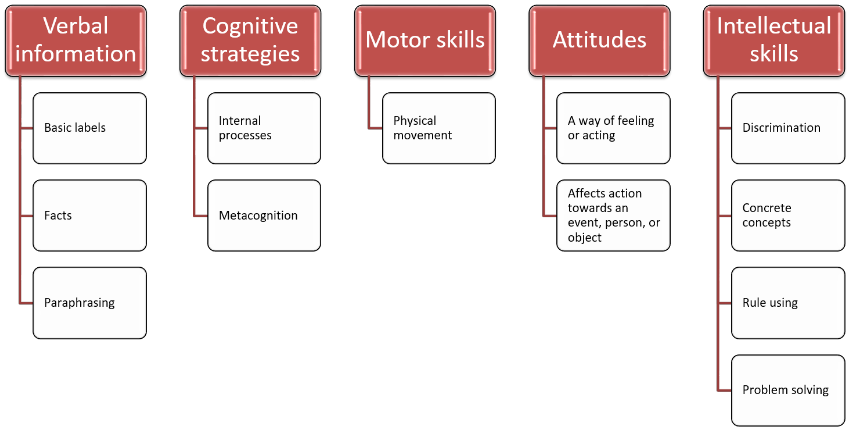
Robert Gagné was working on his Ph.D. in Psychology when World War II began. While assigned to Psychological Research Unit No. 1, he administered scoring and aptitude tests to select aviation cadets. After the War, Gagné joined the Air Force Personnel and Training Research Center where he directed the Perceptual and Motor Skills Laboratory. He held multiple academic positions throughout his career, ranging from the Connecticut College for Women to Princeton to Florida State University. His experiences in the military and training there guided much of his research. In 1959, he participated in the prestigious Woods Hole Conference, a gathering of outstanding educators, psychologists, mathematicians and other scientists from the United States in response to the Soviet Union launching the Sputnik satellite. The results of the conference were published in Bruner’s The Process of Education (1961). Four years later, Gagné published The Conditions of Learning (1965).

Taxonomy of Learning Outcomes

Gagné posited that not all learning is equal and each distinct learning domain should be presented and assessed differently. Therefore, as an instructional designer one of the first tasks is to determine which learning domain applies to the content. The theoretical basis behind the Conditions of Learning is that learning outcomes can be broken down into five different domains: verbal information, cognitive strategies, motor skills, attitudes, and intellectual skills (see Figure 1).

Figure 1

Gagné’s Domains of Learning



Verbal information includes basic labels and facts (e.g. names of people, places, objects, or events) as well as bodies of knowledge (e.g. paraphrasing of ideas or rules and regulations). Cognitive strategies are internal processes where the learner can control his/her own way of thinking such as creating mental models or self-evaluating study skills. Motor skills require bodily movement such as throwing a ball, tying a shoelace, or using a saw. Attitude is a state that affects a learner's action towards an event, person, or object. For example, appreciating a selection of music or writing a letter to the editor. Intellectual skills have their own hierarchical structure within the Gagné taxonomy and are broken down into discrimination, concrete concepts, rule using, and problem solving. Discrimination is when the learner can identify differences between inputs or members of a particular class and respond appropriately to each. For example, distinguishing when to use a Phillips-head or a flat-head screwdriver. Concrete concepts are the opposite of discrimination because they entail responding the same way to all members of a class or events.

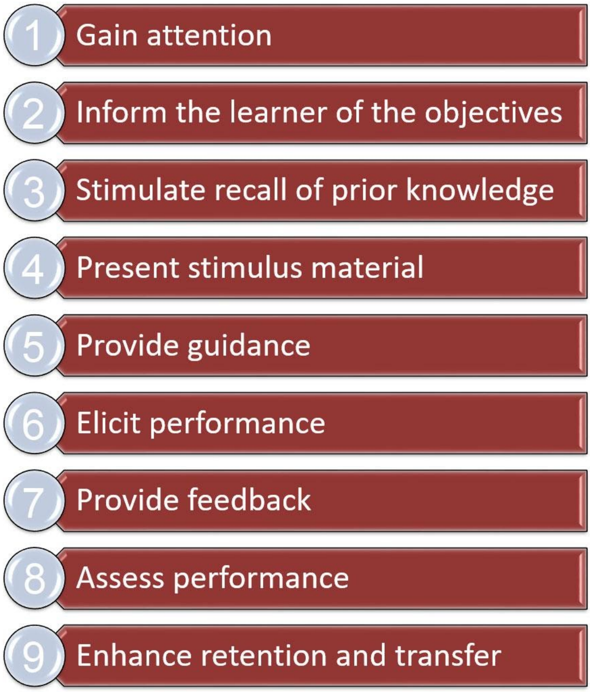
An example would be classifying music as pop, country, or classical. Rule using is applying a rule to a given situation or condition. A learner will need to relate two or more simpler concepts, as a rule states the relationship among concepts. In many cases, it is helpful to think of these as “if-then” statements. For example, “if the tire is flat, then I either need to put air in the tire or change the flat tire.” Finally, problem solving is combining lower-level rules and applying them to previously unencountered situations. This could include generating new rules through trial and error until a problem is solved.

Nine Events of Instruction

Beyond his assertion that not all learning is equal, Gagné also theorized an effective learning process consisting of nine separate and distinct steps or events (see Figure 2). These events build naturally upon each other and improve the communication supporting the learning process. The events facilitate learner engagement as well as retention of the content being presented. For an instructional designer, they provide a framework or outline to structure the delivery of instructional content.

Figure 2

Gagné’s Nine Events of Instruction



Event one: Gain attention. Before learning can happen, the learners must be engaged. To gain the learners' attention, any number of strategies can be employed. It could be as simple as turning the lights on and off, the teacher counting down, or the teacher clapping three times. Other options could include a discussion prompt, showing a video, or discussing current events.

Event two: Inform learners of objective. Once learners are engaged, they are informed of the objective of the instruction, which gives learners a road map to the instruction. It allows them to actively navigate the instruction and know where they are supposed to end up. This could be written on a whiteboard in front of the class, highlighted on materials, spoken verbally, or posted clearly in an online context.

Event three: Stimulate recall of prior learning. Stimulating recall of prior learning allows learners to build upon previous content covered or skills acquired. This can be done by referring to previous instruction, using polls to determine previous content understanding (and then discussing the results), or by using a discussion on previous topics as a segue between previous content and new content.

Event four: Present the stimulus material. Presenting the stimulus material is simply where the instructor presents new content. According to Gagné, this presentation should vary depending on the domain of learning corresponding to the new content.

Event five: Provide learner guidance. Providing learner guidance entails giving learners the scaffolding and tools needed to be successful in the learning context. Instructors can provide detailed rubrics or give clear instruction on expectations for the learning context and the timeline for completion.

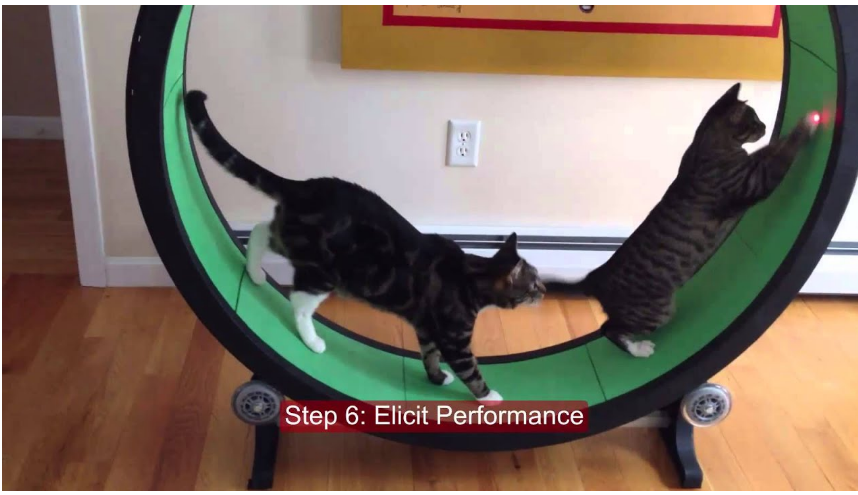
Event six: Elicit performance. Eliciting performance allows learners to apply the knowledge or skills learned before being formally assessed. It allows learners to practice without penalty and receive further instruction, remediation, or clarification needed to be successful.

Event seven: Provide feedback. Hand in hand with eliciting performance in a practice setting, the instructor provides feedback to further assist learners' content or skill mastery.

Event eight: Assess performance. Following the opportunity to practice the new knowledge or skill (events five, six, and seven), learner performance is assessed. It is imperative that the performance be assessed in a manner consistent with its domain of learning. For example, verbal knowledge can be assessed using traditional fact tests or with rote memorization, but motor skills must be assessed by having the learner demonstrate the skill.

Event nine: Enhance retention and transfer. Enhancing retention and transfer gives the learner the opportunity to apply the skill or knowledge to a previously unencountered situation or to personal contexts. For example, using class discussion, designing projects, or by writing essays.

The Nine Events: Explained by Training Cats



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Gagné's Impact on Instructional Design

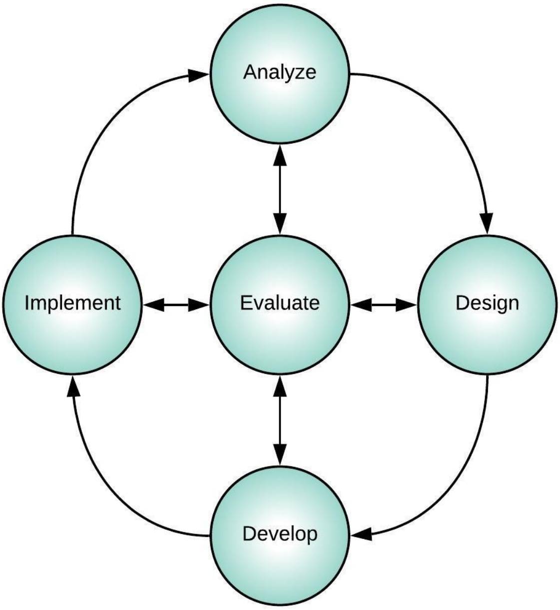
The impact Robert Gagné had on the field of instructional design cannot be understated. For example, from his initial work we can trace the evolution of the domains of learning from the Conditions of Learning through other theories such as Merrill's Component Display Theory (1994), to Smith and Ragan's Instructional Design Theory (1992), to van Merrienboer's complex cognitive skills in the 4C/ID model of instructional design (1997). Beyond that, Gagné's Nine Events of Instruction also paved the way for a systematic process for designing instruction. For the first time, those designing instruction had a process to follow, a blueprint. And almost 60 years later, Gagné’s work still serves as the basic framework all instructional designers who use systematic processes follow.

ADDIE

In 1965, the United States Air Force created their first major instructional system. By 1970, the system had grown into a full Five-Step Approach to designing instruction (US Air Force). The five steps for designing instruction were: Analyze system requirements; Define education training requirements; Develop objectives and tests; Plan, develop, and validate instruction; and Conduct and evaluate instruction. Reflexive within this circular model was feedback and intervention. This model gave way to the conceptual framework known as ADDIE, upon which the majority of subsequent systematic instructional design (ID) models are inherently based. It consists of five phases: Analysis, Design, Development, Implementation, and Evaluation (see Figure 3). Each of these phases builds on the previous phase to systematically identify and clarify an instructional problem, develop and implement a solution, and evaluate the effectiveness and efficiency of the solution. Additionally, evaluation occurs throughout the other phases to inform the design of the instruction.

Figure 3

The ADDIE model



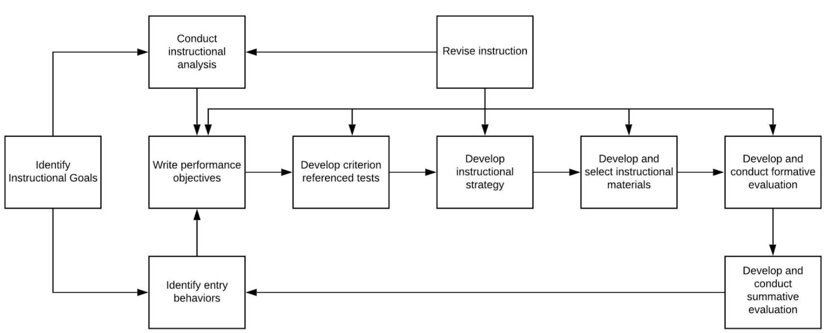
The systematic process of designing instruction begins with the analysis of a problem to determine whether instruction is a possible solution. The analysis phase includes analyzing the needs, tasks, and learners in order to clarify the problem, goals and objectives of the instruction, the learning environment, and learner characteristics. Based on the results of the analyses, the instructional designer clarifies the instructional problem and identifies the instructional goals and objectives. During the design phase, the instructional designer writes the learning objectives and chooses an ID model. The development phase consists of creating all instructional materials. Implementation is when the instruction is delivered to learners either in a formative or summative setting. The evaluation phase is reflexive with formative evaluation, which consists of ongoing feedback as the instruction is designed and developed, and summative evaluation consisting of the final evaluation after full implementation. These phases are discussed more in-depth in their respective chapters.

Dick and Carey Model

Working from the conceptual framework of the ADDIE model and building upon a systematic approach to instruction like Gagné’s Conditions of Learning, the Dick and Carey Model is one of many systematic instructional design processes. While each model may have its own individual process, they also have many characteristics in common such as attention to detail and precision. The Dick and Carey model is comprised of nine stages incorporating elements from previous design models as well as elements from behaviorism, cognitivism, and constructivism (see Figure 4). This model provides the designer with a process that incorporates flexibility and allows the designer to make appropriate adaptations for their particular situation.

Figure 4

The Dick and Carey model



Instructional Goals

Instructional goals can be set using a variety of methods; however, the key is to determine whether instruction truly is the solution or if there are other factors that may be contributing to a performance issue. The designer’s job is to sift through many points of data to get to the root of the problem. For example, employees in auto manufacturing may not be meeting company-defined benchmarks due to poor training, but it could also be due to poorly defined processes that take too much time to complete. In education, students may fall behind on benchmarks due to poor teaching, but it could be that teachers are required to cover too many topics and the students are not able to retain all of this information. To help gather this information, instructional designers perform a performance analysis and needs assessment.

Performance analysis. In a performance analysis, the designer will compare a desired performance outcome to the current performance level and identify a performance gap. This process involves reviewing data to identify the gap. Some designers will use a SWOT (strengths, weaknesses, opportunities, threats) analysis framework to help define this gap.

Needs assessment. In a needs assessment, the designer works to identify what the learners will need in order to bridge the identified performance gap. Some methods to help identify this gap can be performance data, including tests, observations, interviews, surveys, and even doing the work of the learner to help identify challenges or opportunities.

Instructional Analysis

Once goals have been established, it is important to map out the step-by-step process students will need in order to achieve these goals. In an instructional analysis it often helps to use a flow-chart to map out each skill into its smallest step but also to identify any additional steps or skills, often called subordinate skills, that must be mastered before mastering the main skill.

Entry Behaviors and Characteristics

It is also essential to identify the behaviors and characteristics of the learner in order to provide the optimum learning experience. This involves determining what the learner already knows or can do—these are called entry skills. However, it is also important to gather information on their attitudes toward learning, their motivation for learning, education backgrounds, ability levels, and personal characteristics such as age or experience with technology.

Performance Objectives

Performance objectives are what the learner will be able to do following instruction. While there are variations on how to write performance objectives, a general rule is to include a condition, a behavior, and a criterion. Many designers use Bloom’s Taxonomy or Mager’s ABCD model to help define measurable behaviors in their objectives. Ultimately, objectives should be specific and measurable.

Criterion-Referenced Test Items

Criterion-referenced test items are used to measure the performance objectives. These items can be used on assessments such as pre- and post-tests as well as performance-based measures such as performance observations using rubrics or attitude changes.

Instructional Strategy

When the assessment has been defined, the designer can work on mapping out an instructional strategy. The designer will need to review and sequence the content into a meaningful lesson. They will also need to decide on the types of learning experiences and activities they want the learner to engage in. As described earlier in this chapter, Gagné's Nine Events of Instruction is one method for structuring a learning experience.

Instructional Materials

Once the instructional framework is developed, appropriate materials are created. This can include using existing print or media materials or creating new materials. This should be an iterative process, gathering feedback and making improvements. Some designers will provide rough draft outlines to graphic or multimedia designers for development.

Formative Evaluation

As mentioned previously, formative evaluation is used to help a designer measure the effectiveness of their instructional strategy and materials. The designer will work with individuals and groups to review the instruction and identify weaknesses and/or gaps. The materials are revised based on this input to make sure the instruction is appropriate and clear for the learners.

Summative Evaluation

Finally, the instruction is reviewed by experts and field-tested. The objective is to ensure that the instruction targets the necessary skills defined in the instructional analysis and produces the desired results in the field.

Conclusion

The study of instructional design is eclectic and full of history. From its roots in cognitive psychology and the training of troops in World

War II to the rise of the systematic instructional design models, researchers have worked to provide those designing instruction a process by which not only could they create meaningful instruction more quickly, but also to consider the diversity of learners and learning contexts as well as the difference in the types of content to be learned.

If a student of instructional design looks critically at the models and theories in the field, it is not very hard to trace the continuing influence of these early researchers into today's current practices. For example, Gagné's domains of learning influenced Merrill's Component Display Theory (Merrill, 1983), as Merrill had similar categories of learning, but gave them different names. However, the idea that all content falls into one distinct domain of learning shifted with the research of van Merrienboer (1997) who wrote about complex cognitive skills that have aspects of multiple domains. The same can be said of the systematic instructional design models. The Conditions of Learning led to the Air Force model (Department of the Air Force, 1993) and the ADDIE framework. The ADDIE framework gave way to other instructional design models like the Smith and Ragan (1992); ASSURE (Heinich, Molenda, Russell, and Smaldino, and 2001); and the Morrison, Ross, and Kemp (2012). Most recently, David Merrill (2002) distilled the similarities in each model down to what he termed the "First Principles of Instruction," a model that encompasses all the others and provides a new framework for designing problem-based instruction.

The influence of Robert Gagné and the systematic instructional design models on the field of instructional design is clear. What was new in the 1950s and 1960s is now accepted unilaterally and generally implemented: not all instruction is equal; there are different domains of learning and each should be presented and assessed appropriately; and an intentional design process should lead to more effective and efficient instruction.

Application Exercises

1. Consider the different ID models in this chapter. What are the benefits of using these processes? What are the challenges with using these processes?
2. Compare and contrast the ID models in this chapter. How might the differences in each model impact the overall design process?
3. Consider instruction you have participated in at school, work, or in the community. Describe how you would apply Gagne's Nine Events of Instruction to improve that instruction.
4. You have been asked to design instruction for a large company on their new telephone system. Use either ADDIE or the Dick and Carey Model to describe the steps you would take to provide this instruction. Be specific and use the language of the model to frame your discussion.

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22

Curriculum Design Processes

Bucky J. Dodd

Whether you realize it or not, we experience curriculum every single day. Curriculum influences the most obvious learning situations like classroom lessons and workplace training sessions, but it also influences a variety of less-obvious situations such as how we learn about products, how we learn from online tutorials (yes, to an extent this applies to using YouTube to fix a leaky faucet!), and how organizations plan large-scale change efforts. Curriculum influences how people learn and grow from very young ages and continues to shape learning experiences throughout our lives.

The purpose of this chapter is to provide a survey of curriculum design processes across diverse educational and professional contexts and to highlight essential curriculum design skills embedded in these processes. Curriculum design is a core pillar of how we educate, train, and engage in formal learning experiences. At the core of curriculum design is a mental model for how people learn and a design representation for how knowledge and skill transfer occurs from theory into practice.

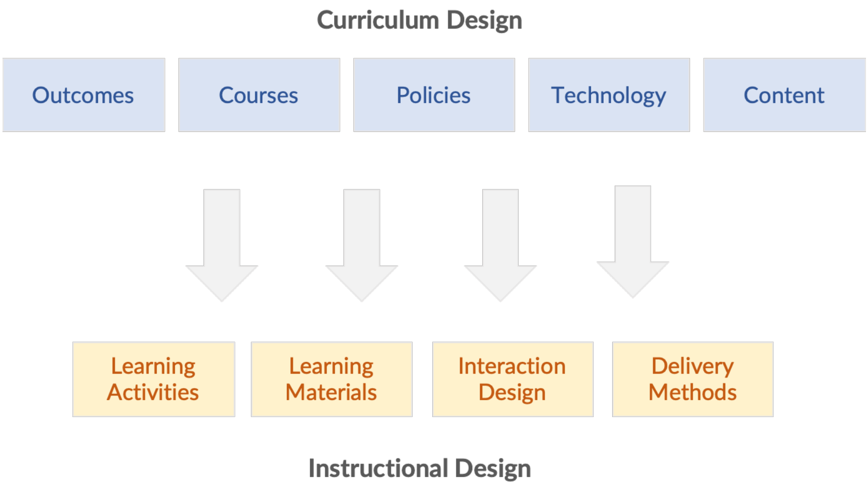
For emerging professionals in the instructional design field, curriculum design is one of a series of core competencies that are necessary for professional success (Burning Glass, 2019). In the most basic of terms, curriculum design is the process of planning formal learning experiences. Yet, there are many tacit criteria that differentiate between effective and ineffective curriculum design processes. For the purposes of this chapter, we will examine curriculum design as a strategic-level process for how learning experiences are designed. This differentiates from instructional design processes, which tend to involve more operational-level processes. For example, you can differentiate curriculum design from instructional design as curriculum design is more “big picture thinking” while instructional design is concerned with more tactical decisions within instructional materials and interactions.

Defining Curriculum Design

Curriculum design is operationally defined for this chapter as the intentional planning, organization, and design of learning strategies, processes, materials, and experiences towards defined learning and/or performance outcomes. Curriculum design is concerned with much more than learning materials. In one sense, curriculum design is creating a holistic plan for the environments where learning happens. This includes considering the physical, digital, social, and psychological factors that define the spaces and places where people learn (American Educational Research Association, n.d.).

Figure 1

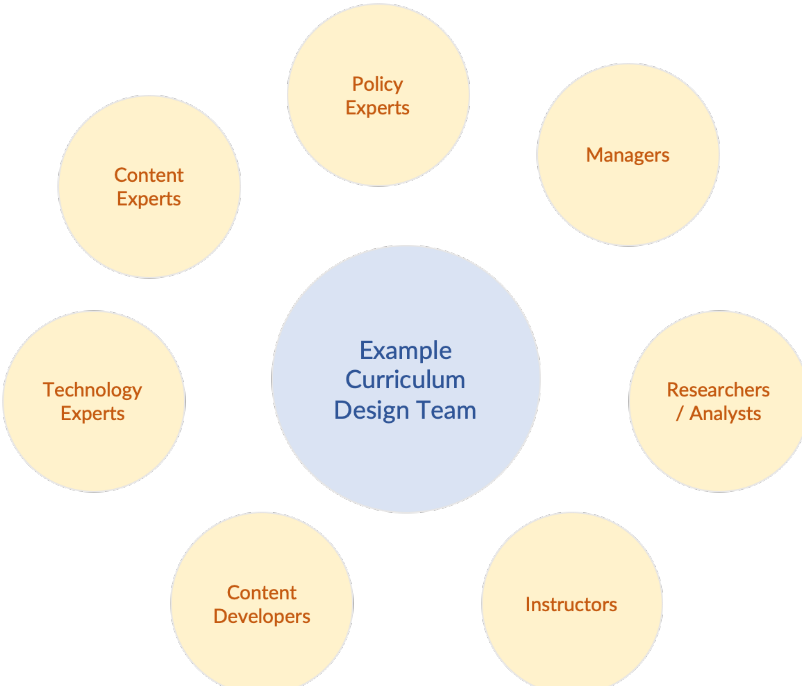
Diagram Illustrating Elements of Curriculum Design vs. Instructional Design



Curriculum design is a team sport. The teams who engage in curriculum design processes are comprised of people with diverse areas of expertise. Typically, a curriculum design team will include subject matter experts (e.g. faculty member), curriculum coordinator/director, curriculum oversight groups, instructional design and development specialists, and teaching/facilitation personnel. Depending on the nature of the curriculum, this can also include information technology specialists, organizational development specialists, data and research specialists, and senior leadership.

Figure 2

Diagram Illustrating an Example Curriculum Design Team



Curriculum design, when done well, is a process that is collaborative, results-oriented and transforms diverse ideas into a focused vision for learning.

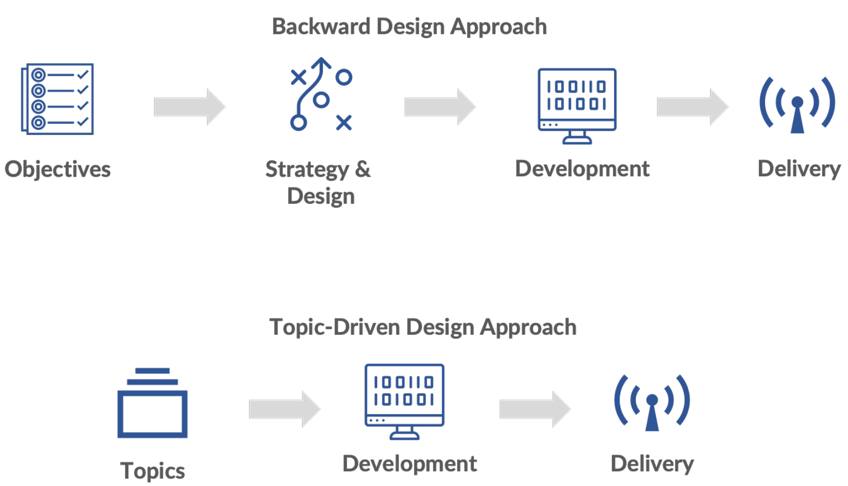
Designing Curriculum with the End in Mind

The primary goal of curriculum design is aligning learning strategies, materials, and experiences to defined outcomes. From this standpoint, good curriculum should be results-focused and efficient. To accomplish this, curriculum designers often use tools such as learner personas, needs analysis, and existing assessment data to determine the scope of a project. From there, it becomes important to develop learning strategies that connect to the characteristics of the intended learners to help them reach the desired outcomes.

Designing curriculum with the end in mind involves managing, designing, and organizing learning objectives, competencies, and standards within a curriculum. The process of designing curriculum with the end in mind is commonly referred to as "backward design" (Wiggins & McTighe, 1998). The major concept important to curriculum designers is that instead of starting with content or topics (common historical practice by many educators), backward design starts with the outcomes and then works backwards to address the content, topics, strategies, and materials.

Figure 3

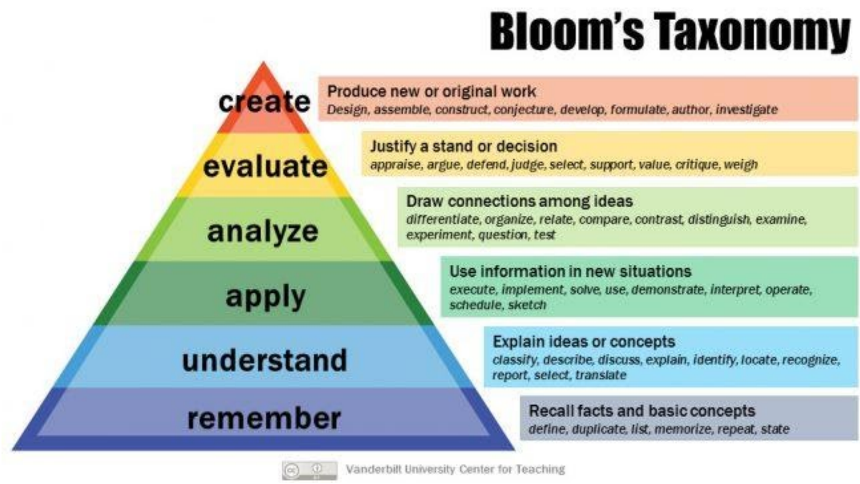
Diagram Comparing Design Approaches



One of the key tools important to backward design is the use of learning objectives taxonomies. One of the most widely used of these taxonomies is Bloom's Taxonomy (Bloom, 1956). Bloom's Taxonomy organizes learning objectives based on a "level of learning." The revised version classifies these as: remember, understand, apply, analyze, evaluate, and create. These levels describe cognitive learning processes that are demonstrated through various forms of behaviors.

Figure 4

Bloom's Taxonomy (Source: https://edtechbooks.org/-dpW)



Taxonomies like Bloom's provide a framework for organizing types of learning outcomes and selecting appropriate curriculum strategies for a specific level of learning. For example, a learning objective at the understand level will likely be designed for differently than an objective at the evaluate or create levels. This not only influences the types of strategies used, but also the alignment of curriculum elements and appropriate level of learner (i.e. novice, intermediate, advanced).

Standards and competency frameworks are common resources curriculum designers use in the process of conducting their work. These frameworks vary across countries and disciplines; however, they often serve a common purpose of aligning curriculum to common outcomes and learning/performance goals (e.g. Common Core Standards, Talent Develop Capability Model).

Representing and Mapping Curriculum

Curriculum design can be a complex process that includes many different forms of data, information, and goals. On a practical level, curriculum designers often use forms of representations or diagrams to help manage the complexity and decision-making processes. Curriculum representations provide a method for communicating and collaborating with others during the curriculum design process. This often includes representing plans for how curriculum will be organized and made available to the learner.

When mapping curriculum, there are several major and interdependent variables of curriculum that can be important to visualize. These variables are referred to as design “layers” (Gibbons, 2014). While there can be many different aspects important to represent in curriculum design processes, the following list outlines major considerations, or design variables.

- Outcomes—the intended learning or performance result from the curriculum
- Content—the topics or information included in the curriculum
- Instructional Strategies—how the curriculum is organized, structured, and/or presented to achieve a defined result
- Technology—the digital or analog tools used to support the curriculum delivery, development, or assessment
- Data—how metrics and data elements are captured, organized, stored, and represented
- Media—the physical or digital assets used to present

curriculum to the learner
- Policy—the guiding principles, rules, or regulations that frame the design of the curriculum

These “layers” represent the essential variables that effective curriculum designers consider when working on curriculum projects and initiatives. Each of these layers are interdependent and should be considered in concert with one another and not independently. For example, both outcomes and content should align to ensure the content being presented supports learners as they work towards achieving specified learning outcomes.

In the process of designing curriculum layers, curriculum designers often use representation tools and methods to organize ideas and communicate this information to stakeholders. While there are many different approaches to representing curriculum, the following list highlights common frameworks used in the curriculum design field.

- “The Canvas.” Canvas tools are analog or digital documents that organize various elements of curriculum design decisions in a single visual field. The purpose of curriculum canvas documents is to provide a structured way of organizing ideas at a conceptual level and establishing a common vision for the curriculum. Canvas tools are often used to support collaboration and brainstorming processes; however, they can also be used as a way to organize individual ideas and communicate those to others in structured ways.

Figure 5

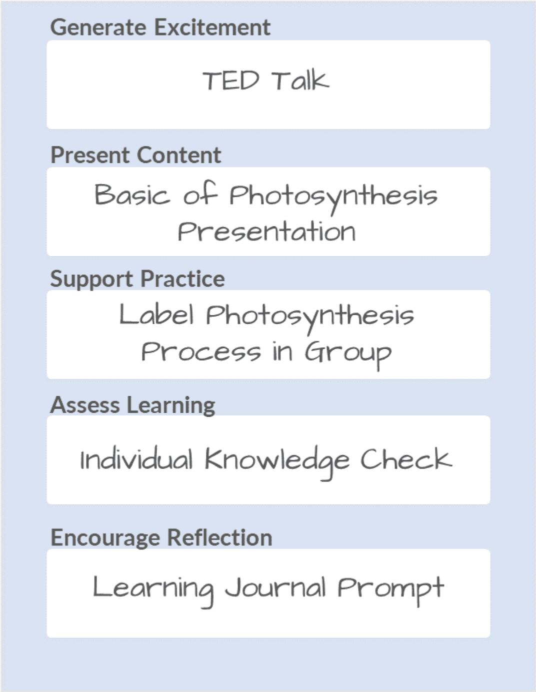
Conceptual illustration of a Canvas Curriculum Planning Tool

Visit http://www.lxcanvas.com/ for an example of a canvas-based curriculum design tool. The following video explains the elements of the Learning Experience Canvas.

- "The Lesson Plan." Lesson plans are one of the most common forms of curriculum representations across various education and training contexts. There are many, many different formats and approaches to creating curriculum lesson plans. These can range from simple outlines, to structured documents that represent many elements of curriculum including learning outcomes, instructional sequence, facilitator prompts, time markers, and teaching notes. How a lesson plan should be created is largely dependent on the intended uses and audiences for the documents.

Figure 6

Conceptual Illustration of a Lesson Plan

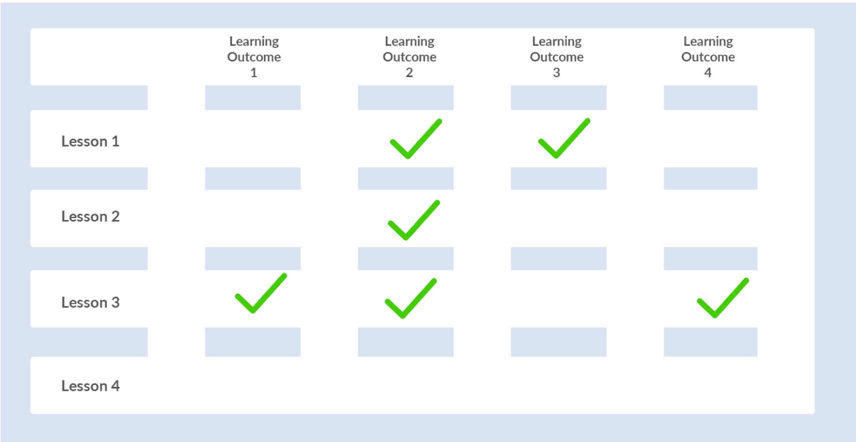


Visit https://edtechbooks.org/-TTeu for example lesson plan formats.

- "The Curriculum Matrix." Curriculum matrices are documents that represent relationships and alignment between key variables in the curriculum. This representation is often presented as crosstabulation tables that have one variable across the top row and another down the left column. Next, relationship indicators are placed in the interesting cells to show a relationship between the two variable elements. A curriculum matrix representation is commonly used to show how learning outcomes are represented across courses or units in the curriculum.

Figure 7

Conceptual Illustration of a Curriculum Matrix

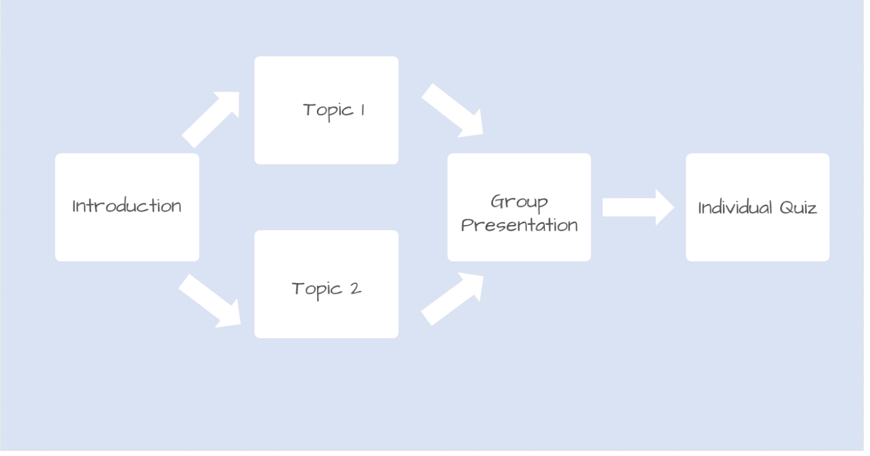


Visit https://edtechbooks.org/-Jewdb for an example curriculum matrix.

- “The Blueprint.” Blueprint-style curriculum representations integrate a number of design variables in a single diagram, or “blueprint.” The primary purpose of this type of representation is to create documentation that can be used to develop and implement curriculum. Blueprint representations often contain instructional elements organized in segments and sequences as well as production notes to guide how the curriculum should be developed and/or implemented. They often also represent relationships between the various curriculum elements. For example, a blueprint may note that a learner must complete a certain set of exercises successfully at a given mastery level before progressing to the next set of exercises. The blueprint represents the curriculum design strategy in an actionable format.

Figure 8

Conceptual Illustration of a Blueprint Curriculum Diagram



Visit https://edtechbooks.org/-LyV for an example curriculum blueprint.

Comparing and Selecting Curriculum Mapping Tools

Selecting the most appropriate curriculum mapping method is often determined based on the current phase and goals of the curriculum design process. The following table compares the curriculum mapping tools discussed in this chapter and presents selection considerations.

Table 1

Comparison of Curriculum Mapping Tools

	Canvas	Lesson Plan	Matrix	Blueprint
Uses	Use early in the design process for brainstorming and ideation	Use to plan and facilitate specific lessons	Use to align curriculum to outcomes Use for assessment of learning outcomes	Use to plan the sequence and arrangement of curriculum
Pros	Encourage group collaboration and interaction	Common format for many professionals in education and training	Clearly shows alignment between curriculum and outcomes	Visually shows curriculum elements, flows, and sequence.
Cons	Can lack specifics needed to implement curriculum	Some may see lesson plan as limiting creativity or adaptability of curriculum	Some matrix documents can be very complex which may limit their application in practice	Blueprints can be visually complex and unfamiliar for some audiences.

Learning Environment Modeling™—A Method for Creating Curriculum Blueprints

A particularly critical challenge faced by many curriculum designers is the lack of a generally accepted design language and system in the field (Gibbons, 2014). For example, many design professions have a language to represent their work so that the audience versed in the language can easily understand and build from their work. Architects, engineers, and software programmers are all examples of professionals that use design languages to communicate ideas.

Learning Environment Modeling™ was created to advance a solution to the absence of a shared design language for curriculum and instructional design. At the core of Learning Environment Modeling™ is a language that represents five "building blocks" of curriculum, four learning contexts, three transitional actions, and two standard notations. These language elements are combined together in a blueprint that shows how the curriculum is to be organized and implemented.

Visit https://edtechbooks.org/-rqn to learn more about Learning Environment Modeling™ and how it can be used to design curriculum.

Over the previous several years, a number of digital platforms have become available on the market to manage curriculum design processes. While these platforms vary in strategy, most seek to increase efficiency and provide a common digital hub for managing information and communication about curriculum processes. These platforms are currently distinct from content authoring tools used for creating materials, in that they focus solely on the curriculum organization and design, rather than content development and delivery. In addition to standalone curriculum design platforms, many learning management systems are incorporating similar features as part of their capabilities.

Examples of Curriculum Design Platforms

- Coursetune
- eLumens
- Synapes

Examples of Learning Management Systems with Integrated Curriculum Design Capabilities

- Moodle
- Canvas
- Brightspace by D2L
- Blackboard

Innovation Considerations for Curriculum Design Processes

As innovations in learning design and technology are created and scaled, curriculum design processes must adapt to ensure these methods remain grounded in effective learning practices. This section discusses several innovation trends and their possible implications on curriculum design processes.

One of the foundational innovations influencing curriculum design processes is a shift from individual-focused design to team-based curriculum design. Curriculum design is becoming more and more a "team sport" where people from diverse backgrounds, professions, and areas of expertise work together to create curriculum. The increasing influence of technology continues to not only incorporate new backgrounds (e.g. technologists), but also allows people from all around the world to collaborate on curriculum more efficiently. Successful curriculum design professionals are master facilitators across different types of contexts and through the effective use of collaborative technologies.

In addition to curriculum design becoming more collaborative, it is also becoming a more strategic and holistic activity. Traditionally curriculum was viewed like a product that was self-contained and independent. As such, curriculum design processes mirrored product development cycles and approaches. As organizations, learning needs, and technologies change, curriculum design is moving more towards a holistic perspective of learning environment design. This mindset goes beyond curriculum as a product, and more about designing the collective spaces and places where people learn at a strategic level. While this may seem like semantics at first, the implications for how curriculum is designed and connected with other elements in a learning environment is profound.

Moving from curriculum design to learning environment design requires a systems thinking perspective that involves not only designing elements in the learning environment, but also designing how those elements interact together. A good example of this is the emergence of blended learning as a common instructional practice. Blended learning is the combination of classroom and digital learning experience in a unified strategy. Curriculum designers must not only be considered with the design of classroom curriculum and digital curriculum, but also how they interact together in a unified learning environment.

The broad adoption of mobile devices have also caused innovations in curriculum design. For example, designing curriculum that is responsive across different types of devices with different screen sizes is a basic innovation influencing the field. In addition, designing curriculum for other mobile device features such as geo-positioning, imaging, and content creation capabilities offer exciting and often challenging situations. Many modern mobile devices now have immersive virtual space capabilities such as virtual reality and augmented reality. These capabilities highlight the need for new curriculum design approaches that have not traditionally been required. Mobile and extended reality learning capabilities will continue to be a major consideration for tomorrow's curriculum designers.

In addition to collaborative design processes, mobile learning, and extended reality innovations, one of the more profound innovations influencing curriculum design processes is adaptive learning. Adaptive learning is a general concept that describes the process of providing learners with dynamic learning experiences based on their prior performance (Educause, 2017). This is commonly used for recommending remediated learning experiences and encouraging peak learning performance. The reason adaptive learning is such a profound innovation for curriculum design processes is because it introduces the dynamic layers that have not traditionally been used. For example, a curriculum designer would create a defined path for learners to follow based on assumptions and requirements set forth in the design process. Adaptive learning shifts this decision making to programmatic algorithms or a more complex map of learning experience options. This requires curriculum designers to think and make design decisions about much more complex and dynamic learning environments.

Conclusion

Curriculum design processes are essential to effective learning experiences across education and professional contexts. Without effective curriculum design processes, learners often lack the structure and guidance necessary for optimal learning and organizations lack the ability to effectively measure results and optimize their return on investments. While we have all experienced curriculum, the process of designing curriculum is changing, becoming more complex, and incorporating new technologies and strategies. One of the most profound shifts is expanding the scope of curriculum design to consider how curriculum connects to broader and more networked learning environments. Curriculum design is an essential skill for emerging education and learning professionals and will continue to be a dynamic, innovative, and exciting field of practice for years to come.

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26

Using Visual and Graphic Elements While Designing Instructional Activities

Justin Sentz

The time and expense of creating and obtaining visual/graphic elements, or pictures, for use within instruction is not insignificant. Then why use visual or graphic elements during instruction at all? The use of pictures during the design of instructional activities has been shown to have a significant impact with regard to both increased learner motivation and improved learning outcomes (Carney & Levin, 2002). Pictures and graphics can serve to convey information to the learner directly or facilitate the learner's understanding of related textual information within the instruction. Different types of visual and graphic materials are particularly suited for specific functions during instruction, and there are well-established design considerations for their use within instructional activities to increase their effectiveness. The use of pictures and graphics plays an important role in helping to manage the intrinsic cognitive load and reducing the extraneous cognitive load experienced by learners, who are then able to devote mental resources to learning the material within the instruction (Sweller et al., 2019).

The Role of Visual Messages in the Communication of Information

In order to be intentional about the use of visual and graphic elements during the design of instruction, it is important to first consider some of the fundamental concepts related to the role of visual messages within the communication of information more generally. What exactly is a picture, and what purpose does it serve? Knowlton (1966) proposed that visuals, or pictures, could be categorized according to their purpose or function within instruction-realistic, logical, or analogical. Realistic pictures look like the objects they refer to in the real world outside of the instruction. If the intention is to communicate a concrete example of the concept being presented, then a realistic picture is a good option for doing so. Logical pictures, on the other hand, provide a visual depiction of the structure of a concept being presented. If the purpose is to communicate an understanding of the organization of territories within a country or how electricity flows through a circuit, then a logical picture such as a map or diagram would be effective. Finally, an analogical picture depicts relationships among complex concepts through the use of concrete visual elements that are more familiar to the person. When there is a need to compare a particular phenomenon to something a learner is more likely to encounter in everyday life, then an analogical picture is a helpful option for communicating that information.

Using Visual or Graphic Elements to Increase the Effectiveness of Instruction

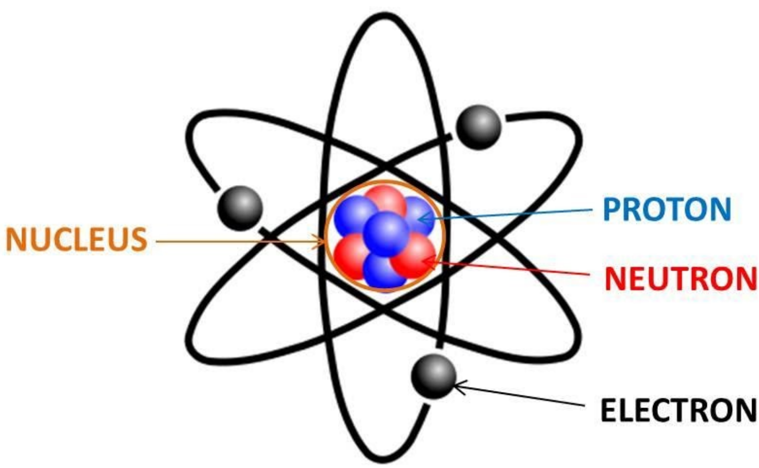
Taking into consideration the role of visual messages in the process of communicating information, it is important to think about ways in which visual and graphic elements can be used to increase the effectiveness of instructional materials. Peeck (1993) has suggested that the effectiveness of pictures within instruction is dependent upon the manner in which they cause the learner to process the information contained within the visual elements provided. This, in turn, is a product of both the characteristics of the learners themselves and the graphic materials used within the design. For example, visual elements can be a powerful means of showing spatial relationships or positioning of objects that are being presented within the instruction. These types of visuals can be placed before a section of text when learners are expected to draw upon prior knowledge of the information. They may also be placed in-line with the text when learners are unfamiliar with the spatial relationships and will benefit from a picture that shows relative positioning of the objects being discussed. Depending on the complexity of the material relative to the expertise level of the learner, pictures may also serve to illustrate abstract concepts that are presented textually within the instruction. Learners can use these visual elements to supplement their comprehension of the material through these representations or confirm their understanding of the text by reviewing the graphics and pictures provided. Yet another element of effectively using visual and graphic elements within instruction is the potential to motivate learners to pay particular attention to specific material and process information from the text more deeply. A learner may prefer to clarify or reinforce their understanding of textual information through visual elements, which can in turn help with the encoding and subsequent retrieval of that information at a later time.

Types of Visual Elements and Their Functions Within Instruction

While pictures and other visual elements can be extremely effective for learner motivation and comprehension, specific types of visual elements are more effective than others based on their function relative to the ways in which they relate to the instruction. Levin et al. (1987) categorize pictures into five general types according to those functions-representation, organization, interpretation, transformation, and decoration. One of the most common types of pictures used in instruction is representational, which illustrates the textual information being presented for the purpose of reinforcement (see Figure 1). When the purpose of using a picture is to present a concrete visual representation of information contained in the instruction, a representational picture is often the way to go.

Figure 1

A Representational Picture Illustrating the Components of an Atom. Retrieved From https://edtechbooks.org/-AgYr



Another type of visual element is organizational, which shows relationships between different parts presented in the text (see Figure 2). These can serve the purpose of illustrating a series of steps in a procedure or provide a large set of data through graphics such as diagrams or charts.

Figure 2

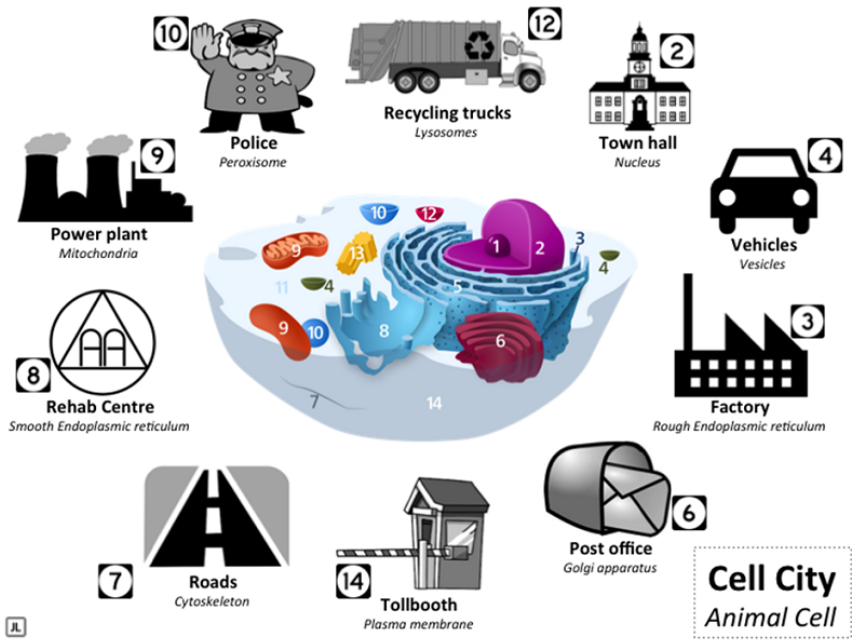
An Organizational Picture Illustrating the Steps for Performing CPR.

Retrieved from https://edtechbooks.org/-FYYb.

An interpretational picture is a third type of visual element that is often used when the intent is to clarify complex information provided within the text (see Figure 3). Much like Knowlton's (1966) idea of analogical pictures, these visual analogies can be used to ground more abstract concepts in visual elements that are easier for the learner to comprehend.

Figure 3

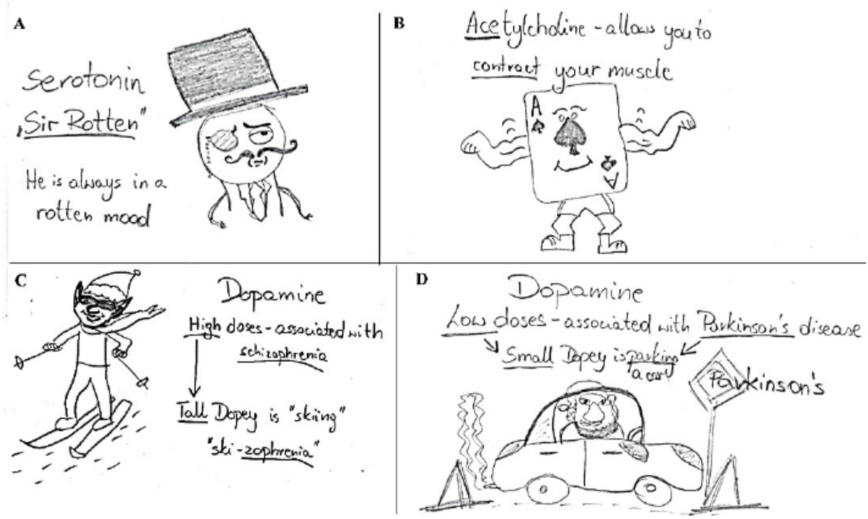
An Interpretational Picture Presenting the Structures in an Animal Cell as Buildings in a City. Retrieved From https://edtechbooks.org/-JXwZ



Yet another type of graphic element that is somewhat infrequently used is the transformational picture, which provides a mnemonic that facilitates retrieval of information from memory at a later time (see Figure 4). If the intent of the visual element is to help the learner memorize information through the association of a related picture, then the creation of a transformational picture may be worth the time and effort to design.

Figure 4

A Transformational Picture Using Mnemonics for the Actions of Neurotransmitters. Retrieved From https://edtechbooks.org/-kFI



A final type of visual element that is used within instruction but has no empirical support for its impact on learning is the decorative picture, which serves to break up textual information or provide "eye candy" for the learner (see Figure 5). While it is sometimes argued that decorative images may motivate learners, their use is not directly tied to improved learning outcomes and are thus generally discouraged.

Figure 5

A Decorative Picture of a Mountain. ["Mountain"]() by barnyz is licensed under CC BY-NC-ND 2.0

Strategies for Structuring Visual or Graphic Elements to Facilitate Processing

We can see that visual and graphic elements have the potential to increase the effectiveness of instruction, and specific types of visual elements are more appropriate based on their intended function within the instruction. However, it is also important to note that the manner in which visual and graphic elements are structured have a significant impact on the manner in which they are processed by learners. Sweller et al. (2019) describe cognitive load as the mental effort required by learning tasks that impact the learner's ability to both process new information and store it within long-term memory. They propose a set of strategies for structuring visual and graphic information to help manage the intrinsic load associated with the material itself and the extraneous cognitive load that is introduced by the instructional techniques employed:

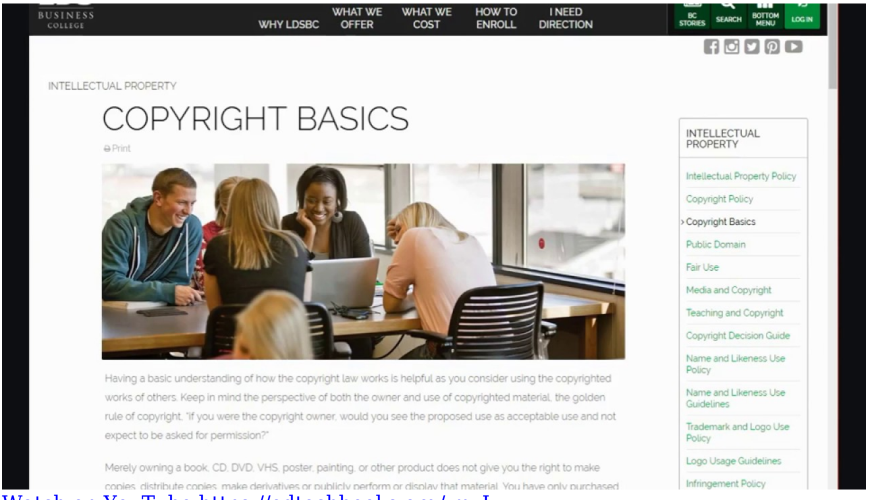
- Integrate textual and graphic information into one element in order to eliminate the effect of splitting the learner’s attention. This could be accomplished by taking a list of procedural steps and overlaying them on a diagram to show where each step should be performed.
- Eliminate multiple stand-alone sources of textual and graphical information in order to reduce the mental effort needed to deal with redundant information. If a visual or graphic element can fully communicate a concept without additional textual information, then it should be used on its own.
- Present concepts before adding context by giving the learner increasingly realistic visual elements during the instruction. By starting with low-fidelity visual elements and building toward high-fidelity elements, the learner is able to gain an understanding of the concepts rather than being distracted by contextual details.
- Gradually present information to learners through visual and graphic elements. Through the use of this simple-to-complex strategy, the learner will be able to avoid getting overloaded by too much information before processing the required information.
- Strategies to reduce cognitive load tend to have a reverse effect on learners with greater levels of expertise, and thus need to be adjusted accordingly. An example of this would be if the instruction will be used with expert learners who are familiar with a procedural diagram, the textual instructions could be removed from the graphic element and replaced with numbers for each step.

Finding and Creating Visual and Graphic Elements

Locating or creating visual and graphic elements to enhance instructional activities according to the principles discussed in this chapter may seem like a daunting task, but there are a number of resources available to make the process manageable. If you would like to find visual elements that have already been created by someone else, a number of sites online have collections of images that can be used without having to pay for their use. A few of these sites include:

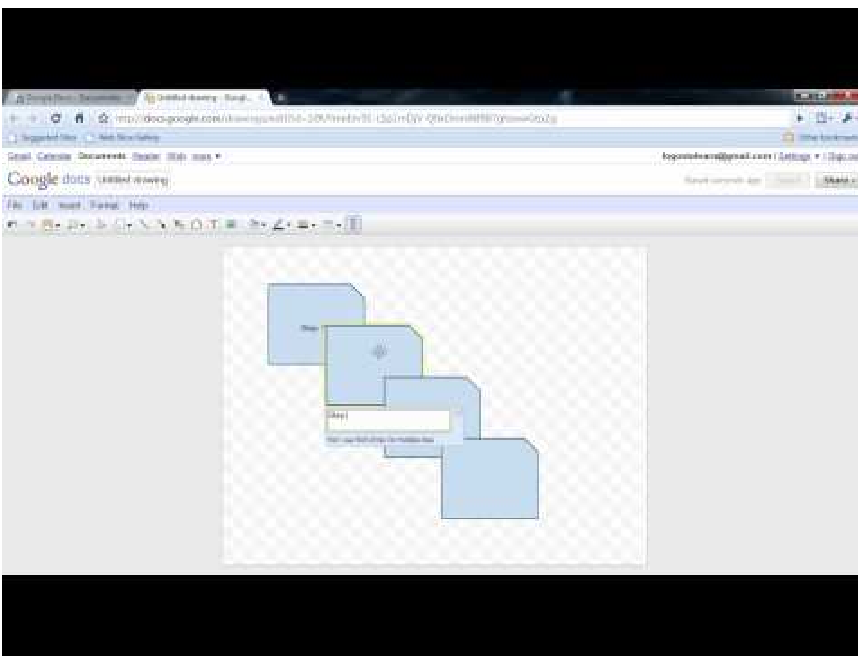
- Creative Commons image search
- Unsplash
- Pixabay
- StockSnap.io
- Pexels

In addition to these individual sites, you can also use the Google Image Search in order to identify visual elements that have usage rights allowing you to employ them in your instruction without infringing on the copyrights of the owner. Watch this video to learn how this is done:



Watch on YouTube https://edtechbooks.org/-mxL

If you are unable to locate existing visual or graphic elements for use in your instruction or have specific requirements in mind, you can always create them yourself in a number of different ways. First, you can take photos with a smartphone or digital camera and download these onto your computer for incorporation into your materials. Second, you could create the visual element by hand with a line drawing that communicates the desired information and scan that image into your computer using a digital scanner or printer. Finally, you can create visual elements in software packages such as Adobe Photoshop or through the SmartArt feature in Microsoft Word or PowerPoint and export them for use in your instruction. Google Drawings is a free, web-based alternative to these types of software that can be used to create charts, maps, or diagrams and download them as PNG or JPEG files without a great deal of design experience. Watch this video to see the basic use of this tool:



[Watch on YouTube https://edtechbooks.org/-QvYU](https://edtechbooks.org/-QvYU)

Conclusion

Employing the use of visual and graphic elements during the instructional design process is not simply a matter of finding or creating a set of pictures that are somehow related to the textual information in the instruction. Research has shown that visual elements have the potential to increase motivation and foster improved learning outcomes, but only when the appropriate role of visual messages in the communication of information is taken into account. Specific types of visual elements can be used to serve a particular function in the instruction based on the manner in which information is presented, such as showing spatial relationships or illustrating abstract concepts within the text. In addition, following basic strategies for structuring visual and graphic information can facilitate learner processing through the management or elimination of the cognitive load experienced by the learner. In the end, the creation and curation of visual/graphic elements for instructional activities will be well worth the time and effort invested when the purpose of using those elements is aligned with the objectives of the overall instruction.

Application Exercises

1. Using an existing unit of instruction or one that you are in the process of creating, explain how you would use visual or graphic elements to increase the effectiveness of the instruction by doing the following:
    1. Showing spatial relationships or the relative positioning of objects
    2. Illustrating abstract concepts that are presented in the text
    3. Motivating learners to pay particular attention to specific material in the text
2. Using pre-existing instruction or materials you have created, explain how visual elements are used (or could be used) to serve each of the following functions:
    1. Representation
    2. Organization
    3. Interpretation
    4. Transformation
3. Within a unit of instruction that employs visual and graphic elements, explain how at least three of the five strategies for structuring visual elements outlined in this chapter could be used to reduce cognitive load and facilitate processing for the learner.

Additional Readings and Resources

Check out these resources for additional information on the topic of using visual and graphic elements while designing instructional activities:

- 233 Tips on Graphics and Visual Design [PDF eBook]
- Instructional Design and Visual Design: The Pillars of Great eLearning
- 10 Types of Visual Content You Should Use to Increase Learner Engagement
- Accessible U: Instructional Graphics
- Do Learners Understand Your Instructional Graphics? [Podcast]

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27

Simulations and Games

Jeff Batt

Simulations present the learner with real world scenarios and allow them to explore the scenario a "safe" environment. A basic pattern for this is to (a) present or show the desired end result; (b) allow students to safely try the result out; (c) then evaluate if the student is able to complete the task; (d) and allow them to play around with the concepts in an engaging way to deepen their learning. Let's call these: present, try, evaluate, and play.

Present: Presenting starts by showing the learner how to perform a certain action. This could be by simply showing them a video or having them click through a series of slides or steps to see how to accomplish a task.

Try: Trying happens as the learner is placed in an environment that is reminiscent of the real-world environment, but this environment has been simplified, altered to minimize or eliminate risks, or has been otherwise modified to draw out the material to be learned. This is what we mean when we say a simulation is a "safe environment." For instance, in a simulated Information Technology environment, the learner can't cause a system to crash or accidentally send out secure user data as they try things out. You do want the simualted environment to be recognizable when compared to the real-world scenario, however, so that learners get an authentic experience and can transfer what they learned back into the real environment.

Evaluate: After learners have seen the desired outcome and tried it in a safe environment, you want to evaluate them: can they do it in an environment with no extra help and with real consequences? Evaluation helps both solidify lessons learned as well as providing the teacher/instructional designer insight into whether the learner can perform the task or not.

Play: Simulations and games allow for exploration; learners' don't have to just proceed through the instructional material in a linear way. And even fun, exciting games can be educational; they create engagement that helps students learn the concepts in a different manner through their simulated play. Games can even create a desire for the student to "try again" to see if they can get a higher score or if they can master a concept. Gaming, then, could be a useful technique to help solidify the concepts being taught.

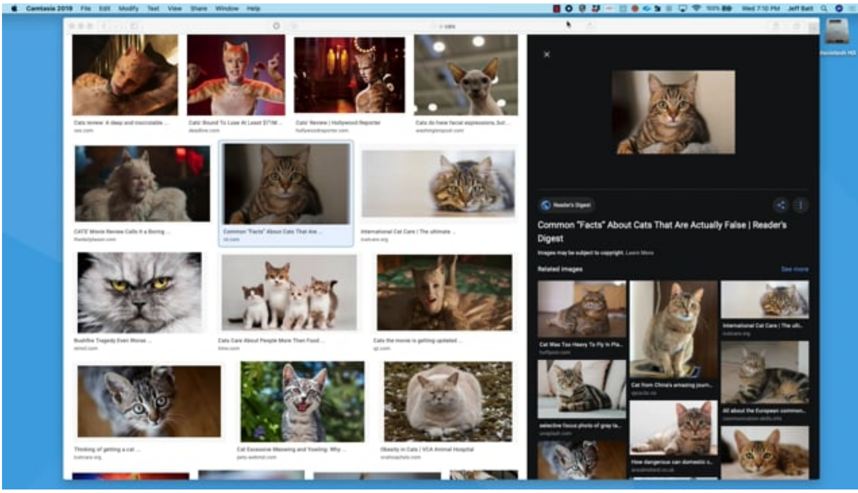
Keeping these four principles in mind, let's consider how they could be applied in some common scenarios.

Simulation—Watch

One form of an instructional simulation asks learners to watch a procedure or skill. One of the more common forms these simulations can take is the software simulation. A software simulation is essentially showing someone how to do some action on a computer by recording your screen. In Video 1 you can see an example of how to create a Watch simulation using the screen recording tool Camtasia.

Video 1

An Example of How to Create a Watch Simulation



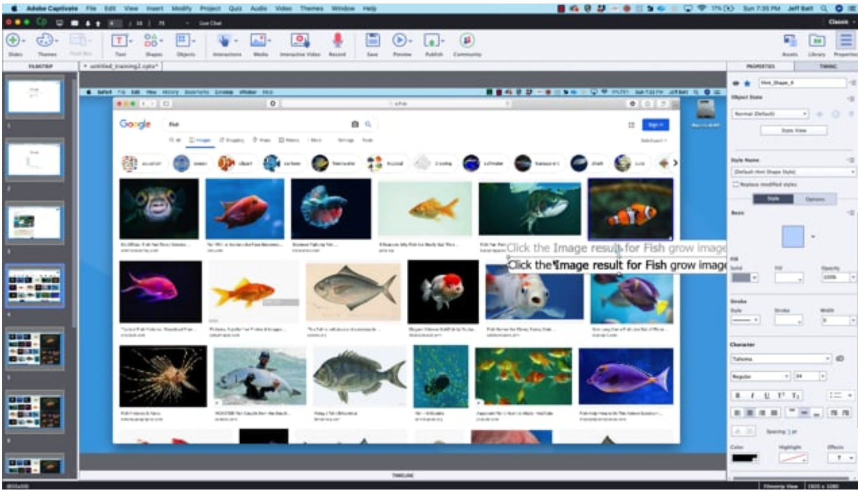
[Watch on Vimeo https://edtechbooks.org/-MFS](https://edtechbooks.org/-MFS)

Simulation—Try

The next kind of simulation is one that allows students to try a skill or procedure themselves. This allows the learner to engage with the content and practice it in a safe environment. There are various applications that can be used for creating a Try simulation; in Video 2 you can see an example of how to create a Try simulation using the tool Captivate.

Video 2

An Example of How to Create a Try Simulation



[Watch on Vimeo https://edtechbooks.org/-gTuT](https://edtechbooks.org/-gTuT)

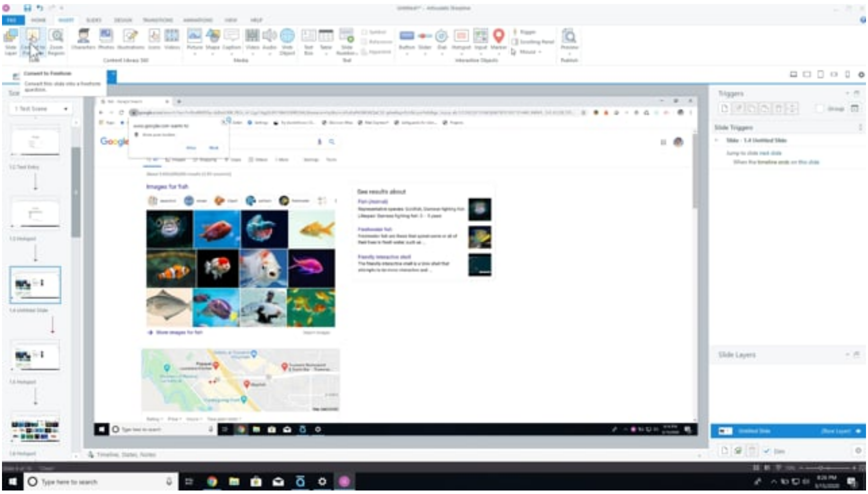
One last tip: you create Try simulations, consider including ways that the student could possibly fail. Failing is part of learning; it can help the learner see what happens if they select various alternatives, as well as help them consider how they can recover from their mistakes.

Simulation—Evaluate

After the learner has watched a procedure and tried it out for themselves, you may need to ensure they know how to perform certain tasks. This is where the role of Evaluate simulations come into play. Evaluate simulations help both you and the learner judge if they are able to perform a task they have just learned. The most helpful evaluation simulations are ones that allow the user to fail and learn from their mistakes. The key here is to try to make the simulations as close to the real environment as possible. Video 3 shows you how to get started doing this.

Video 3

An Example of How to Create an Evaluate Simulation



[Watch on Vimeo https://edtechbooks.org/-iAG](https://edtechbooks.org/-iAG)

Simulation—Play

The last type of simulation allows students to play with ideas or concepts associated with the instructional environment. Playing helps learners work with the knowledge they have gained in different, engaging ways. The goal is to help them take what they learn and apply it in novel ways so they are able to master it better. Let's walk through some important parts of a game.

There are key factors that go into creating a learning game which enables this simulated play. I don't think anyone expects you to create a World of Warcraft type game, but there are some parts you can use to make the game stand out in an engaging and fun way for the learner. Some important considerations for Play simulations include: Theme, Progression, and Challenge. Consider each of these principles using the extended example below.

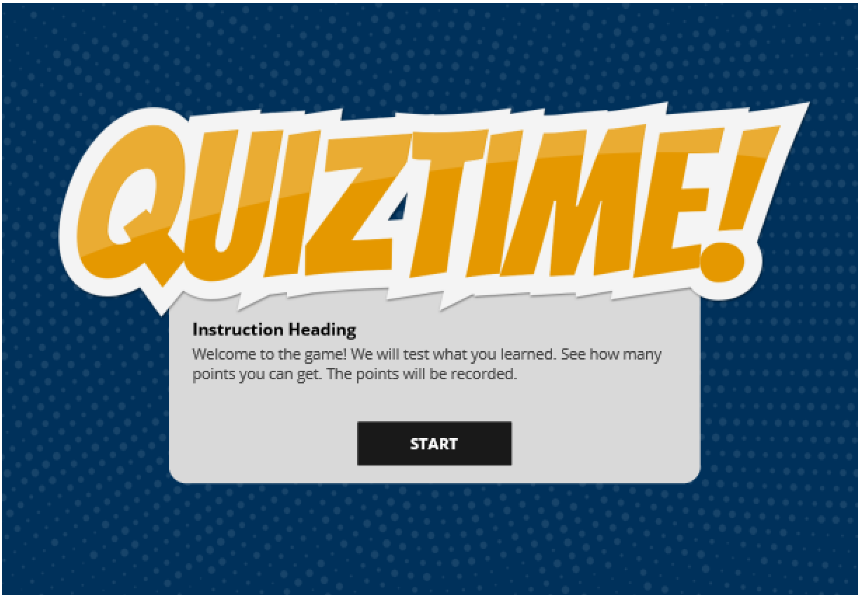
Theme

A theme is a unifying core to your game that helps express its purpose, and bring a sense of harmony between that purpose and the tone, visuals, audio, video, text, and other elements you create. To immerse learners into the game, introduce a theme as soon as possible, perhaps expressed by using a clever or unique logo. This helps the learner know they are exiting the standard instructional format and entering a gamifed environment.

Review this Jeopardy-style game. Notice how a theme is introduced when the learner first begins the game, as are initially presented with a large logo that provides clues about what they will be doing.

Figure 1

Initial Logo of a Game



Providing a theme has a couple of results. It sets the tone of the game through the logo and visuals that compliment the logo. And the theme can help you tell the "story" of the game, or provide cues to the learners about how they should interact with the environment.

Progression

Progression is how learners move from the beginning to the end of your game, and how they navigate through the steps in between. Progression is a principle you could use in different ways. In the case of our Jeopardy game, the tool to manage progression is the game board.

Figure 2

Progression Screen

As the learner moves throughout the game, they clearly see where they have been along with what levels or cards were successful or unsuccessful.

Figure 3

Progression Screen Reflecting Progress

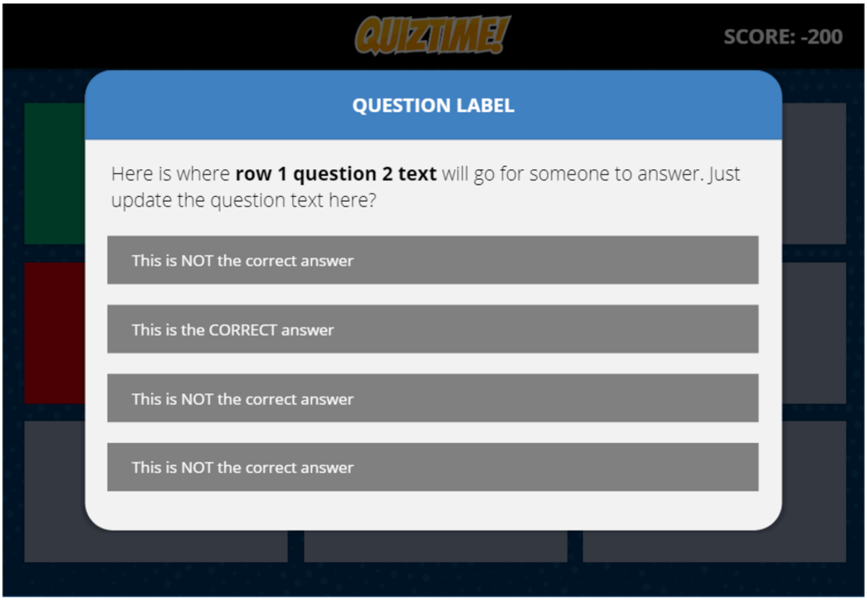
This type of progression tool is also helpful for the learner if they try the game again. They can use the progression board to gauge how they are doing each time they play.

Challenge

Challenges are how you present instructional content and allow learners to interact with that content. In our game, when the learner choosees options on our the progression board, they begin an individual challenge. These challenges can come in many different forms with varying levels of challenge between the tasks. One way to challenge the learner is through a standard question.

Figure 4

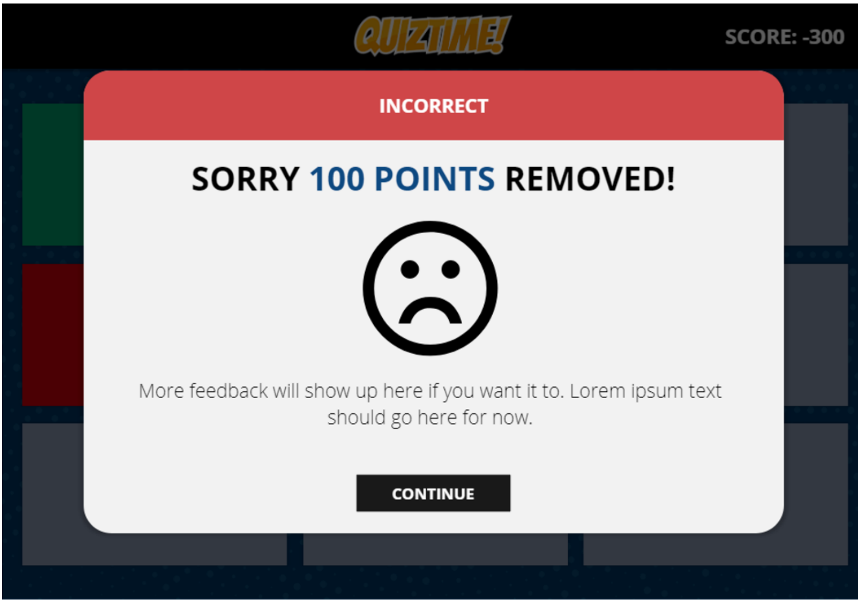
Standard Question



If the learner gets the answer incorrect, they will see some kind of visual indication, and perhaps some feedback.

Figure 5

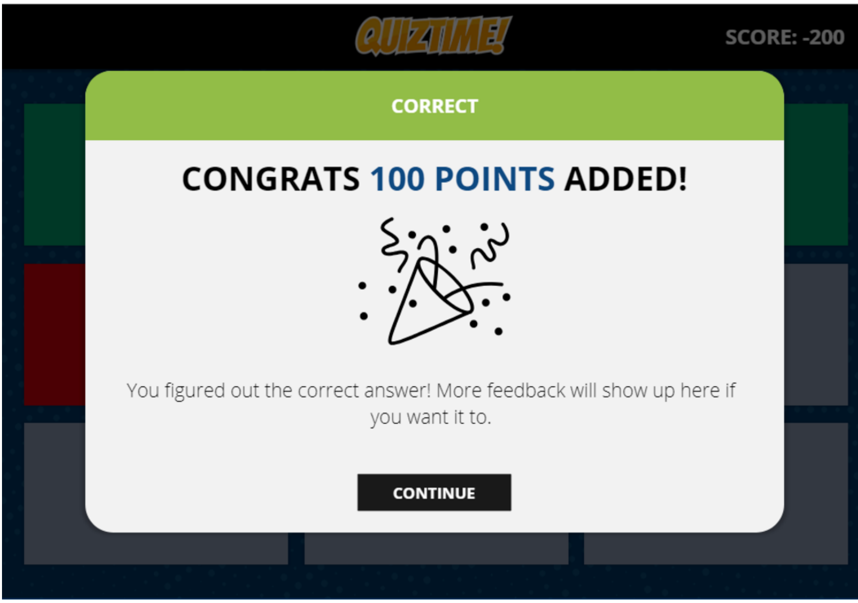
Feedback on Incorrect Answer



If the learner gets the question correct, they will see correct feedback.

Figure 6

Feedback on Correct Answer



But you can present challenges in ways other than through questions. You can also add some more ambitious aspects into each challenge, like having them try a procedure or a skill.

Also, since this is a game, you might want to have an overall score that is visible to the learner. When the learner gets the challenge correct, the score increases. To make it even more challenging, points could be taken away when the learner does not answer correctly. You could also add a timer or other sense of urgency for students to complete the game.

Managing Interactions in Simulations and Games

Simulations and games require you to manage interactions that students have with the program, such as when you have to pass information from one screen to another based on how students respond to a question. Three common ways of managing interactions you should know about are Variables, Triggers, and Conditions.

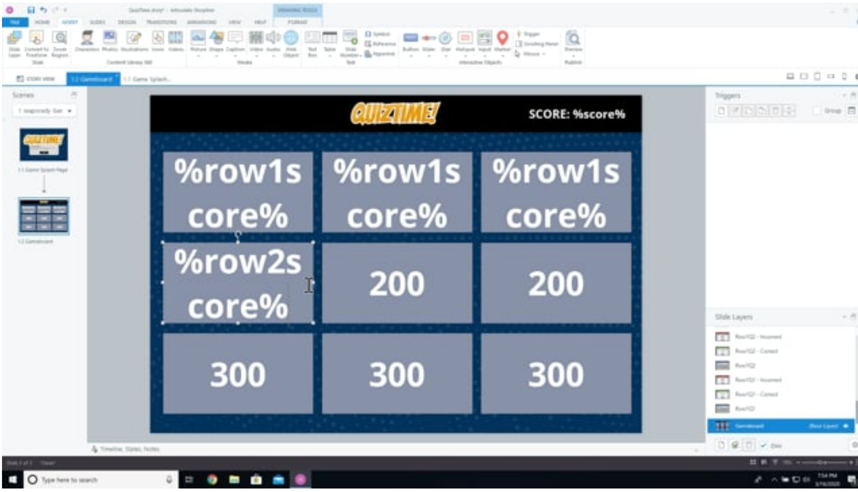
Variables

Variables are storage locations. They hold information that can change or be updated later. The most common type of variable for a game is the Number variable which will store a number value. This is perfect for scoring or being able to calculate end results in a final interaction. For instance, if you create a game with a score, you want to create a variable that holds the initial starting value (probably 0), but can then be changed depending on whether learners earn points or have them taken away.

Let's explore how to create a variable in this video in a common instructional authoring tool.

Video 4

Creating Variables



[Watch on Vimeo https://edtechbooks.org/-btAP](https://edtechbooks.org/-btAP)

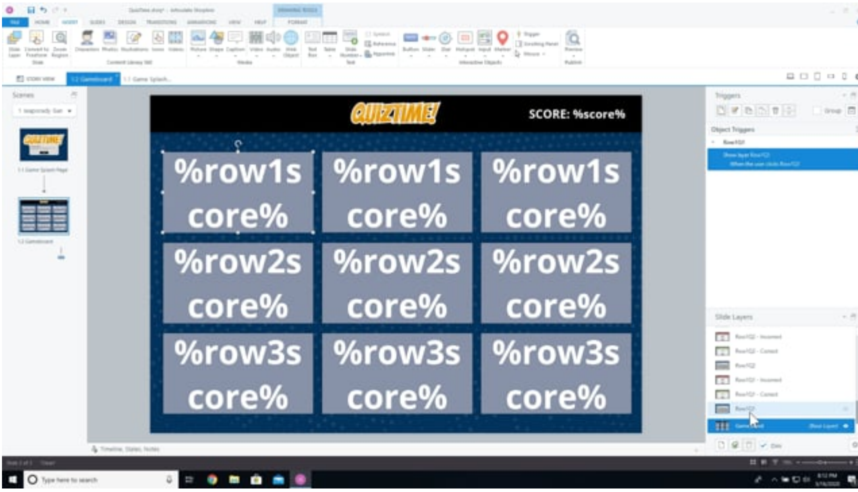
Triggers

Triggers are events that happen in a simulation. For instance, when a button is clicked, what should happens next? In many instructional authoring tools, you'll use triggers to show and hide different elements based on how learners interact with a page.

You have a lot of flexibility with triggers, and the key to adding different types of interactive play is to try out different types of triggers. Instead of only using standard questions in a game, for example, you can use drag and drop, timed elements, and more. This creates the interaction and intensity of simulated play.

Video 5

Using Triggers

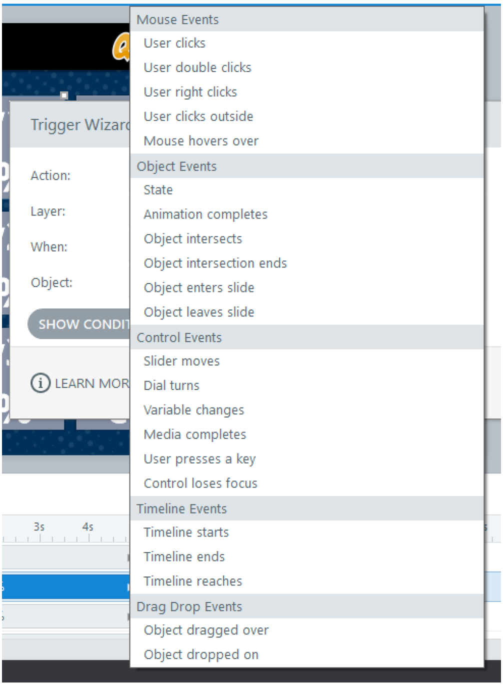


Watch on Vimeo https://edtechbooks.org/-JNe

One key to using triggers is deciding when the trigger will happen. This is done under the "when" part of the triggers. Figure 7 provides a list of instances when a trigger can fire.

Figure 7

Trigger Selection Screen



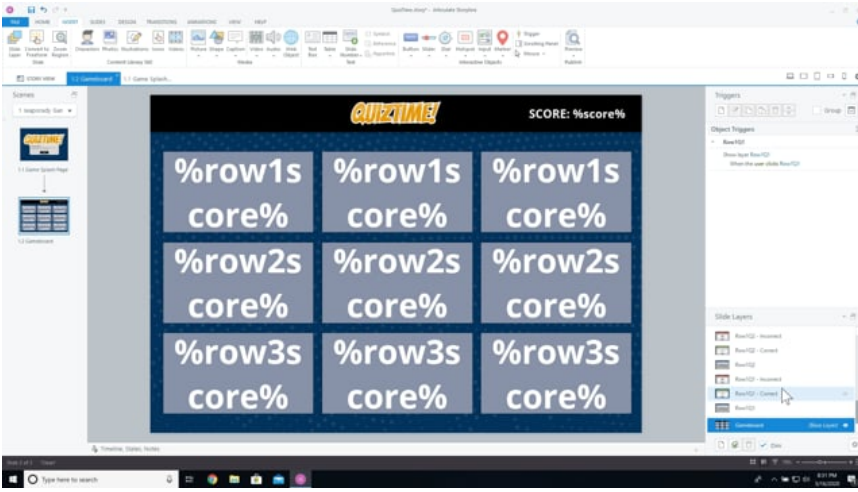
Conditions

Triggers are great, but there may be times you only want the trigger to happen if a certain condition is true. Consider the following statement: "If you're happy and you know it, clap your hands."

This is a simple statement, but it reflects so much of what a condition is. It starts with the key word if. Meaning, we only want this condition to happen if certain conditions are true, and the conditions are, "if you are happy and you know it." We are checking for two conditions, then running the action if the condition is true.

Video 6

Understanding Conditions

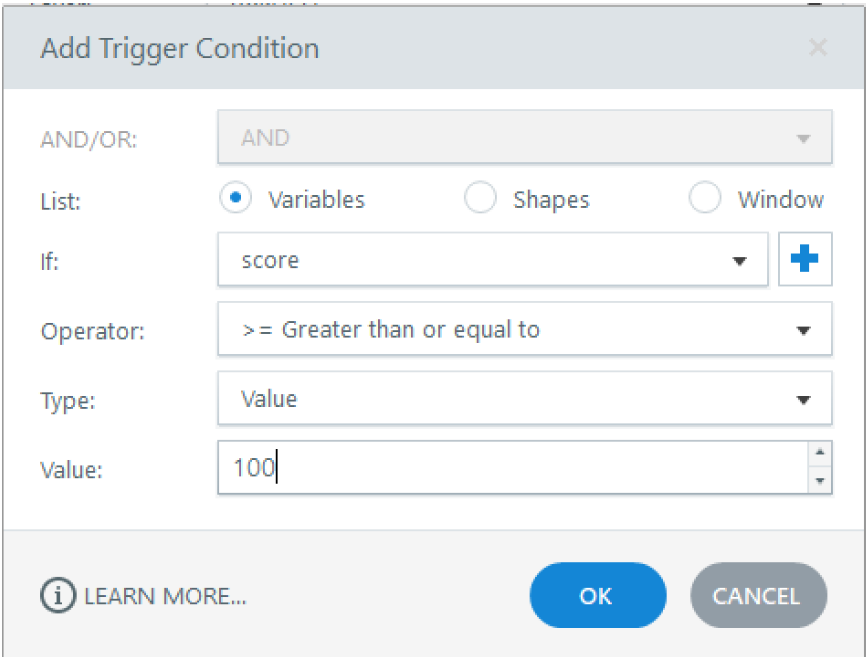


[Watch on Vimeo https://edtechbooks.org/-keR](https://edtechbooks.org/-keR)

Most of the time you will use conditions when you are checking a variable value. So, with the Variable option selected, find the variable you are checking for and select the value. It will then ask you to select an operator. Let's use the score variable and check if it is greater than or equal to 100.

Figure 8

Trigger Condition Screen



Now this trigger will only run if the value is 100 or greater. This is a great way for you to only have triggers run if a condition is met.

Conclusion

The goal of instruction is to help the learner first understand and then be able to apply what they are learning in safe and controlled environment. Simulations and games are great tools for doing this, allowing learners to test the new concepts before entering the real world, practice mastery through fun and engaging games, and try scenarios in an environment that allows them to fail and learn from their mistakes.

30

Measuring Student Learning

Lisa Harris & Marshall G. Jones

Measuring student learning is critical in the teaching and learning processes and can serve many purposes. Instructors can use assessment results to plan future instruction, adapt current instruction, communicate levels of understanding to students, and examine the overall effectiveness of instruction and course design. The measurement of student learning can take place before, during, or after instruction. Before lessons are even developed, instructors need to know what students already know and can do related to the content. There is no point in wasting time teaching something students already know, or in starting at a level that is so advanced students don't have the prerequisite knowledge necessary to be successful. To that end, the learner analysis in instructional design could be considered a type of assessment. Giving a pre-assessment, also called diagnostic assessment, can provide instructors with this valuable information. Measuring student learning during instruction, a formative assessment, provides instructors with important information about how students are progressing towards the learning objectives while there is still time to adjust instruction. Instructor may ask questions such as:

- Are students getting it?
- Are they confused about something that needs to be retaught?

- Is it time to move on with new material?

Finally, measuring student learning at the end of instruction, a summative assessment, provides information about the degree to which students mastered the learning objectives.

This chapter outlines practical strategies instructional designers can use to develop high-quality assessments to measure student learning. Best practices are the same for constructing diagnostic, formative, and summative assessments. Links to additional tools and resources are also provided.

Constructing High-Quality Assessments

High-quality assessments are those that lead to valid, reliable and fair assessment results. Validity refers to the trustworthiness of the assessment results. For instance, if a student gets 80% of test items correct, does that mean they understand 80% of the material taught? Does the assessment measure what it purports to measure, or is the final score polluted by other factors? For example, consider a test that assesses mathematical ability and is made up of word problems. When taken by an English language learner or by an emerging reader, does the test assess math, reading, or a combination of both? The reliability of an assessment refers to the consistency of the measure. Multiple-choice test items, when properly constructed, are highly reliable. There should be only one correct answer and it is easy to grade. Essay items or performance assessments, on the other hand, are more subjective to grade. Finally, the extent to which an assessment is fair is a characteristic of a high-quality assessment. Fairness is the degree to which an assessment provides all learners an equal opportunity to learn and demonstrate achievement. While some aspects of validity and reliability can be measured through statistical analysis, it is uncommon that such complex measurement procedures are used for typical classroom assessments. Attending to best practices in assessment alignment and test item and assessment construction helps instructional designers increase the validity, reliability, and fairness of assessment instruments.

Assessment Alignment

One of the most important concepts in assessment is alignment. It is critical that assessments and assessment items are aligned with goals and objectives. It is impossible to determine the extent to which learners have met course or workshop goals and objectives if their knowledge and skills have not been assessed. Assessment alignment tables and test blueprints are two tools instructional designers can use to align assessments and assessment items with learning objectives.

Learning Taxonomies and Learning Objectives

Learning taxonomies assists instructional designers in constructing both learning objectives and assessment items. Bloom's Revised Taxonomy and Webb's Depth of Knowledge (DOK) are two frameworks commonly used by educators to categorize the academic rigor of an assessment as a whole or individual assessment items. To increase the content validity of an assessment, the complexity of the individual test questions should align with the level of knowledge or skill specified in the learning goal. If a learning objective states that a student compares and contrasts information, it is not appropriate for test items to simply ask students to recall information. Likewise, if the learning goal states that students will be able to synthesize information, a paper-and-pencil test will likely not be a sufficient measure of that skill.

Bloom's Revised Taxonomy divides learning into three domains: cognitive, affective, and psychomotor (Anderson et al., 2001). This chapter focuses on the cognitive domain which consists of six levels that vary in complexity. The three lower levels (remembering, understanding, and applying) are referred to as lower order thinking skills also called LOTS. The top three (analyzing, evaluating, and creating) are referred to as higher order thinking skills, or HOTS. Lists of verbs associated with each of these levels are readily available on the web and are very instrumental in helping instructional designers write measurable learning objectives and test questions that go beyond recalling definitions. (For an example, see: https://edtechbooks.org/-EZbp.)

Similar to Bloom, Webb divides levels of knowledge into increasingly complex categories. These include recall and reproduction, skills and concepts, strategic thinking, and extended thinking (Webb, 1999). Student tasks range from a student being able to recall facts to synthesizing information from a variety of sources. A description of tasks at each level can be found online at https://edtechbooks.org/-bVW. These descriptions can help instructional designers design assessment tasks that range in complexity.

Assessment Alignment Tables

Regardless of the assessment method, instructional designers can ensure that learning goals, objectives, and assessments align by creating an alignment table. In the example below, course goals, student learning outcomes, and assessments are aligned in a table. This example is from a college level course on teaching with technology for pre-service teachers. This table indicates there is at least one learning objective aligned with each course goal and at least one assessment method aligned with each objective. If you find that a particular learning objective isn't being assessed, you can go back and develop an assessment to measure the learner's progress. A link to an Assessment Alignment Table Template is provided at the end of this chapter in the Additional Resources list.

Table 1

Example Assessment Alignment Table

Course Goal	Student Learning Objective (SLO)	Assessment(s)
Plan and implement meaningful learning opportunities that engage learners in the appropriate use of technology to meet learning outcomes.	SLO1. Develop a technology integrated activity plan that meets the needs of diverse learners (e.g. ELL, at-risk, gifted, learners with learning disabilities).	Technology Integration Portfolio
	SLO2. Explain how and why to use technology to meets the needs of diverse learners (e.g. ELL, at-risk, gifted, students with learning disabilities).	Technology Integration Portfolio Midterm
Use technology to implement Universal Design for Learning.	SLO3. Describe the elements of UDL included in the technology integrated activity.	Technology Integration Portfolio
Model and require safe, legal, ethical, and appropriate use of digital information and technology.	SLO4. Describe legal, ethical, cultural, and societal issues related to technology.	Midterm Final

Table of Specifications

In addition to creating an alignment table for all assessments in the entire course, instructional designers can also create a table of specifications, or test blueprint, to align individual test items to course objectives. A table of specifications aligns the learning objective, all items on a single test, and the level of knowledge being assessed. This is evidence of content validity. This also helps the instructional designer see if the test includes items related to all the learning goals, and if the assessment items are written to elicit knowledge at the appropriate level of complexity. If you find that you have too many questions about one topic or not enough about another, or that you are only asking lower level questions when the learning objective is focused on higher order thinking skills, the test can be edited accordingly. The figure below shows a test blueprint for a 12-item test about assessment. Each number represents the question number on the test. A link to a Table of Specifications Template is provided at the end of this chapter in the Additional Resources list.

Table 2

Sample Test Blueprint for a 12 Item Test

Learning objective	**Level of Knowledge**	
	Lower Order	**Higher Order**
Analyze learning objectives in terms of format, specificity, reasonableness, and alignment.	1, 2	8, 12
Explain the importance of alignment when designing lessons and assessments.	3, 5	10
Compare and contrast reliability and validity of classroom assessment	4, 6, 7	11, 9

Assessment Formats

Common assessment formats include multiple-choice and essay questions, observation, oral-questioning, and performance-based assessments. This chapter focuses on paper-and-pencil tests and performance assessments. Best practices in constructing each are described below. These guidelines help increase the validity, reliability, and fairness of assessments.

Multiple-Choice Best Practice Guidelines

Multiple-choice items are very easy to grade (assuming there is only one correct answer) but very difficult to write. Coming up with plausible distractors, or the incorrect responses, is the hardest part. If some answer choices aren't plausible (ones that are meant to be funny, for example), the probability that a student will be able to guess the correct answer increases. It is also difficult, but not impossible, to write multiple-choice questions that assess higher-order thinking skills. Tips for constructing multiple-choice test questions that assess HOTS are provided below.

1. All answer choices should be similar in length and grammatically correct in relation to the item stem.
2. Avoid "all of the above", and "none of the above" answer choices.
3. Avoid confusing combinations of answer choices such as "A and B"; "B and C"; "A, B and C but not D".
4. Avoid negatively stated stems. If you must use them, bold the negative word to make it what you are asking clearer to the learner.
5. Avoid overlapping answer choices. (This most commonly occurs with number choices.)
6. The item stem should make sense on its own and not contain any extraneous information.
7. Don't include any clues in the item stem that would give the answer away.
8. Don't include too many answer choices. Typically, multiple choice questions contain four options.
9. Ensure the correct answer is the best answer.
10. Randomize the order of the correct answers.

Table 3

Examples of Poor and Improved Items

Poor Item	Improved Item	Explanation
If a boy is swimming two miles an hour down a river that is polluted and contains no fish and the river is flowing at the rate of three miles per hour in the same direction as the boy is swimming, how far will the boy travel in two hours? a. four miles b. six miles c. ten miles d. twelve miles	A boy is swimming two miles per hour down a river relative to the water. The water is flowing at the rate of three miles per hour. How far will the boy travel in two hours? a. four miles b. six miles c. ten miles d. twelve miles	The poor item contains extraneous information and a confusing sentence structure. In the improved item, the extraneous information was removed. In addition, the prompt was broken up into several sentences and the actual question stands on its own.
Which one of the following is not a safe driving practice on icy roads? a. accelerating slowly b. jamming on the brakes c. holding the wheel firmly d. slowing down gradually	All of the following are safe driving practices on icy roads EXCEPT a. accelerating slowly. b. jamming on the brakes. c. holding the wheel firmly. d. slowing down gradually.	When reading the poor item, a test taker may not recognize that they are being asked to pick a non-example of a safe driving practice. In the improved item, the word “except” is in all caps and underlined to call attention to what is being asked.
In most commercial publishing of a book, galley proofs are most often used _________ . 1. page proofs precede galley proofs for minor editing. 2. to help isolate minor defects prior to printing of page proofs. 3. they can be useful for major editing or rewriting. 4. publishers decide whether book is worth publishing.	In publishing a book, galley proofs are most often used to 1. aid in minor editing after page proofs. 2. isolate minor defects prior to page proofs. 3. assist in major editing or rewriting. 4. validate menus on large ships.	In the poor item, each answer choice is not grammatically correct in relation to the item stem. Often, a test taker can pick out the correct answer choice because it is the only one that is grammatically correct and not because they actually knew the answer. In the improved item, the item stem and answer choices have been edited so that they are all grammatically correct.

Tips for Writing Higher Order Thinking Multiple-Choice Questions

Tip 1: Use scenarios or provide examples that are new to learners. This allows you to ask learners to do more than simply recognize the correct answer. (Note that this can be problematic if you are assessing struggling readers or ESL learners. Know your audience!)

Tip 2: Develop multiple-choice questions around a stimulus you provide such as a map, graph, diagram, or reading passage. These are called interpretive exercises. Interpretive exercises include a set of data or information and a series of multiple-choice questions having answers that are dependent upon the information given.

Best Practice Guidelines for Writing Essay Items

Essay questions are a good way to assess deep understanding and reasoning skills. Students can provide more in-depth answers in essay questions. Essay questions are also much easier to write than multiple-choice items. They are, however, harder to grade. Below are best practice guidelines for constructing and grading essay items and some real-world examples.

- Select the most important content in the workshop or unit to assess with essay times. Using essay items limits the amount of content you can cover on any one test because they take more time for a learner to answer. If one topic is less important than another, consider only asking multiple-choice questions about it.
- Write the prompt to focus learners on the key ideas they should address in their response. For example, tell learners how many reasons should they give, or how many examples should they provide. Stating directly what you want means that the learner doesn't have to try to interpret how much is enough.

- Break multi-faceted questions up into individual items. If the question is very long, make it more than one essay question on the test. This helps focus both the test taker and the grader.
- Include scoring criteria with the prompt and assign appropriate point values. If you want someone to provide three reasons why the Renaissance began in Italy, decide how many points each reason should count and make that clear to the learner. It is very difficult to objectively grade an essay question worth 10 or 20 points without first determining the grading criteria.
- Only include essay items that require higher-order thinking. Essay questions are too time consuming to grade. If it can be assessed with a multiple-choice question instead, don't waste valuable time reading essay answers.
- Avoid allowing learners to select which essay items they answer. This keeps learner scores comparable. If learners can choose which essay questions to answer, the test is not assessing the same thing for all students.

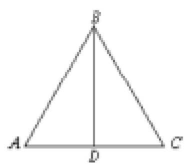
Note: Essay items can also be assessed with rubrics. See Performance Assessments and Rubric Development for more information on how to construct a rubric.

Essay Item Examples

Below are examples of high- and low-quality essay items. Note that the high quality examples include explicit instructions about what needs to be included in the answer. In addition, how the points will be allocated is clear. The low quality essay items are both very broad in scope. A test taker could easily answer the question without touching on any of the topics the instructor wanted them to include in their answer. In addition, it isn't clear to the test taker or the instructor how the points are allocated. This can lead to inconsistencies in grading.

High-Quality Examples

1. Proof 1: Given ABC is equilateral, and BD is the angle bisector of angle ABC. Prove that the measure of angle ADB and angle CDB is equal to 90 degrees. Provide the statement and reason for each step using the two-column proof format. (1/2 point for each correct statement and 1/2 point for each correct reason given. 8 total points.)



2. Compare and contrast large-scale assessment and classroom assessment on the dimensions of frequency and nature of feedback. (2 points frequency, 2 points feedback. 4 total points)

Low-Quality Examples

1. Explain weather and climate. (20 points)
2. Describe the three principles of Universal Design for Learning. Do you believe they should be used to guide instruction? Why or why not? (10 points)

Best Practice Guidelines in Developing Performance-Based Assessments

Performance-based assessment allows learners to apply knowledge and skills in authentic situations. Performance-based assessment results in the creation of a performance or a product. Performance examples include public speaking, inventing something to solve a problem, putting on a play, or playing in a basketball game. Public service announcements, digital videos, and infographics created by learners are examples of products. Consider the following guidelines when constructing performance assessments:

1. Design a task that applies to real-world situations. The more authentic a performance-based assessment can be the more meaningful it will be to the learner, although access to resources and time will certainly impose project limitations. For example, writing a paper on gardening, designing a garden, and creating a garden are all examples of performance tasks with varying degrees of authenticity.
2. Develop a task description that includes the following:
    a. Purpose/learning objectives. Why are the learners completing this task? Write the learning objectives in learner friendly language.
    b. Clear directions. Break down the task into its component parts. Don’t assume learners know how to jump immediately into creating the final performance or product.
    c. Perimeters and constraints. How much time do the learners have to complete the project? What resources are they allowed to use? Is it a group or individual project? Who are they allowed to ask for help?
    d. Assessment criteria. How will the performance or product be graded? This is discussed in more detail below in the Rubrics section.
3. Develop any job aides learners will need in order to complete the task. Do you need to teach any additional skills such as how to locate articles in a database, how to measure volume, or how to use a particular piece of software?
4. If at all possible, provide learners with an example.

Rubrics

As discussed earlier in the chapter, reliability is related to scoring consistency. One way to help ensure scoring consistency is to use rubrics for grading subjective assessment items, including essay questions and performance assessments. Rubrics focus the attention of a grader on what is most important about the assignment. Rubrics include topics or elements and descriptions of levels of performance. This provides a roadmap for how to assess an assignment that is more subjective than a multiple-choice question. Without a rubric, it is easy for a grader to grade for one thing for the first 10 papers and grade for something else the last 10 papers. This occurs when an instructor has a lot of papers to grade, grading takes place over several days, and if more than one instructor is grading the same assignment. Providing a rubric up front is also beneficial to the student. They communicate to the student from the beginning what is important, on what to focus, and where to spend time and energy.

There are three types of rubrics: holistic, analytic, and single-point. This section will focus on analytic rubrics, because they allow instructors to assess the component parts of the performance assessment individually and provide the clearest grading criteria. Several additional resources about the different types of rubrics are provided below.

An analytic rubric consists of criteria, levels of performance, and descriptors.

Figure 1

Example of an Analytic Rubric

Rubric

Criteria | Levels | Descriptors

	Exceeds Expectations	Meets Expectations	Below Expectations
Accuracy of information	Product includes accurate references to the **UDL Principles and Guidelines.** 3 points	Product includes accurate references to the **UDL Principles or Guidelines** only. 2.5- 2 points	Product includes **inaccurate references** to the UDL Principles and/ or Guidelines. < 2 points
Depth of Knowledge	Product shows use of **complex thinking** about what Universal Design for Learning is and why it is important for teaching and learning. Explanation/ justification is clear and includes multiple and varied facets of UDL. 3 points	Product shows **application** of UDL concepts and why it is important for teaching and learning. Explanation/ justification may lack clarity. Justification includes multiple and varied facets of UDL. 2.5- 2 points	Product shows **a basic knowledge** of UDL Or Information about UDL is inaccurate. Or Justification does not include multiple or varied facets of UDL. < 2 points
UDL Examples	Product includes concrete examples of UDL Principles and Guidelines. 3 points	Product includes concrete examples of UDL Principles only. 2.5- 2 points	Product does not includes concrete examples of UDL Principles or Guidelines. Or Examples may be general. < 2 points

Best Practice Guidelines for Creating Rubrics

1. Determine the criteria. Criteria can be written as a learning objective or category. Criteria should be measurable, important to the performance task, and taught. For example, creativity is often assessed in performance-based assessments. If creativity was not explicitly taught, it shouldn't be measured.
2. Determine the weight of each criteria. Will they all be worth the same amount of points or will some count for more than others?
3. Determine the number of performance levels. How many levels of the rating scale will be delineated on the rubric? Will they be numbers such as 4, 3, 2, 1 or descriptive such as developing, meets expectations, and exceeds expectations. Typically, analytic rubrics contain three to five performance levels.
4. Write descriptors for each of the performance levels. This is the hardest part! Descriptors should address the quality of the product. It is okay to count project elements for some of your criteria (i.e. number of references, number of graphs), but not for all of them. See examples of quality and numerical

descriptors below.

Numerical Descriptors vs Quality Descriptors Example

Table 4

Numerical Descriptors in an Annotated Bibliography Rubric

	4	3	2	1
Quality / Reliability of Sources	All sources cited are reliable and trustworthy.	At least 80% of sources cited are reliable and trustworthy.	At least 50% of sources are reliable and trustworthy.	Less than 50% of sources cited are reliable and trustworthy.
	5 points	4-3 points	2 points	0-1 point

Table 5

Quality Descriptors in a Technology Lesson Plan Rubric

	Exceeds Expectations (A)	Meets Expectations (B to C)	Below Expectations (C- and below)
Teacher candidate develops a learner-centered, technology-integrated activity that promotes creativity, collaboration, or communication, and results in a learner-created product.	Activity promotes significant learner engagement through creativity, collaboration, and communication. Actively includes opportunity for learner to create a product.	Activity promotes creatively, collaboration, or communication and focuses on learner engagement with technology. Actively includes opportunity for learner to create a product.	Activity focuses on teacher-use of technology but lacks opportunities for learner engagement and/or product creation
	5 points	2-4 points	1 point

Note also that the rubric element directly above is written as a learning objective rather than simply a category.

Conclusion

Aligning test items and performance assessments to learning objectives, using best practice guidelines to create assessments, and using rubrics to grade complex tasks, are strategies instructional designers can use to develop high-quality assessments. High-quality assessments provide instructors with accurate information regarding the extent to which learners met the learning objectives, a critical component of the teaching and learning process. Accurate assessment results help instructional designers plan future instruction, adapt current instruction, communicate levels of understanding to students, and examine the overall effectiveness of instruction and course design.

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Webb, N. (1999). Alignment of science and mathematics standards and assessments in four states (Research Monograph No. 18). Washington, DC: CCSSO.

Additional Readings and Resources

- Assessment Alignment Table Template (also included at the end of this chapter)
- Making Data Driven Decisions using Assessment Data
- Single-point, Analytic, and Holistic Rubrics
- Rubric Wordsmith
- Table of Specifications Template (also included at the end of this chapter)

Templates

Assessment Alignment Tables

Use this template to align your course goals, student learning objectives and assessments. This table helps instructional designers ensure that they have assessed all course goals and objectives. Delete the sample goals, objectives, and assessments in the blue font below and insert your own.

Table 6

Example Alignment Table

Course Goal	Student Learning Objective (SLO)	Assessment(s)
Plan and implement meaningful learning opportunities that engage learners in the appropriate use of technology to meet learning outcomes.	SLO1. Develop a technology integrated activity plan that meets the needs of diverse learners (e.g. ELL, at-risk, gifted, learners with learning disabilities).	Technology Integration Portfolio
	SLO2. Explain how and why to use technology to meets the needs of diverse learners (e.g. ELL, at-risk, gifted, students with learning disabilities).	Technology Integration Portfolio Midterm
Use technology to implement Universal Design for Learning.	SLO3. Describe the elements of UDL included in the technology integrated activity.	Technology Integration Portfolio
Model and require safe, legal, ethical, and appropriate use of digital information and technology.	SLO4. Describe legal, ethical, cultural, and societal issues related to technology.	Midterm Final

Table of Specifications Template

Use this template to create a table of specifications for a test. This table helps you align the learning objective, all items on a single test, and the level of knowledge being assessed. Using this table helps you ensure that each item on the test is related to the learning goals and that you are asking higher order questions about the topics. Add rows to this table as necessary.

Table 7

Test Blueprint Template

Learning objective	Level of Knowledge	
	Lower Order Test Question #s	**Higher Order Test Question #s**
Learning Objective #1		
Learning Objective #2		
Learning Objective #3		
Learning Objective #4		
Learning Objective #5		

31

Working With Stakeholders and Clients

Lee Tran, Kathy Sindt, Rudy Rico, & Benjamin Kohntopp

Throughout your experiences as an instructional designer, you may form many different relationships with your colleagues. However, one of your most important relationships will be the one you have with your stakeholders or clients. It is important to recognize that the relationship with your stakeholders or clients is not solely based on transaction, but is also one of collaboration. In any instructional development process, there will be many different roles that each collaborator plays, as each brings a different set of expertise.

Remember, as an instructional designer, the communication style you choose to use will involve feedback from both parties. Your stakeholders or clients are looking to you for guidance in instructional design and content delivery. However, part of your work will be reliant on the content that your stakeholders or clients are giving you.

As instructional designers, we want to build trust with those we work with to better collaborate and deliver an end-product that meets the goals of a project. By building a stakeholder or client relationship, we can better understand who our target audience is, the project needs, and what our learning outcomes are.

For example, let’s say you received a set of instructional materials on how to make toast. The instructional material provided may be simple to follow, but there may be details missing needed for you to start your work, such as knowing if your target audience has access to a toaster. This detail would be important in your design to ensure that learners have access to all of the materials needed to successfully complete the course. As we continue this chapter, think about what kind of details you would need to start a course development and write them down.

Throughout this chapter, we will be looking at different aspects of the client relationship, including the process, guidance and communication, scope of work, collaborative workspaces, challenges, ethical concerns, and reviewing content.

The Process

Every instructional design project should follow an instructional design model. The most familiar model is the ADDIE model. This model includes the following components: Analyze, Design, Develop, Implement, and Evaluate (Kurt, 2017).

Another popular model and the one we use at Colorado Community Colleges Online (CCCOnline) is the backward design model (Wiggins and McTighe, 1998). In this model, the focus is on the result of the instruction, while also asking what the students should be able to understand and do after the instruction has been provided. All instruction, learning activities, and assessments direct the students toward achieving the result.

Whether you are following the ADDIE model, the backward design model, or another process to design your instruction, it is important that your stakeholders understand your process and the reasons you are using that process. It's also important to be sure your stakeholders know what you expect of them as part of the process. Getting buy-in on your process at the start will eliminate problems later. If the stakeholders understand what you expect, and the reasons for the expectations, they are better equipped to follow your procedures and processes.

There are different ways to ensure your stakeholders understand your process. One excellent option is to have initial meetings with all the stakeholders where you provide the stakeholders with information about the process and your expectations of each of them.

At CCCOnline, all of our stakeholders are required to take an orientation course that describes our processes and expectations. Once all stakeholders have completed the orientation, an initial vision meeting is held to discuss the scope of the project, to clarify the expectations from the stakeholder perspective, and to establish the duties and roles of all members of the team. After the vision meeting is completed, a kickoff meeting is held a couple of weeks later to review and finalize the project outline and scope, to set the timeline for the project, including deliverable due dates, review dates, and the final project deliverable due dates. The kickoff meeting is the beginning of the design phase of the project.

Guidance and Communication

Setting Communication Standards

As you work with your clients in your course development, you will want to ensure there is a standard of communication in place. A communication standard may include preferred methods of communication, frequency, and availability. By setting communication standards, you and your client can follow the expectations of each party in the development and promote a steady workflow. Remember that even though you are the instructional designer, your client is very much your partner throughout the development to ensure content validity and that the end product meets the needs of the target audience.

Becoming a Learning Coach

Your client will be looking at you for guidance in your expertise in instructional design. This expertise makes you what we will be calling a Learning Coach. A client may be an expert in their particular field, but may not have the same expertise with learning theories and applications to deliver their content to a mass audience. By understanding your role as not only the instructional designer, but as a Learning Coach to your clients, you are there to help guide your clients in their instruction development journey. Some clients may come to you with anxieties or questions like, “How do we engage the audience within different learning environments?” or “How do we measure the appropriate outcomes?”. Your coaching is meant to put your client at ease. As you coach your client through their concerns, you may notice your client becoming more confident in what your instructional product will be and in turn providing content that is better suited for the learning environment. This mutual understanding can ensure success.

Flexibility

Always remember that your client is human. Much like you, certain circumstances in their lives may affect the delivery of content. We want to ensure that the proper expectations are set in place, but also be flexible enough to understand that certain circumstances may get in the way. By being flexible and empathetic, you ensure that neither you nor your clients lose motivation or energy throughout the development process.

Scope of Work

When beginning work on an instructional design project, it is important to ensure that all the stakeholders agree on the scope of work (SOW) for the project. The project scope determines the goals/objectives, deliverables, and deadlines of the project.

At the start of any project, define the goals and objectives so you understand what the stakeholders are expecting. We have included some templates that can aid in defining your goals and setting the scope of your project. These include a PreMeeting and vision Meeting Guide, a Vision Scope Template, a Kickoff Call script, and a Course Map (outline of the project).

In addition to the goals and objectives, determine what deliverables you will provide as part of the project. Will you be creating a large, full-scale curriculum project, with multiple courses, or are you developing a single course? You need to know what kinds of media you will be developing. Are you expected to create video or interactive content, or will you be developing more static content? If you are developing any multimedia, be sure to determine the length/amount of this content before beginning. The more multimedia and interactive content you will be developing, the more resources your project will take. You need to be in agreement with your stakeholders on all aspects related to the scope of the work before the start of the project.

Finally, you need to determine the timeline of the project. Decide upfront when each deliverable is due, how long the stakeholders have to review the content, and how long you will need to make any revisions requested by the stakeholders. Agreement on these issues avoids conflict later in the process.

In addition to having the scope clearly defined at the start of the project, it is important that you and the stakeholders have clearly defined expectations of all members of the team. Are the stakeholders expected to write content? Are they expected to review content, and if so, at what stages of the project? Some stakeholders may only be directly involved at the beginning and end of a design project, while others may be involved during the entire process. Be sure that each stakeholder, including you, understands the expectations of them during the development process.

A major reason for clearly defining the scope of the work and your expectations of the stakeholders is to help eliminate scope creep. Scope creep occurs when a part of the project takes longer or more work than originally determined. This usually happens when one of the stakeholders expects or asks for additional work beyond the original agreement or statement of work. The best way to avoid scope creep is to have clearly defined and agreed upon scope and expectations before the project starts.

Setting up a Collaborative Workspace

In this section, we will focus on collaborating with your design team and setting up a workspace that allows each member to contribute. Depending on your situation, a collaborative workspace can include both physical and virtual spaces. Setting up a collaborative workspace is key to ensuring that all stakeholders can contribute during the design process and questions about content can be addressed before developing course materials.

The first step to consider when setting up a collaborative workspace is the types of materials that will be delivered. If the instructor or subject matter expert you are working with is delivering large files, such as MP4 video files or large text files, then a cloud-based file hosting service like Dropbox, Microsoft's One Drive, or Google's G Drive may be a solution. File hosting services allow the user to upload large files and share the uploaded content with members in your organization.

Once you agree on a file hosting service, set up a folder, and share the folder with the stakeholders who will be delivering content. Make sure you provide the right type of access so that the stakeholders have permission to edit and add content.

In addition to setting up a file-sharing collaborative workspace, you should set a schedule for delivering content, and schedule regular meetings to check in with your stakeholders. Having a regular meeting scheduled can help prevent any communication issues or identify issues that come up as content is delivered.

Collaboration Tools

Tools for Meeting With Stakeholders

Web conferencing software – ex. Zoom, Skype

Tools for Project Planning

Spreadsheets, Shared Calendars – ex. MS Excel, Google Calendar

Tools for Content Delivery

Cloud-based services – ex. Dropbox, MS One Drive

Depending on your institution, a face-to-face meeting can be held at the start of the project and then transition to online meetings or conference calls. Meeting with all your stakeholders face-to-face at the beginning of course development can help determine which members of the development team are essential to future meetings and which content to assign for development to each member.

Challenges

Communication with stakeholders, as stated in our section on setting up a collaboration space, is key to ensuring completion of the course development on deadline. One common issue that occurs when developing online courses is lack of communication leading to confusion on how content is delivered, when content is to be delivered, and how content is reviewed for quality. For example, while working on a teacher education course last summer, I encountered an issue with the subject matter expert's schedule. At the initial meeting, the subject matter expert indicated she was familiar with the content from previously teaching the course and would have no issues making the content updates. However, the subject matter expert also indicated during the meeting that she would be on vacation abroad and would not be able to deliver content until after she returned. Since the subject matter expert indicated she was familiar with the content as an instructor, I recommended that she complete an initial review and submission of new content for the course's first two modules prior to going on vacation. Knowing that the subject matter expert would be unavailable during the first phase of development prompted me to update the content delivery schedule. Therefore, setting up expectations early on is essential to catching possible scheduling conflicts and avoiding confusion later in the content delivery stage of course development.

To avoid communication issues, also speak with your stakeholders regularly. We emphasize "speak," because long emails can lead to more confusion. Email communication is good for quick updates, but long emails chains can be more time consuming than simply talking on the phone for 5 minutes to clarify an issue. Therefore, set up a regular meeting time each week and check in with your stakeholders often by phone or web conference. After all the stakeholders are comfortable with the development process, you can hold meetings less frequently, but at the beginning stages of development avoid going more than a week between meetings.

Not communicating expectations early on with all of your stakeholders can lead to missed deadlines and content delivery falling behind schedule. Therefore, make deadlines clear and use a project plan to keep track of all the major milestones during the content delivery phase. If a deadline is missed, communicate with your stakeholders immediately and identify the issue that caused the delay. However, sometimes the stakeholder in charge of delivering the content may have fallen behind and need additional support to create the content. Courses that incorporate Open Educational Resources (OER) may be more challenging to develop content for and, therefore, may require more time. This is due to the "open" nature of OER content. While there are many free resources available to educators, not all OER content is high quality, or accessible.

Technical issues may also prevent the delivery of content; checking with your stakeholders when they miss deadlines can help identify if it is a technology issue or a content issue. Depending on the file-sharing system you selected, there may be issues updating content in the online workspace, and you may need to coach your stakeholders as to how to properly upload and share content with the design team.

When content is not delivered, and several deadlines are missed, set up a meeting with the key stakeholders, and develop a plan to get content delivery back on schedule. For this reason, it is often a good idea to set up a buffer between the end of content delivery and the start of the course launch. I typically set an early content delivery date of about 3 weeks before content is due for review.

Ethical Concerns

On some days during your course development cycle, you may feel like teacher dealing with a student. You know that the student is very skilled, but at times they may need your guidance. This is especially true when it comes to Ethical Concerns that might arise during the course development process. While a subject matter expert (SME) is exactly that, an expert in their chosen subject, they aren't expected to know everything. This means that, regardless of the type of development (OER or otherwise), your subject matter expert will be looking for outside sources to supplement their material.

Plagiarism

Although some might think of plagiarism as a concern reserved for students, it is a reality for the individuals creating the courses as well. Any time a subject matter expert looks for material, they run the risk of plagiarizing content. In most environments, this is very problematic. Many places will take ownership of a SME's work upon its completion; therefore, having plagiarized or stolen content can cause problems for that institution or place of business. Here a few strategies you can use when working with your SME:

1. When the content first comes in, be sure to read it thoroughly. Reading your content is the simplest way to tell if a SME has been plagiarizing. You should have a feeling for how a SME writes by now, from emails to course maps, so if anything in their content seems suspect to you, it might be time to raise a red flag and ask them about it, especially if they are missing citations for their material.
2. If you're able, run the content through a plagiarism checker, such as Turnitin, Quetext, or Prepostseo (those last two are free). Keep in mind that while the plagiarism checker will give you a better idea of where an SME's content came from, it doesn't necessarily mean plagiarism has taken place.
3. As you read over the content and suspect plagiarism in a particular passage, highlight it, and paste the suspected content into a Google search. Believe it or not, the search results that come back may be bolded portions of a website where the content is from. If it is, you need to discuss this with your SME.

Catching plagiarism early is vital. SMEs may not be aware that what they're doing is plagiarism and may continue to do it throughout the process. It might be helpful to discuss Creative Commons licenses with them to elucidate what they can and cannot do. Reading through a basic overview of the licenses (https://edtechbooks.org/-JMt) might save you from future issues.

Conflict

Unfortunately, sometimes, conflicts between you and your SME arise. Remember that during development, communication is key. More often than not, SMEs are happy to dispense their knowledge, but they also must be heard. They are not a tool to be used and discarded. Keep this in mind to save your developments from falling apart. Here is one example:

During the development of a course, the SME, who was writing an entire OER eBook, decided that she wanted links to the eBook placed in every page of the course so students could readily access it everywhere. While I immediately disagreed with her, I allowed her to finish her reasoning. Once she concluded, I explained that from a design perspective, this could cause confusion for students, regardless of her good intentions. I told her I appreciated her input and told her that if she disagreed, we could have a meeting involving the dean (her boss) and we could talk things out with him. She decided to do so, we talked it out and we came to an agreement: the links to the eBook would be placed in only the most relevant and useful places. We both walked away from the conflict satisfied with our agreement.

Reviewing the Content

Quality Assurance

We all want our students to have the best quality courses. One of the most important components of a course development comes during the quality assurance (QA) check. Whether you as the ID do it alone or you're lucky to have someone there to help you with it, quality assurance is paramount. CCCOnline implements QA via a two-fold approach: we have a designated QA person checking the course throughout the entirety of the build. When the content first comes in, they go over all the essential components thoroughly and write feedback and recommendations. Then, once the course is in place in the LMS, they review it again. Throughout the entire process, the QA person is viewing the course as a student would and ensuring everything makes sense. As Instructional Designers, we should never forget the end user: our students.

Approval

Not only should a QA person sign off on the content, but the SME and the program leader(s) should also have a say in approving the content. Essentially, when the content is in, and before it is placed in the LMS all parties should have their voices heard:

1. The QA person should be viewing the course from the student's perspective, giving valuable insight that might go unnoticed otherwise.
2. The SME and program leader(s) should have the best understanding of the content and should, therefore, ensure the course aligns with all objectives and hits all of its necessary deliverables.
3. As the ID, you must do some of both: ensure the content aligns with the outcomes that have been set and ensure the course will make sense from a student perspective.

Conclusion

In this chapter we discussed some strategies for collaborating with various stakeholders during a course development and provided some recommendations for solving some common issues instructional designers encounter during the collaboration phase. As the instructional designer, having a well-developed project plan, that includes deadlines for content delivery and dates for meetings with stakeholders, is essential for a successful course development. Therefore, when developing your project plan remember some of the issues we presented here and the types of challenges your stakeholders may encounter during content delivery. What can you do as the instructional designer to help your stakeholders meet the deadlines? Consider the following:

1. What type of content are your stakeholders expected to deliver?
2. When is the course expected to launch? Consider potential time constraints for stakeholders.
3. How much time will the quality assurance process take?
4. Will stakeholders be asked to review content on multiple occasions? How will reviews and feedback be managed?

Templates

- Kickoff Call Script
- Pre-Meeting and Vision Meeting Guide
- Vision Scope Template
- Course Map (.xlsx)

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Appendices

Book Editors

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Dr. Jason K. McDonald is an Associate Professor of Instructional Psychology & Technology at Brigham Young University and the program coordinator of the university’s Design Thinking minor. He brings twenty years of experience in industry and academia, with a career spanning a wide-variety of roles connected to instructional design: face-to-face training; faculty development; corporate eLearning; story development for instructional films; and museum/exhibit design. He gained this experience as a university instructional designer; an executive for a large, international non-profit; a digital product director for a publishing company; and as an independent consultant.

Dr. McDonald's research focuses around advancing design practice and design education. He studies design as an expression of certain types of relationships with others and with the world, how designers experience rich and authentic ways of being human, the contingent and changeable nature of design, and design as a human accomplishment (meaning how design is not a natural process but is created by designers and so is open to continually being recreated by designers).

At BYU, Dr. McDonald has taught courses in instructional design, media and culture change, project management, learning psychology, and design theory. His work can be found at his website: http://jkmcdonald.com.

Richard E. West

Dr. Richard E. West is an associate professor of Instructional Psychology and Technology at Brigham Young University. He teaches courses in instructional design, academic writing, qualitative research methods, program/product evaluation, psychology, creativity and innovation, technology integration skills for preservice teachers, and the foundations of the field of learning and instructional design technology.

Dr. West's research focuses on developing educational institutions that support 21st century learning. This includes teaching interdisciplinary and collaborative creativity and design thinking skills, personalizing learning through open badges, increasing access through open education, and developing social learning communities in online and blended environments. He has published over 90 articles, co-authoring with over 80 different graduate and undergraduate students, and received scholarship awards from the American Educational Research Association, Association for Educational Communications and Technology, and Brigham Young University.

He tweets @richardewest, and his research can be found on Google

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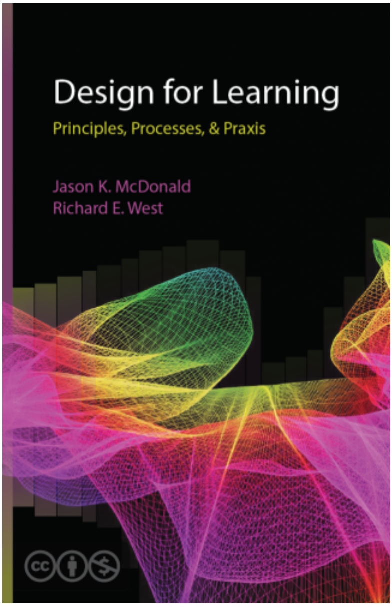

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