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# Designing Technology-Enhanced Learning Experiences

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The field of instructional/learning design has at times been conflicted about the role of technology in helping students learn (see the classic debate between Richard Clark and Robert Kozma in the "media debate" of the early 1990s—Clark, 1994; Kozma, 1994). While this debate effectively moved the field away from considering digital technologies as the primary variable affecting student learning, these technologies still play an important role in how we learn about, design for, and evaluate learners. In the 21st Century, as networked technologies undergird nearly all human activities, it is nearly impossible to conceive of most instructional situations being devoid of technology entirely.

Indeed, technology may be considered an important layer in most instructional systems, similar to how architectural buildings comprise various layers from the framing to the electrical to (nowadays) the technological. Gibbons (2014) articulated this layered approach to instructional design, arguing that just as multiple layers work together to support the purpose of the building, various design layers must similarly work together within instructional products. As we attend to different elements within instructional design layers, we should consider the content, purposes, and instructional strategies as well as how the instruction is represented and controlled through available technology tools. This enables us to design more effective and purposeful instructional solutions and promote powerful learning experiences.

In this chapter, we attempt to provide suggestions for making instructional design decisions that utilize available digital technologies effectively. We will begin by discussing what instructional technologies are, and how we can incorporate them into our designs. We will review design layers that are particularly relevant when using technology to design instruction and discuss the importance of analyzing the technology's affordances and matching them to the underlying pedagogical purposes. We will include a discussion about utilizing different models to focus the technology choices on student learning. We then conclude with some challenges to be aware of when integrating technologies into our designs.

## What Is an Instructional Technology?

The field of learning and instructional design considers "technology" to be any tool that extends human capability or assists us in achieving a desired learning outcome. In this definition, the technology or tool does not need to be digital. Experts in the field of educational technology often adopt the terms "hard" and "soft" technologies. In this dichotomy, hard technologies refer to machine-based or digital technologies, such as a computer or a web-enabled app, while soft technologies are human-driven processes, methods, and theories that similarly extend or improve our abilities to teach or learn. As an example, in the second edition of the Handbook of Educational Communication Technology, (Jonassen, 2004), there was a section for chapters on “hard” technologies, such as television, virtual reality, and internet-based learning, and a separate section for “soft” technologies such as programmed instruction and game-based learning.

Many of the chapters in this textbook are, in fact, discussing “soft” technologies to support designing instruction (see particularly the sections on instructional design knowledge and processes). However, this dichotomy is becoming less relevant, as hard and soft technologies are increasingly considered simply “strategies” for influencing learning and typically involve some combination of process, pedagogy, and digital tools. Our chapter continues to merge these ideas together by discussing “hard” digital technologies specifically, but with strong consideration for their pedagogical fit.

## How Can Instructional Technologies Influence Learning?

As mentioned above, technologies are tools that extend human capability, including learning. In the past, educators and instructional designers viewed technologies as primarily hard technologies, a medium to learn *from*. This view was associated with the teacher-centered instruction or transmission model of education and associated theories. The focus was typically on content transmission, practice of basic skills through repetition, reinforcement of desired behaviors, and evaluation of how accurately the learners could respond to pre-programmed questions. The technology may have allowed for some interaction with peers and instructors, but mostly the learner individually interacted with the content in isolation. The learner's role was to acquire provided information and reproduce it for evaluation. The instructor's primary roles were to manage the content and evaluate learners' work. This perspective is still valuable for some tasks and types of instruction. However, alone, these types of activities have only limited power in actively engaging learners in the meaning-making process necessary for successful learning and transferring knowledge to new situations.

As an alternative, Jonassen (1996) envisioned instructional technologies as mindtools that students learn *with*, not from, requiring attention to the underlying strategies for using the technology, i.e., soft technologies, in addition to the medium, i.e., hard technologies. This perspective acknowledges that technologies do not directly mediate learning. Learning is mediated by thinking, collaboration, and dialogue facilitated by a variety of tools. Technologies as mindtools support learners as they interpret and organize their knowledge, engage in critical thinking about the content, and actively participate in knowledge construction. Examples of such tools are semantic and conceptual maps (Hwang et al. 2011, visualization tools (Huang, 2020), microworlds and simulations (Warren & Wakefield, 2013), and even emerging technologies such as robotics (Mikropoulos & Bellou, 2013).

Building on this idea of mindtools, and reflecting a general trend in education toward a learner-centered paradigm, the instructional technology field began using technology to mediate meaningful learning experiences and to focus on supporting the learner and the process of learning. Terms such as learning design and technology-mediated instruction reflect this shift in thinking. As Ertmer and Ottenbreit-Leftwich (2013) explained, "technology integration is no longer an isolated goal to be achieved separately from pedagogical goals, but simply the means by which students engage in relevant and meaningful interdisciplinary work" (p. 176).

Learning experiences are now designed with greater emphasis on our understanding of how people learn (Bransford et al., 2000). Learners are viewed as active agents who bring their own knowledge, past experiences, and ideas into the learning process, which impacts how they learn new information. As learners engage in the learning process, they construct and negotiate new meaning individually and with others. The goal of learning is to gain new understanding, broaden perspective, and apply knowledge in practice rather than to reproduce a specific set of facts. The instructor facilitates the interactions among peers to promote deeper understanding and acts as a guide and a mentor rather than "a sage on the stage."

In this approach, technologies are used more intentionally as tools that mediate learning in a variety of ways. In this chapter, we will briefly discuss three powerful ways that technology can improve learning through (1) simulating authentic human activity, (2) enhancing interaction among people, and (3) enriching the learning process.

## Technologies Can Simulate Authentic Human Activity

Learning, and especially learning of complex professional skills, is optimal when it is contextualized and situated in real-life experiences and authentic activities. Certain approaches use varied technology tools to mimic real-world situations to support learning. For example, computer simulations and problem-based learning (PBL) use technology to create conditions that are similar to real life and encourage the learner to gain new knowledge and skills through repeated practice and solving authentic problems. Inquiry-based learning (IBL) encourages the learner to actively explore the material, ask questions, and discuss possible solutions modeling the real-life process of examining issues and systematically looking for answers. Another similar approach, project-based learning (PjBL) engages learners in authentic and complex projects, often developing a tangible product, enabling learners to actively explore real-world problems and gain deeper knowledge and skills. In all these methods, technologies can be used to create authentic or near-authentic problem-solving scenarios and simulations. Additionally, easier replication of digital problem scenarios enables multiple practice opportunities, and using the actual technological tools of the discipline supports learners as they develop professional skills to practice problem solving while in school.

### Technologies Can Enhance Interactions

Digital technology has a tremendous potential to enable interactions and connections between people. Whereas individuals were previously limited by space and time constraints, they can now interact through near ubiquitous access and connection to each other. This has led to the development of several theories of digitally mediated social interaction, such as the Communities of Inquiry framework. This theory describes learning as happening within a community where technology enables different types of human presence:

- social presence (the feeling of being connected and present with each other, for example through video or text discussions designed for students and instructors to learn about each other),
- cognitive presence (the feeling of being intellectually present in the community, growing and developing meaning through interaction, for example through online question and answer sessions or group collaboration via shared documents), and
- teaching presence (the feeling of being supported by a teacher designing and facilitating the interactions and content, for example through well-designed online curriculum and opportunities for feedback).

Collaborativism (Online Collaborative Learning Theory) is another model of online learning that creates opportunities for meaningful learning experiences through technology (Harasim, 2017). In this process-oriented model, collaborative technology enables students to actively work together, create knowledge, and learn to use the language, analytical concepts, and activities of the discipline while being supported by an experienced educator who helps them move through three stages. In stage 1 (Divergent Thinking), students engage in discussions about a specific problem or a topic. They generate ideas, questions, responses, and solutions based on their personal perspectives and experiences and share them in a group setting. During stage 2 (Idea Organizing), conceptual changes and convergence of different ideas begin as students clarify, organize, and narrow down options through reflection, analysis, and negotiation of ideas that were shared previously. During Stage 3 (Intellectual Convergence), the group is actively engaged in the co-construction of knowledge. Everyone contributes as the group works on a joint knowledge product or solution, which may later extend to an authentic application or be further refined through another collaborative learning cycle.

## Technologies Can Enrich the Learning Process

Technologies have a powerful potential to enrich and transform the learning process in ways that may be difficult or impossible without these tools. For example, online and collaborative technologies offer unique affordances that go beyond connecting learners across time and space by enabling easy access to multiple perspectives from diverse populations and across the globe. The asynchronous and recorded character of technology-mediated exchanges enables coherent organization of thoughts, clear and authentic expression, and deep analysis and reflection, which in turn facilitates deeper learning and enhances theory-to-practice connection. The opportunity to create multidimensional and multidisciplinary responses presents authentic evidence of a deeper understanding that goes beyond "correct" answers. Technology also enhances participation opportunities for all types of learners, not just for the traditional mainstream student. Those that may be timid, need more time, or are learning the language are automatically provided with additional support to access the material and interactions in ways that meets their needs. Furthermore, through its flexibility, technology provides access to learning for many non-traditional students as well as busy professionals who may not be able to gain credentials or participate in ongoing professional development in more traditional ways.

## How Should We Incorporate Technology In Our Designs?

Entire handbooks have been written about the topic of how to effectively design learning through the support of technologies (see, for example, Bishop et al., 2020; Dillon, 2020; Mayer, 2014; and Stanley, 2013). This chapter cannot expound on all of these theories and ideas, and truthfully, the path of an instructional/learning designer is one of continuous learning—particularly in the area of instructional technologies because these technologies are continually evolving. However, we present two key ideas that will guide you in making wise technology choices in your design work, namely: (1) align technology with pedagogy and (2) focus on what students will do with the technology.

### Principle 1: Align Technology with Pedagogy

The quality and accessibility of technology-mediated learning experiences is an issue of both technology and pedagogy. Whether we design a single learning experience, a course, or a full program, strategic orchestration of desired results, assessments, and instructional methods with intentional use of technology are essential. Understanding by Design (UbD) or Backward Design (McTighe & Wiggins, 2005; see also Dodd, 2020, in this book) is a useful framework that helps designers align these essential elements, focus on student learning, and attend to the underlying pedagogy. Rather than the content, materials, or tools dictating what the student should learn, designers pinpoint the most important ideas, knowledge, and skills that the students should learn, and identify appropriate assessments and pedagogies for supporting student learning..

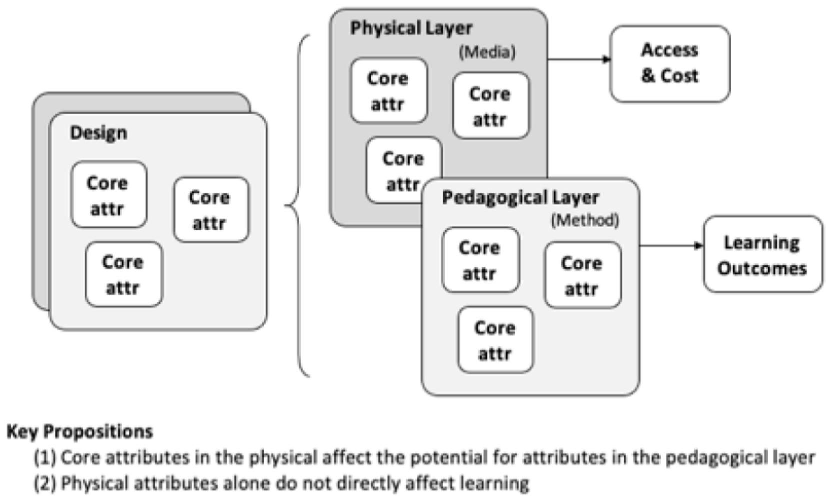
## Pedagogy

Pedagogy refers to principles and practices guiding instructional action with a goal to support learning.

Recognizing that technology is a strategic tool encourages designers to deliberately align technology with underlying pedagogical strategies. Any design can be visualized as having two main layers: a *physical layer* and a *pedagogical layer* (see Figure 1). Each layer has distinct core attributes that make the design functional. Core attributes within the physical layer exemplify the surface features of presentation and delivery of instruction and influence access and cost. The pedagogical layer core attributes represent the underlying pedagogical structures and strategies, enable learning to take place, and contribute to successful achievement of learning outcomes (Graham et al., 2014). To increase the effectiveness of any instructional design, the layers and its core attributes should be aligned during the design and development process.

**Figure 1**

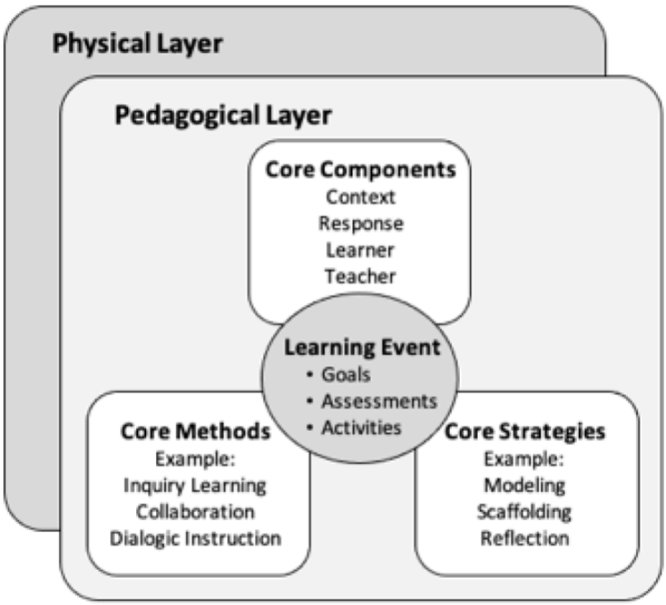
*A Visual Representation of Two Design Layers From Graham, et al. (2014).*




Allman and Leary (2020) studied the process and identified a set of core attributes within the pedagogical layer that drive the two design layers' alignment. This set of attributes, so-called pedagogical intent, pivot around the learning event and encompass core components, core methods, and core strategies (see Figure 2). As designers establish pedagogical intent related to a specific learning event, it is easier to recognize technological affordances that may be needed and match them with available technological tools. The alignment is achieved iteratively through purposefully utilizing available technology tools to fulfill the underlying pedagogical intent requirements.

**Figure 2**

*Pedagogical Intent—A Set of Core Attributes Within the Pedagogical Design Layer.*




## Affordances

The concept of affordances represents what a specific technological tool can do, as well as, “afford” the user, a designer, a teacher, or a learner, to do. Affordances are determined by the properties of the tool but also by the capabilities of the user.

Although the choices of technological resources are important, it is the pedagogical purposes that should drive the form of instructional design solutions. By allowing the function to guide the form through prioritizing pedagogical purposes and aligning pedagogical and physical design layers, we can design more effective technology-mediated learning experiences and use current technologies in innovative ways.

## Principle 2: Identify What Students Will Do With the Technology

In the discipline of instructional/educational technology, researchers have developed many different models for describing how teachers can integrate technology into their teaching. Most of these models focus on how teachers utilize technology. See, for example, the following:

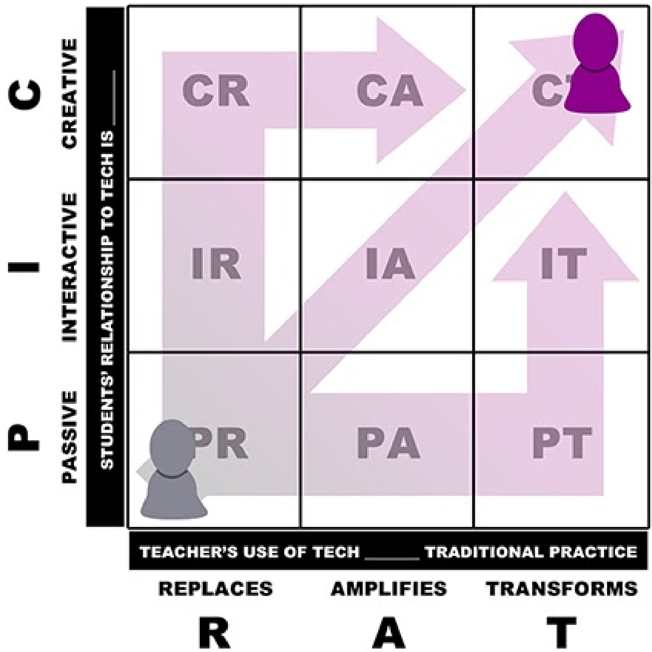
- The TPACK model, which focuses on teacher technological pedagogical content knowledge (Koehler and Mishra, 2009);
- The SAMR model, which focuses on how teachers can use technological strategies to substitute, augment, modify, or redefine their current pedagogical practices (Hamilton et al., 2016);
- The RAT model, which similarly categorizes technology decisions according to whether the technology replaces, amplifies, or transforms the teachers' existing teaching practices;
- The LoTI model, which depicted seven levels of technology use by teachers in the classroom (Moersch, 1995).

While these models can be helpful in teacher preparation programs, they perpetuate a teacher-centric approach to technology use, often ignoring the learner's experience.

**PICRAT**. However, a new model has been proposed that builds off of the common SAMR/RAT approaches, but turns the emphasis away from what the teacher does with the technology and toward how the student utilizes the technology (Kimmons et al., 2020). In this model, called PICRAT, designers still consider how to use technology to replace, amplify, and transform the learning; but in addition, designers consider what the student is doing as part of the activity: is the student's learning passive, active, or creative? The PICRAT model does not dictate that all good instruction must be transformative or that students must be creative while using the technology. However, it does help teachers and designers to diagnose how often they incorporate activities in each of the squares, and whether they are overusing some strategies to the detriment of others. For example, we often find that designers/teachers overuse technology to replace passive forms of learning (e.g. viewing a lecture, reading a textbook) and PICRAT can stimulate thinking about how to engage students more actively and creatively in their learning with technology.

**Figure 3**

*PICRAT Model*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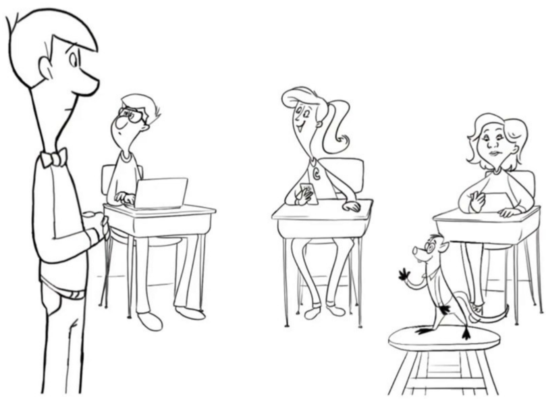
**PICRAT for Effective Technology Integration in Teaching**



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

This video was developed for preservice teachers, and discusses the basic ideas of the PICRAT model.

## Challenges When Designing Learning With Technology

In this chapter, we have mostly proposed technology as a powerful asset for designers as they create effective learning, as long as they first, focus on aligning the technology’s affordances with matching pedagogies; and second, focus on the students’ experiences with the technology. By maintaining these two foci, technology can have a powerful influence on student learning. However, research has provided several additional cautions. We highlight a few important ones here, but be aware that there are many more, and technology, as would be the case with any tool or strategy, should be applied judiciously after careful learner/needs analysis.

## Challenge #1: Technology Can Be Distracting

While technology can enhance learning, it can also easily distract from it. We are all familiar with overworked Powerpoint slides or videos where the core message is lost amid spinning graphics, useless animations, distracting photos, or disconnected audio. Richard Mayer, and his collaborators, have outlined key principles for designing effective educational multimedia in their Cognitive Theory of Multimedia Learning, or CTML (Mayer, 1995). These principles are based on core cognitivist assumptions and theories such as dual coding theory (Paivio, 1990) and information processing limits and activity (West et al., 2013). The core idea behind the theory is that of congruence—or that various media should work together, not at disarray, to solidify interpretation of an idea and the development of appropriate mental schemas. More specifically, Mayer and Moreno (1998) identified 5 key principles for designers:

1. **Multiple Representation Principle:** It is better to present an explanation in words and pictures than solely in words.
2. **Contiguity Principle:** When giving a multimedia explanation, present corresponding words and pictures contiguously rather than separately.
3. **Split-Attention Principle:** When giving a multimedia explanation, present words as auditory narration rather than as visual on-screen text.
4. **Individual Differences Principle:** The foregoing principles are more important for low-knowledge than high-knowledge learners, and for high-spatial rather than low-spatial learners.
5. **Coherence Principle:** When giving a multimedia explanation, use few rather than many extraneous words and pictures.

The research on CTML is quite extensive with a great deal of applicability to designers, and you are encouraged to continue your learning in this area by seeking out recent publications on this topic.

## Challenge #2: Equity

Although technology has the potential to contribute to equity among learners, it is frequently a great source of inequality with regards to access and usage. Technology is typically adopted faster and in more engaging and innovative ways in schools serving affluent communities. Students in low-income schools may have comparable access to computers while at school but their access to computers and reliable internet may be limited at home. Additionally, low-income schools frequently employ technology for routine drills, content delivery, and in teacher-centered ways rather than facilitating access to knowledge and learning further enlarging the digital divide (Reich, 2019; Warschauer et al., 2004).

Effective use of technology can remove barriers to learning. It can make content and materials more accessible, less culturally biased, and less linguistically challenging. Technology can support educators to regularly assess their learners' needs, promptly respond to their progress, and provide tailored support based on those needs. In order for technology to promote a more equitable learning environment, access to computers, tablets or devices and reliable fast internet connection must be ensured both at school and at home. Next, attention needs to be paid to ongoing professional development and instructional coaching to support teachers, particularly to understand how they can influence student equity.

However, change in teacher practice and effective technology integration occurs gradually. In order to create more equitable learning environments and innovative uses of technology in their classrooms, teachers need to see multiple examples and have opportunities to practice in their classrooms. Finally, to promote equity, it is imperative that we see beyond technology integration and recognize the importance of using technology-generated data to better understand where learners are and monitor their progress as well as utilize learner-centered educational approaches to promote authentic and meaningful learning experiences mediated by technology.

## Challenge #3: Media Centrism

The field of instructional design evolved in part from a foundation in educational media. Perhaps for this reason, there is sometimes a bias towards overemphasizing technology in our designs. Throughout the history of our field, we see initial, frenzied excitement over a new technology that eventually is born out to be not nearly as disruptive as originally envisioned (e.g. virtual reality, moocs, interactive whiteboards, clickers, etc.).

Gibbons (2018) outlined succinctly a common pattern for new instructional designers, arguing they begin media centric, because "The technology itself holds great attraction for new designers. They often construct their designs in the vocabulary of the medium rather than seeing the medium as a . . . preferably invisible channel for learning interaction" (para. 3). According to Gibbons, designers then evolve to focus on the instructional message, then the instructional strategy, before finally learning to design according to an instructional model. "Model centering encourages the designer to think first in terms of the system and model constructs that lie at the base of subject-matter knowledge. . . . Then to this base of design is added strategy, message, and media constructs" (para 6).

Because of this inherent bias towards technology as the first solution, designers must practice discipline in not choosing the novel technological choice first before fully analyzing its true affordances.

### Challenge #4: Time/Cost/Efficiency Tradeoffs

Technology is often expensive to integrate into a learning environment—particularly if it is a new technology and especially if access must be provided for a large number of students to maintain equity. For example, the ability to teach mathematics to young children using virtual manipulatives using proprietary software on expensive tablets may be superior for some learning objectives to plastic, physical manipulatives. However, would the cost of buying and replacing the tablets be worth it? In addition, how much time will it take to train teachers and students on the new software? How much instructional time will it take in the class period to conduct the activity, including charging the devices, organizing them on the media cart, and retrieving them from students afterwards?

In making decisions about integrating technology into learning environments, designers must not only analyze what decisions will help people learn best, but also which decisions are most practical.

## Conclusion

It is clear that technology plays a very important role in our discipline, as many academic programs include the word in the title of their department. However, what technology designers use in the learning environments they create is less important than how they use it. In this chapter, two key principles have been outlined for designing effective instruction with technology: First, match the pedagogy to the technology's affordances; and second, focus on what students will do with the technology, more so than the teacher. Four challenges have also been outlined that are common when technoloy is used in design, and some suggestions have been provided for confronting these challenges. Perhaps the most important idea is to remember digital technologies, like theories, processes, and models, are tools—and tools are only as effective as the builder and the blueprints that will utilize the tools.

### Application Exercise

Consider a time in your life when you needed to learn something difficult. Some examples might be fractions as a child, learning another language, or learning a new routine at work. First, analyze what your needs were as a learner: what did you need to learn, and what made it challenging? Second, describe what kind of technology could have helped you? What affordances of the technology would have made it useful? Third, pick one of the challenges outlined in this chapter and discuss how an instructional designer could have utilized the technology effectively while minimizing those challenges. For example, how could they have reasonably provided equitable access? Or utilized CTML design principles?

## References

Allman, B. & Leary, H. (2020). *Aligning Pedagogy with Technology in Online Course Design* [Manuscript submitted for publication]. Instructional Psychology & Technology, Brigham Young University.

Bishop, M. J., Boling, E., Elen, J., & Svihla, V. (2020). Handbook of Research in Educational Communications and Technology (5th Ed.). Springer.

Bower, M. (2008). Affordance analysis – matching learning tasks with learning technologies. *Educational Media International*, *45*(1), 3–15. https://doi.org/10.1080/09523980701847115

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How people learn (Vol. 11). Washington, DC: National Academy Press.

Clark, R. E. (1994). Media will never influence learning. *Educational Technology Research and Development*, *42*(2), 21–29.

Dillon, R. (2020). The digital gaming handbook. Boca Raton, FL: CRC Press.

Ertmer, P. A., & Ottenbreit-Leftwich, A. (2013). Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning. *Computers & Education*, *64*, 175–182.

Gibbons, A. S. (2014). An architectural approach to instructional design. Routledge.

Gibbons, A. (2018). What and how do designers design? A theory of design structure and layers. In R. E. West (Ed.), *Foundations of Learning and Instructional Design Technology*. EdTech Books. Retrieved from https://edtechbooks.org/lidtfoundations/what_and_how_do_designers_design

Graham, C. R., Henrie, C. R., & Gibbons, A. S. (2014). Developing models and theory for blended learning research. In A. G. Picciano, C. D. Dziuban, & C. R. Graham (Eds.), *Blended learning: Research perspectives (Volume 2)*, *2*, 13–33. Routledge. https://doi.org/10.4324/9781315880310

Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The substitution augmentation modification redefinition (SAMR) model: A critical review and suggestions for its use. *TechTrends*, *60*(5), 433–441.

Harasim, L. (2017). Learning theory and online technologies (2nd ed.). New York: Routledge. https://doi.org/10.4324/9781315716831

Huang, Y. M. (2020). What drives students to continue using social mindtools? The perspectives of social support and social influence. *Computers in Human Behavior*, 106447.

Hwang, G. J., Shi, Y. R., & Chu, H. C. (2011). A concept map approach to developing collaborative Mindtools for context-aware ubiquitous learning. *British Journal of Educational Technology*, *42*(5), 778–789.

Jonassen, D. H. (1996). Computers in the classroom: Mindtools for critical thinking. Prentice-Hall, Inc..

Jonassen, D. H. (Ed.). (2004). Handbook of research on Educational Communications and Technology (2nd edition). Mawah, New Jersey: Lawrence Erlbaum Associates.

Kimmons, R. (2017). K-12 technology frameworks. Adapted from R. Kimmons (2016). K-12 technology integration. PressBooks. In R. West (Ed.), *Foundations of Learning and Instructional Design Technology*. Retrieved from https://edtechbooks.org/-dk

Kimmons, R., Graham, C. R., & West, R. E. (2020). The PICRAT model for technology integration in teacher preparation. *Contemporary Issues in Technology and Teacher Education*, *20*(1), 176–198.

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)?. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Kozma, R. B. (1994). Will media influence learning? Reframing the debate. Educational Technology Research and Development, *42*(2), 7–19.

Mikropoulos, T. A., & Bellou, I. (2013). Educational robotics as mindtools. *Themes in Science and Technology Education*, *6*(1), 5–14.

Moersch, C. (1995). Levels of technology implementation (LoTi): A framework for measuring classroom technology use. *Learning and Leading with Technology*, *23*, 40–42.

Mayer, R. E. (2014). The Cambridge Handbook of Multimedia Learning (2nd ed.). New York,
NY: Cambridge University Press.

Mayer, R. E. (1995). Cognitive theory of multimedia learning. *The Cambridge Handbook of Multimedia Learning*, *41*, 31–48.

Mayer, R. E., & Moreno, R. (1998). A cognitive theory of multimedia learning: Implications for design principles. *Journal of Educational Psychology*, *91*(2), 358–368.

Paivio, A. (1990). Mental representations: A dual coding approach. New York, NY: Oxford University Press.

Reich, J. (2019). Teaching our way to digital equity. *Educational Leadership*, *76*(5), 30–35.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–23.

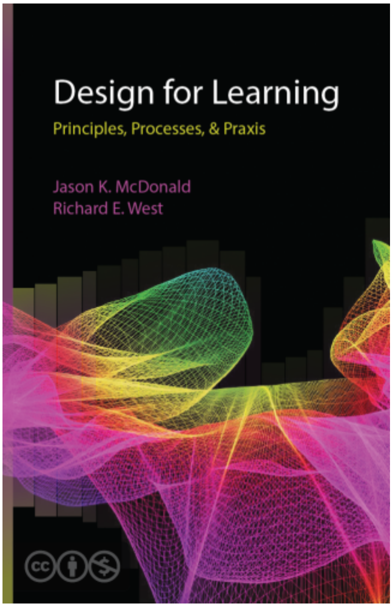
Stanley, G. (2013). Language learning with technology: Ideas for integrating technology in the classroom. Cambridge, UK: Cambridge University Press.

Warren, S. J., & Wakefield, J. S. (2013). Simulations, games, and virtual worlds as mindtools. *In Learning, Problem Solving, and Mindtools* (pp. 78–99). Routledge.

Warschauer, M., Knobel, M. & Stone, L. (2004). Technology and equity in schooling: Deconstructing the digital divide. *Educational Policy*, *18*(4), 562–588.

West, R. E., Hannafin, M. J., Hill, J. R., & Song, L. (2013). Cognitive perspectives on online learning environments. *Handbook of Distance Education*, *3*, 125–141.

Wiggins, G., Wiggins, G. P., & McTighe, J. (2005). Understanding by design. ASCD.




West, R. E. & Allman, B. (2021). Designing Technology-Enhanced Learning Experiences. In J. K. McDonald & R. E. West (Eds.), *Design for Learning: Principles, Processes, and Praxis*. EdTech Books. https://edtechbooks.org/id/designing_technology