Instructional Systems Design and the Diffusion and Adoption of Technology
(Volume 1)

Chapter 1: The Diffusion and Adoption of Instructional Technology

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1. The Diffusion and Adoption of Instructional Technology

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Key Points:

- Instructional design is the use of tools, techniques, applied theory, and technology to effectively communicate and accomplish learning objectives.

- The adoption of technology is a process that starts with knowing of the innovation, developing an opinion, making a decision, implementing the technology, then determining to continue, re-invent, or discontinue use.

- Diffusion is a function of time, where innovators, early adopters, early majority, late majority, and late adopters see and implement the benefits of the innovation.

Abstract

Instructional designers, instructional systems designers, and other educational technologists are, by their nature, innovators. These professionals apply and extend the applied science of learning, systems, communication, and instructional design theory to help students learn. Technology in some capacity is used to make the connections between subject matter experts, teachers, instructors, and their learners. It is common for instructional designers to seek new tools, techniques, and innovations for the improvement of learning, access, quality, and
student satisfaction. However, the adoption and diffusion of new educational technology and innovation is a complex process that depends on many variables. Understanding these processes and variables can help designers and technology leaders successfully implement positive change. This chapter serves as a brief summary of innovation diffusion models, organizational change models, and serves as an introduction to the work of other talented instructional designers who have explored specific aspects of educational technology adoption and diffusion. Together we hope that you find these cases, examples, and lessons learned insightful and help you plan for an innovation diffusion of your own.

**Introduction**

Why do some (many? most?) technology innovations fail? Why and how is it that some innovations are widely successful? How can instructional systems designers and instructional technologists plan for successful innovation deployments in their organizations? Answers are hard to come by, success can depend just as much on good planning and communication as it can on serendipity, luck, and other factors outside of our control. However, study and learning from research, models, success stories, and stories of failure, can help us improve our odds of success. That is what this book is about, an analysis of technology innovations, how and why they succeeded (or didn’t), and how we as instructional professionals can apply lessons learned from these examples.

The talented authors in this book present a number of compelling educational technology innovations and consequences of innovations such as 1:1 devices programs, the diffusion of Zoom, augmented and virtual reality, gamification, online learning management systems, and the digital divide. These topics are presented in the context of classic diffusion and innovation frameworks including the types of adopters, the adoption bell curve, and the diffusion s-curve (Rogers, 2003). Though before we start exploring those topics… what is technology adoption and diffusion?
An innovation can be an idea, process, or new technology that may meet the needs of a group of potential users. Adoption is a user’s choice to use an innovation. This choice is reached during an adoption process that includes knowledge of the innovation, persuasion and creation of an opinion, the decision, implementation, and confirmation of the innovation effectiveness (Rogers, 2003). Diffusion happens on a larger scale and is the process of larger numbers of user’s attempting to use the innovation. Understanding innovation diffusion will help change agents such as instructional designers successfully deploy new tools and techniques to help their learners. To begin this exploration, it is helpful to visit and review systems theory and communication theory.

**Systems Theory**

General systems theory can be used to describe many complex technologies, organizations, organisms, and other entities, endeavors, or objects with complex inner-related components. A system is a bound collection of components that work together to transform inputs, resources, and information feedback into actions and outputs (Von Bertalanffy, 1928). General systems theory originally described biological organisms, however the approach and model soon expanded to describe systems in many other disciplines (Von Bertalanffy, 1975).

An organization is a system (see Figure 1). The groups and departments within the system are interrelated and help each other reach common goals. For instance, teams of nurses, doctors, administrators, and staff in a hospital should all (in theory) be helping each other to provide the best care possible for their patients. Similarly, teams of teachers, IT staff, administrators, and other staff work together to serve their students. Complex systems have layers, often sub-systems that include the layers that deal directly with clients, layers that support client services, and layers that support the entire system (Altschuld & Kumar, 2010). Thinking about organizations as systems helps us understand the inner workings and inter dependencies within the system and how to approach diffusion planning.

**Figure 1.**
Organizations as Systems

Note. Organizations are systems that have interconnected components that work together to use resources, feedback from outputs, and reaction, pressure, or information from its environment to accomplish common goals and outputs.

Communications Theory

Communications theory helps us model one-to-one, one-to-many, and many-to-many mass and interpersonal dialog, discussion, news, and other message deliveries. The original theory and model developed from the need to describe and design telephone systems (Shannon & Weaver, 1949). The model describes a message being encoding into signals that are transmitted over a network to another device that acts as a receiver that converts those signals back into the message (see Figure 2). Shannon and Weaver also describe noise sources that can impact the network and potentially damage the accuracy of the message. In the original context telephones are the devices, there is inherently a two-way connection established between each device, as such each device can function as both the transmitter and receiver. Erroneous electrical interference, signal loss over wires and repeaters, and the
user’s distance from the microphone can all generate ‘noise’ or errors in the system (and the system should be designed to compensate). Another analogy could be the use of microphones, cameras, speakers, and displays on laptops to establish two-way communication using Zoom web conferencing as the medium connecting the devices. Another example would be an developer (message sender) designing instructional activities into an app that is downloaded from the Internet (communication medium) onto a student’s iPod (receiving device).

**Figure 2.**
*The General Communications Model*

*Note.* While developed in the context of telephone networks, the model of interconnected devices using a network to send and receive messages between each other can be generalized and used to describe many applications.

**Technology Adoption and Diffusion**
Along with learning theory, general systems and communication theory form the basics foundation that other instructional design theory builds upon. Classic diffusion research started in the 1930s with the study of Iowa farmers and their adoption of hybrid corn seeds (Ryan & Gross, 1943). Researchers found that farmers adopted the new innovation not at once, but over time. The rate of adoption was impacted by communication flow, tolerance for risk, and the ability to see results. Similar research on weed killer adoption and diffusion found similar results (Rogers, 1958). The similarity of these findings compared to other innovation diffusion work in health care, social science, and marketing led to the development of a general model of diffusion (Rogers, 2003). This model describes a normalized distribution, along familiar “S” and bell curves that model the rate that innovation diffuses in a social system. Rogers compiled and analyzed previous research and theorized that there are a series of adopter categories, and that these categories strongly influence how quickly an innovation spreads and the percentage of growth over time. Table 1 summarizes how adopters of an innovation tend to be characterized.

Table 1.
Innovator Categories and Characteristics

- **Innovators**
  - Tend to be venturesome, have resources, accept risk, and understand complexity

- **Early Adopters**
  - Are often opinion leaders, role model, trigger critical mass, are visionary and ‘big picture’ focused

- **Early Majority**
○ Tend to deliberate, research the innovation first, longer innovation-decision period, pragmatic and application focused

● Late Majority
  ○ Tend to be skeptical, adopt out of necessity, willing to risk less resources, must be convinced of safe investments before adopting

● Laggards (Late Adopters)
  ○ Are traditional, suspicious of change agents and innovations, extremely cautious, require simplicity, the innovation may not meet their needs

The adoption of an innovation starts slowly, adopted first by the Innovators. Innovators will tend to be fans of the technology, are eager to give it a try, and are comfortable with both uncertainty (in terms of the long-term effectiveness of the innovation) but also are willing to deal with an incomplete product. Early adopters will tend to have a vision that the innovation can help meet or accomplish, they are less concerned with operation support, and are also willing to risk resources on implementation. According to Rogers’ research, there is a point where the adoption of the innovation will be self-sustaining, where ‘word of mouth’ or interpersonal communication will sustain the momentum of adoption. This concept is the point of “critical mass”, or a 5 to 20% tipping point where adoption is escalated by the early majority (Rogers, 2003). At this point, the innovation is mature enough to reach mainstream users who have seen the innovation be successful. The theoretical average user will share characteristics of both early and late adopters. The late adopters will see that the innovation has worked well for others, the cost of ownership may have gone down, and there are support services available. The later adopters are called laggards by Rogers, though he admits that no ill intention is implied. However, the
term “laggard” may reveal pro-innovation bias in the model (and the inherent and incorrect assumption that any and all innovation will follow the curve of this model). It could be that the innovation simply does not meet enough of the late adopter’s needs to be adopted any earlier. Figure 3 illustrates the classic adoption “S” curve.

**Figure 3.**
*Adopter Categories and their Adoption of an Innovation Over Time*

Note. Adoption starts slowly with eager Innovators and, if successful, will reach a point of crucial mass where the Early Majority will accelerate adoption, Late Adopters will slowly also adopt as the innovation reaches its theoretical 100% market saturation.

Plotting the percentage of adoption by user categories over time is another way to analyze a technology’s diffusion in a marketspace or system. Rogers and others have found that this percentage function appears to take the shape of a classic, normalized bell curve (see Figure 4). The Innovators represent the smallest group, followed by the Early Adopters, the Early Majority and Late Majority are the largest groups,
with the Late Majority actually being the third largest group (and ironically representing quite a large user group).

Figure 4.
The Innovation Adoption Bell Curve, or Percentage of Adopters over Time

Note. Innovation adoption tends to follow a model characterized by statistical standard deviations, on a scale where the earliest Innovators fall outside of the 2nd standard deviation, and Late Adopters who fall outside of the first standard deviation from the center-most average.

The model, if used incorrectly by change agents or those encouraging the innovation’s adoption, may suggest that any innovation can reach its lucrative Early Majority, Late Majority, and late Adopters categories if given time. However, history is laden with technology innovations, that while far more advanced than its competition, never reached critical mass and mainstream audiences (i.e. the Apple Newton, Sony MiniDisc, Sony BetaMax, GM’s EV-1, and many, many others).
Several practitioners have theorized that a significant distinction exists between early Adopters and the Early Majority that prevents many innovations from reaching wild success. The chasm model was first proposed by Lee James and Warren Schirtzinger while marketing consultants at Regis McKenna Inc. in the late 1980s and was soon adopted by Geoffrey Moore while also serving as a consultant at Regis McKenna Inc. (Desmond, 1989; Moore, 2014; Schirtzinger, 2022). Figure 5 illustrates this theoretical gap between adoption categories and where a concerted focus has to be made by change agents.

**Figure 5.**
*The Potential for a Chasm between Early Adopters and the Early Majority*

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*Note.* Early Adopters and the Early Majority have different needs, motivations, and tolerance for risk, which could explain why an innovation does not bridge the gap and reach mainstream users and extend growth.
In the bottom of the chasm is a metaphorical graveyard of educational technology innovations that include hardware classroom Clickers, Google Glass, Apple iTextbooks, Palm Pilots, Xybernaught wearable PCs, and free MOOCs (or were some of these fads, innovations that very temporarily reached mainstream beyond the Early Majority, but faded from use very quickly?). If we as educational technologists feel that an innovation is worth the risk and investment to be adopted in our organization, how do we get it across the chasm? Table 2 describes several steps that can be taken to reach beyond Early Adopters.

Table 2.

*How to get Across the Chasm*

- Segment your market (narrow focus on smaller, similar subsystems)
- Focus on meeting specific needs of a few small subsystems
- Simplify and standardize (make the innovation easy and reliable)
- Establish your credibility (a function of observable subject matter expertise, trustworthiness, and empathy over time)
- Build a social media communication plan that has an interpersonal focus (on the specific needs and questions of the potential user)
- Provide great support (remove the risk)
☐ Establish an opinion leader/reference for others (with testimonials posted online)

☐ Provide models, demos, examples, and references from other early majority users (whose needs and use cases match other potential users)

☐ Create a reputation for great service and quality

☐ After critical mass, repeat in other market segments and subsystems

*Note.* Modified from McCroskey & Teven, 1999; Moore, 2014; ODU IDT 752/852, 2022; & Rogers, 2003.
Organizational Change

Instructional designers, or their clients, are often part of larger organizations, and successfully implementing innovation in large organizations is notoriously difficult. The biological system that is any modern organization must understand the need for the innovation, understand the innovation plan, and understand the consequences of not changing.

It is not that humans are afraid of change, they are afraid of loss (Heifetz et al., 2009). For instance, getting a raise, buying a new car, moving into a nicer house are all good changes and those experiencing those changes likely will be okay with those changes. However, a change where they lose their job, lose their car, lose their house, those are potential changes that create fear. Less dramatic examples in terms of fear of change include loss of comfort, security, reputation, time, money, power, control, status, resources, and loss of independence (Heifetz et al., 2009). Organizational change can be brought on via innovation in terms of new technology, new ideas, or generally any need for a system of humans to adjust their system to changes in their environment. It is important for educational leaders and instructional designers, and those who are looking to implement technology innovations to understand and plan for the resistance to innovation.

Many aspects of human behavior follow a normalized, bell-shaped distribution. We can safely assume that just about everyone in any given system will fall somewhere in the Rogers adoption curve. If the group is sufficiently diverse, the individuals in the system will tend to be distributed along the curve as Rogers and others have modeled (2.5% of them will be innovators, 17.5% will be late adopters, etc.). The resistance to technology innovation will likely come from the late majority and late adopters in the potential user base. In general, these are the audiences that want simplicity, an innovation that very closely meets their needs, and support services (Moore 2014, Rogers, 2003). While it may be much easier to win over the early adopters and the early majority, who are more open to risk, new ideas, and helping to develop new tools and techniques, a different set of strategies will have to be implemented to get full organizational buy-in.
Are you an educator or instructional designer looking to implement innovation in your organization? Implementing innovation is difficult, innovation in an organization of complex humans is even more daunting. Volumes have been written on organizational change, a quick search on Amazon.com will yield thousands of options to help a manager or leader like yourself turn around or improve themselves or their organizations. The common themes through many of these guides is systemic structural change, behavioral change, and effective leadership. While an exhaustive treatise on the topic is outside the scope of this chapter, there are a few books considered by many to be classics in the field. Two books in particular have influenced me and helped me guide my organization through periods of significant change.

**Cheese**

*Who moved my cheese?* (Johnson, 1999) is the endearing tale of two mice and two humans. In summary, imagine a maze with two human-sized mice and two humans. All four left their homes each morning and walked a well known path through the maze to their cheese. Then one day the cheese was gone, the mice were able to adapt quickly and moved on, however, the humans had issues. There was a period of disbelief, confusion, and sadness before one of the humans decided to venture back out into the maze. The human had the courage to change, eventually found new cheese (and his mice colleagues), and hoped that his human friend would follow his trail to join him. Along the trail from the old cheese to the new cheese the human had left a series of arrows and messages for his friend (see Table 3).
<table>
<thead>
<tr>
<th>Change Happens</th>
<th>□ They Keep Moving The Cheese</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Anticipate Change</th>
<th>□ Get Ready For The Cheese To Move</th>
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<tr>
<th>Monitor Change</th>
<th>□ Smell The Cheese Often So You Know When It Is Getting Old</th>
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</thead>
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<table>
<thead>
<tr>
<th>Adapt To Change Quickly</th>
<th>□ The Quicker You Let Go Of Old Cheese, The Sooner You Can Enjoy New Cheese</th>
</tr>
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<table>
<thead>
<tr>
<th>Change</th>
<th>□ Move With The Cheese</th>
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</table>

<table>
<thead>
<tr>
<th>Enjoy Change!</th>
<th>□ Savor The Adventure And Enjoy The Taste Of New Cheese!</th>
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<table>
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<tr>
<th>Be Ready To Change Quickly And Enjoy It Again</th>
<th>□ They Keep Moving The Cheese.</th>
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</table>
Note. The cheese in this business fable is a metaphor for whatever wants or needs you, or your organization, has (income, job security, more sales, a new product or service, etc.). Also note how the last step to success is the same as the first. This book is a great read and is highly recommended.

Penguins

It is tough being a penguin, you’re not able to fly, you are harassed by National Geographic, you live in the most inhospitable environment on the planet, and if you are the first to jump in the water looking for food then there’s a good chase of getting eaten by a killer whale. In addition to that, you are the lone innovator and realize that your colony’s iceberg is melting. This is the premise of Our iceberg is melting (Kotter & Rathgeber, 2006; 2016). The Innovator had to convince a diverse group of fellow penguins to reach out and find a new home. He is able to accomplish this by convincing a change agent and opinion leader, demonstrating evidence and data, overcoming irrational traditionalists, and communicating the seriousness of the situation. Kotter’s penguins used this 8-step strategy in Table 4 to reach a new home and a happy ending.

Table 4.
Lessons Learned from Kotter’s “Our Iceberg Is Melting” For Successful Organizational Change

- Establish a sense of urgency (we need to change or we will very soon be extinct)
- Create a guiding coalition (a diverse set of minds to begin planning)
☐ Develop a vision and strategy (to focus efforts)

☐ Communicate the change vision (the goals, objectives, and plans)

☐ Empower employees for broad-based action (let the team bring ideas to the change agents, get and use feedback)

☐ Generating short-term wins (to help keep employees motivated)

☐ Consolidate gains and produce more change (reach goals and objectives with the team, continue to get and use feedback to adjust the system)

☐ Anchor new approaches in the culture (communicate that change is inevitable and will happen again, but that’s okay)

Note. Modified from Kotter, 1995; Kotter & Rathgeber, 2006; & ODU IDT 752/852, 2022. Other great reads from Kotter include Leading Change and The Heart of Change, both also deal with appealing to the emotional aspects of change, urgency and the need to change, and how to get others on board and motivated to change.
Conclusions and Future Directions

While the world has changed since the original research in the early to mid 20-century that led Rogers to the development of his diffusion and adoption models, I’d argue that humans have evolved very little since then. These lessons learned, theories applied, and findings condensed into Rogers’ classic innovation diffusion models are still as relevant today as they were in the 1960s. Innovators will still take risks, later adopters will still avoid risk, and most of us will find ourselves somewhere along this spectrum depending in large part on the innovation, the severity of our need, and how well the innovation meets our needs. Also, nearly all innovations still introduce indirect, unintended, and undesirable consequences, and more research is needed in this area to inform practice.

Future technology innovation diffusion researchers are encouraged to collect data during the innovation processes, rather than at the end or at some other later point. The longer the period between innovation diffusion and data collection, the less research participants will accurately recall their thoughts, actions, and feelings during the innovation decision and implementation processes. Technology diffusion research can often take on a pro-innovation bias, where the consequences of the innovation are assumed to be beneficial for those adopting the innovation (Rogers, 2003). However, learning from failed innovations can likely teach us more in terms of what change agents did or did not do, what assumptions were made about adopters, and what resources were invested in communication planning.

Technology diffusion in education is often different than in other systems and industries. In education, schools often find themselves with limited resources, meaning adopting the wrong technology solution can be a career change opportunity for the change agent. Not only could the risks be higher, but resources across schools are not equitable, describing a potential gap between those who can afford to innovate and those who can not (Rogers, 2003). Add to these traits that very often it is not the most capable technology that becomes the one that makes it to the mainstream; politics, serendipity, and just luck can sometimes strongly influence how a technology is adopted. Overgeneralized models often can not capture the nuances and complexity of the real
world. However, a study of these models, applying the findings from successful diffusion cases, and learning from failed innovation efforts can help us prepare for our own projects.

Instructional design is an applied science that takes the lessons learned from many fields of study, as well as the applied research of instructional designers, and uses these ideas to further learning effectiveness. As such, instructional designers often find themselves as their organization’s innovators, early adopters, change agents, and/or opinion leaders. Understanding how potential users will adopt an innovation, how that innovation can diffuse over time, and how change in the organization can be guided, are best practices that can all be applied to increase the odds of a successful technology implementation.
References


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