1 A CASE FOR DISRUPTIVE INNOVATION IN EDUCATION

Ever tried? Ever failed? No matter.
Try again. Fail again. Fail *better*.

—Samuel Beckett

WHAT IS DISRUPTIVE INNOVATION?

Life and work in the 21st century clearly demand new learning outcomes for students. This means that in addition to the traditional literacies necessary for success, today's students must continuously develop mastery of new knowledge, skills, competencies, aptitudes, and literacies that were not requisite for college and career success in the 20th century. Education has decidedly entered a period of profound disruptive transition. The disruptive innovation train has left the station; however, not everyone is in their seats, or even on board.

One reason may be affect: Many people feel that disruption is a negative force. We don't like being disrupted, whether we are watching television, reading a book, or strumming a guitar. On the whole, we would rather avoid disruptions if we can help it.

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Disruption may invoke such negativity because it presupposes change—a change between the status quo and some new reality. Even the term *change* can evoke a negative visceral reaction. Change requires the investment of one's discretionary energy, something not everyone will do freely, because we take great comfort in our routines. To willingly step outside of our comfortable routines, we must first perceive a significant return on the investment of our discretionary energy.

The term *disruption*, particularly in the context of the classroom, has been given a bad rap over the years. When one thinks about a disruptive classroom,

one envisions every teacher's nightmare: a group of misbehaving students who are completely beyond the influence of their teacher, a class spiraling out of control. While disruption is an uncomfortable proposition in general, disruption in education is even more discomforting given the enormous complexities and variability inherent in the processes of teaching and learning.

Changing the routines and procedures to which educators have become accustomed is exceedingly discomforting—particularly if one achieves a level of success with practices that have withstood the test of time and from which one realizes acceptable results. It is understandable that teachers will fill their pedagogical toolboxes with methods that have had demonstrable reliability over the years, and that the longer they have used such practices, the more reluctant they will be to disrupt or relinquish them.

So why add to the infinite complexities of a classroom full of students by introducing something that is disruptive? To explore that further, let's first rethink the connotations of the word *disruption*. Clayton Christensen and his colleagues (Christensen, Horn, & Johnson, 2008) succinctly summarize that which, for many of us, is a confounding contradiction in terms: "Disruption is a positive force. It is the process by which an innovation transforms a market whose services or products are complicated and expensive into one where simplicity, convenience, accessibility, and affordability characterize the industry" (p. 11).

Christensen et al. (2008) go a step further by offering a new theory—disruptive innovation theory. Unlike sustaining innovations, which are characterized by confusion, obscurity, and a high level of complexity, disruptive innovations are not necessarily breakthrough improvements in processes or procedures. Rather, disruptive innovations are easy to understand. They make sense because they fall easily within our existing paradigm. They seem self-evident. They are manageable, accessible, and not so far out of the range of our current practices or procedures to make them "too far out" for general consideration and widespread adoption (Christensen et al., 2008).

For example, Christensen and colleagues (2008) suggest that the Apple II computer was a disruptive innovation. Personal computers, at the time, were large, cumbersome, and arguably complicated from a user's perspective. Rather than compete with IBM's firm hold on the personal computer market, Apple marketed the Apple II not as a personal computer but as a toy. It even looked like a toy, with the friendly interface and now iconic smiling computer icon. To the novice user, computers were intimidating, but toys weren't. The Apple II wasn't necessarily a breakthrough in computing power, speed, or storage. Instead, it was easy to understand and easy to use. As a result, the Apple II became widely adopted and used in homes, businesses, and most important to our topic at hand, schools (Christensen et al., 2008).

MANAGING DISRUPTIVE TRANSITIONS IN EDUCATION

The Apple II was a "toy" that, in the fall of 1984, when I was a young grad student at Rutgers University, disrupted my earliest thoughts about teaching and learning with technology. But could the introduction of the Apple II in education be considered a disruptive innovation, or was it a distraction from effective instruction? The answer, which I've come to after more than 30 years of failing better, is this: Educational technologies can be either a disruptive innovation or distractive innovation; the dependent variable seems to be the manner in which the technology is used.

One of the first educational technology studies I conducted involved determining the effect of the Apple II on student engagement. Some fellow grad students and I observed and coded the engagement behaviors (low, medium, or high) of a group of local middle school students at the new Rutgers educational computer lab in Camden, New Jersey. The students were to complete the tasks in a recently developed learning program called the Oregon Trail. Students' engagement was consistently high when they first interacted with the program. However, over a relatively short period of time, their engagement level dropped significantly. As students became bored with the program, they were more easily distracted and began seeking other behaviorally disruptive ways to sustain their interest levels.

Because the technology was so new to education, our early research followed a "let's add the technology and see what happens" mindset. The "novelty effect" I first observed in 1984 presaged a predictable pattern: One can expect a short-term increase in student interest and engagement due to the novelty of the technology experience, but because novelty is unsustainable, one can also expect to see a precipitous drop in student interest, engagement, and performance. As new technologies have emerged and been placed in schools over the past 30 years, we've seen the roller coaster of student engagement and performance rise and fall, going up after the addition of some new technologies—the Internet, the World Wide Web, laptops, handheld computers, interactive whiteboards, tablets—and coming back down after the novelty of that technology has worn off.

Former Stanford professor Larry Cuban and his colleagues (Cuban, Kirkpatrick, & Peck, 2001) studiously observed that computers have historically been treated as add-ons to traditional classroom practices. Instead of bringing about innovative disruptions, computers were relegated to the back of the classroom, where students could play games (like the Oregon Trail) as a reward for completing their classwork (Cuban et al., 2001). The commonality of low-value use of technology is hardly cause for celebration.

This pattern has played out over and over again in classrooms where technology is added in a manner that reflects high optimism but low intentionality.

Breaking out of this cycle of distractive innovation with technology will allow our schools to engage in sustainable methods that reliably improve instructional quality and student learning performance.

Frustratingly, while many supporters and critics of public education have described the need to change our system of teaching and learning, many fail to adequately explain exactly what we should be doing differently. We've answered the question of why we need classroom technologies; now we need to address the question of how we use technologies to meet the needs of third millennium students. This may not be so easy to articulate, but the indicators of knowledge generation and knowledge representation—what we want students to know and be able to do, and how they might demonstrate what they know and are able to do—absolutely must be reflective of the digital contexts in which they live. This may provide some stable means of ascertaining how schools in the future might look.

With that future in mind, we must first help school systems begin to transition between low-value uses of digital tools to higher-value uses. This process naturally requires tending to the change process itself, as well as managing the transitions between the ending of some old practices and the tentative steps toward implementing new ones.

To fail better, as Samuel Beckett counsels, education must let go of the false hope of technological determinism: the notion that simply having access to educational technologies will automatically lead to disruptive innovations and gains in student learning performance. To break the cycle, we need to first understand the principles and practices that constitute effective pedagogical practice. A brief overview of these principles and practices follows.

PRINCIPLES OF EFFECTIVE PEDAGOGY

A reasonable starting point for a review of effective pedagogical methods in schools may be found in two singular theoretical principles: John Dewey's (1938) principles of continuity and interaction. Dewey was a progressive educator who was well ahead of his time, and his principle of continuity suggests that the totality of one's past experiences is carried forward and exerts an influence on current and future decisions and experiences. In other words, one's past knowledge and experience are the foundation on which all new knowledge is constructed.

Dewey's principle of interaction refers to the conditional relationship among the learner, the new content information the learner experiences, and the environment in which that interaction takes place (Dewey, 1938). The principle of interaction suggests that learning is an active rather than a passive process. A disruptor in his own right, Dewey roundly rejected the idea that students were empty vessels that their teachers filled with the magical elixir of knowledge, the predominant pedagogical sentiment at the time. Dewey taught us that, rather than sitting quietly and passively absorbing new information, learners need to

create connections between new information and their previously actualized knowledge base by interacting with that new information in meaningful ways within meaningful contexts. To support the interactive nature of knowledge generation, learning environments need to be highly participatory places where students can experientially and playfully build relationships between and among new information, their prior knowledge, their teacher, one another, and their own reflective understandings. Learning is not only a team sport but a contextual team sport.

These two principles, while distinct, are both highly correlated and underscore critical components of any pedagogical context, past or present. It would be worthwhile to consider applying the principles of continuity and interaction, not only as they relate to an individual student but as they relate to the micro context of the learning environment in which the student is effectively generating knowledge connections and the macro context, or the larger societal context in which the learning environment itself exists. The knowledge and experiences gained by students in classroom learning environments not only are impacted by learners' unique backgrounds and interests but also must be reflective of the knowledge, skills, competencies, and aptitudes needed to thrive in the world outside of that classroom.

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Modern perspectives on the environmental conditions that are most conducive to supporting and enhancing human cognition have a solid grounding in the theoretical and empirical research literature on learning. Eminent researcher John Bransford and his colleagues (Bransford, Brown, & Cocking, 2000) build on Dewey's progressive learning principles by identifying five principles that could be regarded as essential to modern interactive and participatory teaching and learning. These five principles are listed in Table 1.1.

TABLE 1.1 ■ Modern Pedagogical Principles

1. Learning builds on previous experiences.
2. Learning is a social activity.
3. New content information should be framed within meaningful contexts.
4. New content information should be connected, organized, and relevant.
5. Feedback and active evaluation enhance the learning process.

Source: Adapted from Bransford et al. (2000).

The cumulative experience that students bring to the learning moment is the foundation on which all new knowledge is constructed. It's imperative, then, that teachers activate this prior knowledge as often as possible to help students build connections and explore the myriad relationships between what they already know and the new content they are experiencing. Activating and building students' background knowledge is a foundational principle for modern learning (Marzano, 2004).

It may not be too far of a stretch to suggest that learning experiences can be optimized by the process of discussing our tentative understanding of new content knowledge with someone who is more knowledgeable than ourselves. This may be part of our genetic heritage as social animals who are genetically predisposed to vast learning capacity (Morris, 1968). Constructivist learning theory suggests that it is through discussion that knowledge and meaning are constructed. To practice and deepen newly acquired content information, learners greatly benefit from engaging in learning tasks that allow them to talk about new information, reflect on that information, and engage in collaborative problem-solving or investigative tasks in which that new information is applied (Vygotsky, 1978).

Humans use language to construct knowledge and representations of what we know, what we are able to do, and how we think about our learning. To make sense of new information within the classroom context, students must interact discursively with their peers. Modern learners need to talk about new content information to fit that information into their current knowledge base. This is a dynamic process that requires students to reflect on how they think about new information, as well as to generate and test tentative claims about that information individually and collaboratively (Magana & Marzano, 2014a; Marzano, 2007).

Contextualizing new content information within a meaningful framework grounds the learning experience for students by adding numerous options for connecting prior knowledge to new knowledge. Putting new content information into a meaningful context helps learners make sense of how the new information they are experiencing is connected to past as well as future content knowledge. Presenting new content knowledge in the absence of a meaningful context confuses students and inhibits their ability to construct understanding and meaning.

New content information needs to be connected, organized in a logical sequence, and relevant to the larger environment in which students live. This helps students not only build connections between their foundational knowledge and new content information but also improve their understanding of and interactions with themselves and the world around them. Never has this been truer than in our modern, globalized society (Magana & Marzano, 2014a).

One of the most reliable ways to increase learning performance is to improve the quality and quantity of learning feedback. Continuous feedback

in the learning process should provide learners with three critical pieces of information: (1) a clear understanding of the learning objective, (2) an estimation of their proximity to achieving proficiency with the learning objective, and (3) an awareness of the strategies and tasks they must enact to achieve the learning objective (Hattie, 2009; Magana & Marzano, 2014a; Marzano, 2007; Marzano, Pickering, & Pollock, 2001).

PRINCIPLES OF EFFECTIVE TECHNOLOGY INTEGRATION

Effective classroom instruction, however, does not occur in a vacuum. The advent of a highly globalized and technologized environment, the macro context, demands that new digital tools be wielded effectively for classroom environments, the micro context, to remain connected, meaningful, and relevant. But should we focus on the pedagogy or the technology?

If you've ever listened closely to the iconic song "Because" on the album *Abbey Road*, then you will recognize this song as having one of the Beatles' most beautiful vocal arrangements (Lennon & McCartney, 1970). The foundation is the melody, as sung by John Lennon. However, when that melody is enhanced by George Harrison's low and Paul McCartney's high harmonies, the song becomes transcendent; it becomes music of the highest order. Listening to either the melody or harmonies alone would inestimably diminish the listening experience. A good melody enhanced by good harmonies results in great music. This is an apt metaphor for effective teaching and learning with technology: Good teaching is the melody, and good technology integration adds the harmony, resulting in greater impact. The whole is greater than the sum of its parts.

We must also consider the fact that today's modern learners begin interacting with multisensory touchscreens at a very early age. So does this level of multisensory interaction in virtual environments have a positive impact on a child's readiness to learn? Perhaps. However, an argument could be made that the virtual environment alone, the digital context, is insufficient as a means of bringing about authentic learning and understanding. Without the meaningful guidance and support of an effective teacher, children's interaction with technology tends to be predominantly banal and trivial (McFarlane, 2015).

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Much of what is currently known about improving a learner's interaction with knowledge has been well established in the research literature. For example, the inclusion of visual or nonlinguistic representations of ideas and new knowledge helps improve how effectively students interact with new knowledge. Richard Mayer's (2001) findings from quantitative studies with

graduate students suggest that learners learn more from pictures and words than from either pictures without words or words without pictures. This dual-coding theory, that learners make better sense of new content through words and pictures, is at the heart of Mayer's (2001) findings. Today, however, if one were to add the tactile-powered interactivity of current touchscreen technologies, one could reasonably argue that such experiences might enhance not only a child's interaction with that new knowledge but also the child's natural inclination to generate and test inferences about that entire experience. One can imagine a child's inner dialogue along the lines of, *When I touch that image of a cow on the screen, I hear the sound of a cow; so if I touch that image of a kitty on the screen, then I'll hear the sound a kitty makes.* Does this kind of experience demand a new tricoding theory that includes words, images, and tactile interaction with those words and pictures? Perhaps it does.

My friend and coauthor Dr. Robert J. Marzano recently summarized his findings on the impact of technology on student achievement, stating that "a good teacher with technology will usually outperform a good teacher without technology" (Magana & Marzano, 2014b). This is indeed cause for optimism, because taken at face value, compounding research evidence points to a strong trend: Learning environments in which technologies are integrated to enhance multisensory interaction, knowledge expression and representation, discussion, feedback, and reflection improve student learning (Hattie, 2009, 2012; Haystead & Magana, 2013; Haystead & Marzano, 2009, 2010; Magana, 2016; Magana & Marzano, 2014a).

Taking all these premises together, a strong argument can be made that modern technology integration practices should reflect the following principles (see Table 1.2).

TABLE 1.2 ■ Modern Technology Integration Principles

1. A primary focus on implementing highly reliable instructional principles and strategies with fidelity
2. A secondary focus on leveraging readily available technologies to support, augment, and enhance highly reliable instructional principles and strategies with fidelity
3. A tertiary focus on mindfully monitoring the impact of Principles 1 and 2 on students' social and academic performance

Still, effective and systemic technology integration in classroom instruction remains frustratingly elusive. A contributing factor may be that far too many educational software and online learning experiences offer only repetitive "drill-and-practice" learning experiences. When using these technologies, students are reduced to mere passive consumers of decontextualized "facts" that

could be delivered as easily by a machine as by a textbook. Such tools are designed to reinforce basic skills through rote memorization in the absence of any meaningful context—precisely the kind of passive learning that Dewey rejected as ineffective nearly 100 years ago.

So how did we get to this unhappy place? The rise of the "digital worksheet" may be another reason for the disappointing impact of educational technologies on student achievement—precisely because it is used as a direct replacement for a human teacher. In regard to the effective use of educational technology, there appear to be two different camps: those who favor technology as a replacement for teachers and those who favor technology as a supplement to a good teacher.

Author Marc Prensky (2001) introduced a metaphor to explain his opinion why, despite large investments for educational technologies in K–12 classrooms, schools in the United States had not realized significant gains in student achievement. Prensky surmised the reason to be that today's students are "digital natives" who use technology as native language speakers while classroom teachers are "digital immigrants" who communicate with a pronounced accent (Prensky, 2001). In his widely circulated paper "Digital Natives, Digital Immigrants," Prensky assertively advocates for replacing teachers with technology and letting the digital natives use computers to teach themselves. He essentially calls for teachers, the digital immigrants, to get out of the way (Prensky, 2001).

John Hattie (2012) disagrees. He suggests that the problem with Prensky's theory of digital nativity is that it is presented in the absence of any evidence. Professor Hattie suggests that Prensky ascribes to children attributes they simply do not possess and therefore his theory should be disregarded because it is "basically incorrect" (Hattie, 2012). Internationally renowned educational technologist Professor Angela McFarlane (2015) also observed that Prensky harbors a kind of "techno-romanticism," which suggests that to realize the potential of educational technologies, they should be used as replacements for classroom teachers (McFarlane, 2015). Professor McFarlane argues that, rather than simply replacing teachers with computers and online content, educational technology tools should be incorporated into the framework of what is currently considered effective instruction:

> In reality much that we know about learning, communicating, creating knowledge and sharing it, remains valid in the face of connected digital technologies. Recognizing this and adapting effective practice to new contexts is at the heart of understanding how digital technologies can best support effective teaching and meaningful, authentic learning. (p. 9)

A final important trend readily emerges from the research literature: When technology tools are used to replace teachers, one can expect a very small to small effect on student academic achievement (Cheung & Slavin, 2011; Hattie, 2009, 2012). When educational technologies are used to supplement teachers'

instructional methods, one can expect a moderate effect on student learning (Hattie, 2009, 2012; Haystead & Marzano, 2009, 2010). However, when teachers use technology to enhance highly reliable principles and strategies, one can expect a large to very large effect on student learning (Haystead & Magana, 2013; Haystead & Marzano, 2009, 2010; Magana, 2016; Magana & Marzano, 2014a). The heart of this work is to ensure that educators and educational leaders have the guidance and resources to reliably integrate readily available educational technologies to optimize students' social and academic growth.

SUMMARY

To consider effective pedagogy in the 21st century, one simply must consider the larger environmental context in which that learning takes place. As work and life in this century transform due to increasing globalization and the application of information and communication technologies, so too should modern learning environments reflect these changes. While this has been a desired outcome for the past 30 years, the impact of educational technology tools on student achievement has not matched the potential of these tools to reliably enhance teaching and learning. A contributing element of this problem may be an overemphasis on low-value use of educational technology tools in our schools.

A potential resolution to this problem rests with the development of an actionable framework for educational technology use that primarily emphasizes highly reliable pedagogical principles and strategies, places a secondary emphasis on ways teachers can enhance these principles and practices with their available classroom technologies, and places a tertiary emphasis on monitoring the impact on student social and academic success. This not only will serve to improve student learning outcomes but also will better prepare students for social and professional success in the conceptual economy of the digital age. In the next chapter we will further explore the benefits of frameworks and how the T3 Framework can serve as a guide for reliably increasing student performance by incrementing the value added by technology use in schools.