2 Resonant Learning

In defining resonant design, we want to be clear about how we think about games, play, and learning, as well as playing in schools. Our practice as designers draws on a large body of work in a rich variety of disciplines. In this chapter, we briefly explain our orientation to the larger body of literature. For those looking for a deeper dive, we highly recommend the work of the people we mention below. Here, our focus is on simply introducing some of the ideas that we have found valuable. These ideas inform our games and principles as part of the process of design-based research, through iteration, tradeoffs, and creativity.

Learning

Much of our intellectual foundation in learning stems from learning sciences research, which positions learning at the core of all human endeavor. Most of the things people do in their everyday lives—speaking, tying shoes, using the handle of a door, driving—are learned, and we are all likely learning something new every day (Bransford et al., 2000). The learning sciences seek not only to understand how we learn but also to improve instruction. There are better and worse opportunities and situations for learning, and by recognizing this, we can advocate for certain types of learning experiences over others.

We can define learning as the process of moving from a novice perspective to an expert's skill or to knowledge. Some of the most important strategies to help a learner move from novice to expert understanding are scaffolding, metacognition, and attention to conceptual change.

• Scaffolding means instructors assist students in understanding by using structured supports that can fall away as students develop their abilities. For example, coaster bikes allow children to learn to ride a bicycle by helping them develop balance before skills in pedaling.
• Metacognition involves helping learners be aware of their own thinking and learning, which helps them take command of and responsibility for their own education. Understanding what one knows and what one still wishes to know can help learners passionately pursue their interests.
• Conceptual change refers to the important moment when a learner's conceptual model of a phenomenon in the world transitions from an incomplete or incorrect one into an accurate one.

Creators of good learning games will pay close attention to these concepts in their designs.

An idea central to our development of resonant games is that learners will best develop knowledge and skills by doing things in the world—knowledge is not delivered but constructed by the learner through and during activity and discovery. The educator and philosopher John Dewey developed this idea at his Laboratory School at the University of Chicago, and Dewey's ideas have influenced many other models of experiential learning. We highlight a few essential ideas and paradigms here—if you are curious, we hope you will track down more of this work, as it is tremendously inspiring.

• From problem-based learning and inquiry learning (cf. Hmelo-Silver, 2004; Holbrook & Kolodner, 2000), we take the idea that questions are crucial to education. By focusing on problems or challenges, learners face questions from others as well as their own questions, creating a clear frame within which to work.
• In project-based learning (Blumenfeld et al., 1991) students learn skills and knowledge and are encouraged to follow their curiosity in carefully scaffolded projects, like starting a small business or building a new park. The learning and creativity in response to challenging real-world constraints is extremely inspiring to us.
• Seymour Papert's model of constructionism (Papert, 1993) emphasizes the creativity of the learner. Papert extended Piaget's notion of children as active agents in building knowledge structures by observing that this happens best when they are engaged in creative, hands-on activities.

Resonant games are also designed for learning with others. Paradigms like cognitive apprenticeship, communities of practice, and communities of learners emphasize not only learning by doing, but by doing things together with others, often in carefully designed activities that balance the agency and self-direction of learners with an egalitarian spirit that encourages all to learn and to learn together.

Resonant games are indebted to a great deal of work on sociocultural learning theory, particularly the importance of context and situation to learning (Lave & Wenger, 1991) as well as the critical value of coaching, modeling, and supporting by thoughtful mentors (Brown et al., 1989; Rogoff, 1994) as well as by other members of the community (Wenger, 1998). Roles, shared goals (Brown, 1997; Aronson & Patnoe, 1997), and carefully designed tools for producing shared knowledge (Caswell & Bielaczyc, 2002; Roschelle, 1992) are all also essential to the development of the resonant games paradigm. Most important is the idea that resonant games *situate* the activities and knowledge in contexts that are meaningful to the learner as well as significant in the larger societal context.

The resonant games approach as an educational technology philosophy is one of transforming classroom practice, not merely digitizing existing practices. One could think of this as the difference between model United Nations innovations and classroom *Jeopardy*. While *Jeopardy* can be an undoubtedly fun way to drill on facts, it provides what gamers might call a weak reskin of the traditional initiation-response-evaluation classroom dynamic (Polman and Pea, 2001). This ping-pong dynamic between students and teachers is anemic in the face of the wild questions, problems, and opportunities for learning that occur in a rich, structured-but-multilateral activity like model UN. Resonant games are for use in a learning environment in which student questions and interests are an important part of the educational exchange. We believe that resonant games, through ambiguity and aesthetic interest, create experiences and opportunities for just this sort of exchange.

Criticisms of these approaches sometimes lump these types of learning theories under the broad category of "discovery" learning, arguing primarily that these experiences are so rich and complex that facts and skills might not stick in learners' memories (Kirschner et al., 2006). To this end, resonant games must be experiences worth talking about, allowing novices to develop the questions that will lead them to expertise. Joplin's (1981) work

in experiential learning is a useful model for how to help learners attend to important information and contextualize it usefully.

In this model, students are focused on skills and information before a challenging activity like a learning game, and they debrief the experience afterward as a community of learners, with mentors giving feedback and support along the way (figure 2.1). Although resonant games provide some kinds of technological feedback and support to players in a game, we design the games to, as much as practical, engage players with human supports, including teachers, parents, and peers.

As we discuss in detail later, resonant games are usually designed as *preparation for future learning*. The result of addressing a challenging action in an experiential learning context and the subsequent debrief will not always result in formal analytical knowledge. Coming out of the debrief, however, students may have material understanding of, for example, pre-algebra *concepts* as well as their own questions and ideas of how to solve such problems. As John Bransford and his colleagues state, "There are times, usually after people have first grappled with issues on their own, that 'teaching by telling' can work extremely well (e.g., Schwartz and Bransford, 1998). However, teachers still need to pay attention to students' interpretations and provide guidance when necessary" (2000, p. 11). This is an approach frequently used with science center field trips. Perhaps the best example of games as preparation for future learning is a study in which community college students, in preparation for a lecture on World War II, were randomly assigned to one of three groups. One control group, one group that played a squad first-person shooting game, and one that played *Civilization*.

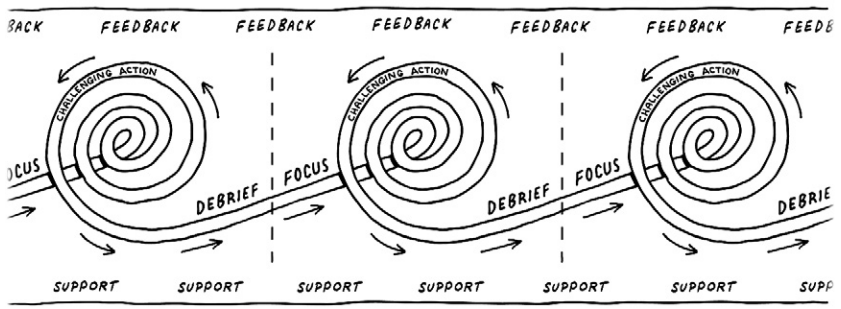

Figure 2.1
A diagram of experiential learning (adapted from Joplin, 1981)

The game players did better on a postlecture exam than the control group, and the first-person group focused more on tactics on the ground, while the *Civilization* players focused more on global issues (Arena, 2012).

Play

Play and Fun

Lev Vygotsky wrote, "A child's greatest achievements are possible in play, achievements that tomorrow will become her basic level of real action" (1978, p. 100). In other words, the imaginings and investigations that children perform in the guise of what we call play are the essential materials and resources of child development. Play is often equated with fun. Ian Bogost (2016) writes that "play is carefully and deliberately working with the materials one finds in a situation" (p. 113), and fun is "not the effect of enjoyment released by a system, but a nickname for the feeling of operating it" (p. 114). As we shared in chapter 1, we often hear the idea that playful learning activities should "make learning fun," as in, "make math fun." But these topics and situations are already fun and interesting at some level or to some people, and students often need only an appropriate lens to the right kind of problem. The idea of making learning fun positions learning environments and experiences on a single axis, between "play" and "learning," with a move in either direction on the axis necessarily sacrificing the other value (see figure 2.2). Any movement toward playfulness necessarily means a less useful learning experience, and vice versa. In other words, you can give up play to have more learning, or give up learning to have more play.

In the Education Arcade, we prefer to think of play and learning as a plane with "play" and "learning" as perpendicular axes (see figure 2.3). Learning is often a playful experience, and the activity of playing often

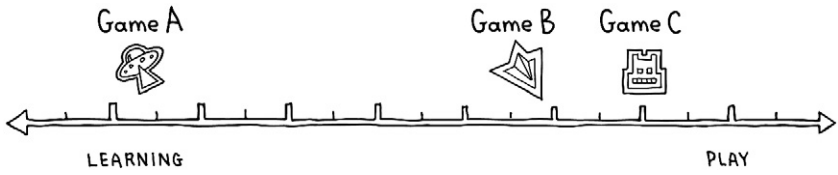

Figure 2.2
The play/learning axis

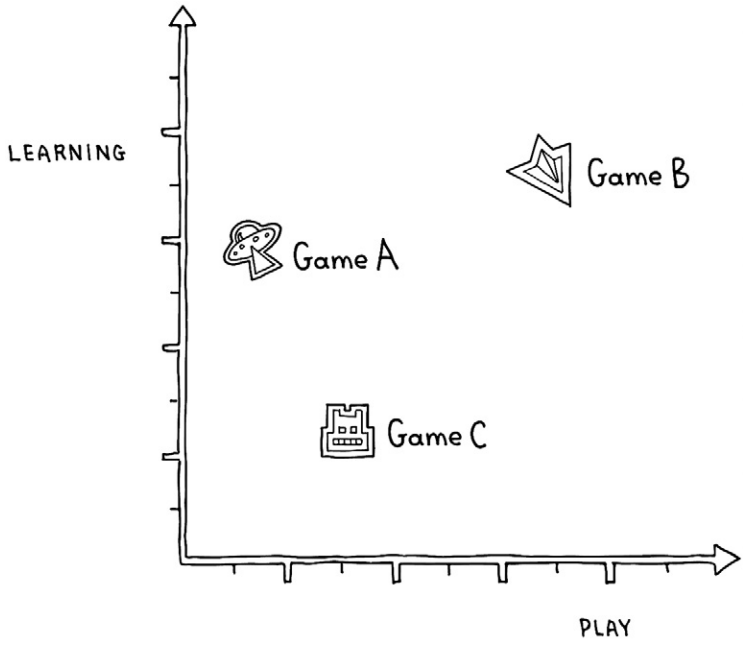

Figure 2.3
The play/learning plane, where Game B is the goal, maximizing both learning and play

involves learning. Most importantly, in any given experience, learning and play are positioned in a zero-sum struggle. Resonant game design purports that experiences can often be their best when both play and learning are maximized in the design and execution of the plan.

Play and learning scholars have often discussed the concept of flow—"optimal experience" moments of playing, in which extreme skiers, mountain climbers, and *World of Warcraft* raiders find themselves in a perfect channel of experience, free from boredom on one hand and anxiety on the other (Csiksentmihalyi, 2000). We rarely aim at "flow" in designing resonant games. There is evidence that games whose mechanics specifically drive toward flow and optimal experience are usually designed for individual experience and can in fact impede learning, while playing with others is more effective for learning and reflection (Raphael et al., 2012).

What can be fun, however, is for learners to have experiences within their zone of proximal development (ZPD). The ZPD is the zone in which

children can advance a skill or accomplish a task with some help (Vygotsky, 1978). Children learn by staying in the ZPD as long as possible, working at the edge of their competence. This leads us more often to think in terms of the engaged attention that Seymour Papert called "hard fun."

In an essay, Papert (2002) says hard fun

> is expressed in many different ways, all of which all boil down to the conclusion that everyone likes hard challenging things to do. But they have to be the right things matched to the individual and to the culture of the times. These rapidly changing times challenge educators to find areas of work that are hard in the right way: they must connect with the kids and also with the areas of knowledge, skills and (don't let us forget) ethic adults will need for the future world.

An appropriate problem that is hard fun (in this case, building a robot)

> requires concentration and discipline. It requires learning to deal with things going wrong by finding out how to fix the problem rather than by giving up in frustration. And for some of those kids it has meant experiencing for the first time the pleasure of writing because they were encouraged to write about something they were doing themselves and doing with passion. (Papert, 2002)

Play and Freedom

Our own Scot Osterweil has advanced four *freedoms* of play, which illuminate the kinds of things we can do while playing—the kinds opportunities that working a problem playfully can afford us. These freedoms should be carefully considered when developing learning experiences, as institutions like schools, even very progressive ones, can strip learning experiences of freedom.

Osterweil's four freedoms of play:

- Freedom to explore: Play allows for players to fool around, to investigate, to run their minds over the surfaces of a new problem or idea, to be surprised by some new idea or experience. You might think of idly putting together Legos or playing with wooden blocks and stumbling on mathematical concepts or equivalence, as Papert famously did, or learning deeply about ratio by fiddling with the gear box of an automobile (see *Mindstorms: Children, Computers, and Powerful Ideas*, 1980).
- Freedom to fail: Play is an excellent opportunity to discover one's capacities as well as the possibilities of materials, systems, and other learning objects without fear of reprisal and with minimal impact on one's sense of competence. James Paul Gee refers to this as a "psychosocial moratorium" (2003).

• Freedom of identity: The capacity to investigate your own identity by trying on other identities and learning what it feels like to perform different types of actions and to ask all sorts of questions.
• Freedom of effort: Play is healthily anchored in a freedom to exert oneself maximally, but also to maintain a lusory attitude (Salen & Zimmerman, 2003) while hanging back, observing, and/or reflecting, as a child playing tag may cease to run hard and instead watch from the periphery before reentering the fray (Opie & Opie, 1969).

Play and Self-Determination

We find the ideas of self-determination theory quite compelling to explain how to design playful and resonant activities. The theory asserts that in order for people to flourish, they need to experience competence, autonomy, and relatedness (Ryan & Deci, 2000). Sebastian Deterding (2012) claims that play is a truly remarkable state of being, free from stress and fear, in which we are able to pursue these three goals. We believe that the kind of games that allow for freedom and hard fun certainly push toward competence and autonomy. The third goal, relating through play, can be somewhat more complex.

Playing with others, interacting, cooperating, and reflecting in a learning community can be a remarkable way to meet learners' need for relatedness in learning contexts. We believe that understanding the social aspect of learning is essential for learning designers. Social play has been ubiquitous and essential to human culture for as long as it has existed. Nonetheless, designers need to be aware of the possibilities of play's darker side. Brian Sutton-Smith (1983) talks of "cruel play," in which children and adults both exalt in the domination of others, and Marjorie Harness Goodwin (2008) writes of the ways in which girls' games and play are used to exclude and diminish each other. Players may feel a real sense of shame if they fail to perform in certain contexts like public play, which contravenes a freedom to fail. Teachers and mentors using playful methods must take care to monitor how play is manifesting with their learners, and designers must pay close attention to the social affordances of their activities.

Finally, play in learning contexts should not be limited to instilling relatedness only between players. Resonant design should include teachers and other learning coaches, being careful not to "instrumentalize" play

and games to fill time on a rainy day or to reward students for finishing a "serious" activity.

We believe that play and respect for students' sense of autonomy, competence, and relatedness should be located at the heart of all learning activities. We strive to create opportunities for curricular autonomy and recognition of professional competence for educators, *as well as* allowing students to be whoever they want while encountering opportunities to fall in love with something new.

Games

Games, for us, are vehicles for play. We principally use Bernard Suits's definition of games: the voluntary overcoming of unnecessary obstacles (Suits, 1990). Other useful features of games, like rules and goals, can be essential for playful learning, but we begin by considering the simplest definition. As Suits says, playing golf is absolutely the worst way to accomplish the goal of getting a small ball into a very small hole far away. We hit the ball with a series of sticks because it is fun, and we enjoy it (even when it is, to be polite, Papert's hard fun). Games are generators of play because they create unnecessary obstacles that we want to engage with and overcome anyway (often through goals, rules, and other structures). Resonant games should be just that, then—unnecessary obstacles that are meant to be (mostly) voluntarily engaged with for use as learning environments and in learning communities.

Games and learning scholar James Paul Gee (2008) has summarized the ways in which these constraints and structures make games, and particularly video games, excellent learning environments. Six main features of games can facilitate deep learning:

- Games use rules to achieve meaningful goals. This means players are attempting to achieve something in the game, and that the goal feels organic and personal, not generic.
- Players have the power of microcontrol. For Gee, games generally offer one of two perspectives on the world of the game: either they provide an embodied intimacy or they extend the player's reach of power and vision. These are two ways to acquaint players with the systems within one's game—either by granting them a powerful, all-seeing status in which they

manage key parts of the world, or from an on-the-ground perspective, connecting with an avatar and that character's experiences of the systems.

• Games for deep learning feature the best of what studies in the learning sciences have been able to tell us about excellent environments for learning *from experience*. Gee highlights the value of games providing a goal, feedback in pursuit of that goal, opportunities to demonstrate and transfer the skills used in pursuit of that goal (or goals), and then the opportunity to formalize players' experiences and further develop or elaborate these skills in concert with others in discussion and collaboration.

• Games can offer concrete experiences with underlying models that enable learners to easily abstract their experiences toward more general concepts.

• These concrete experiences can allow for probing by matching the tools or bodies of players' games to the Gibsonian affordances of the world, giving meaning to their probes and their intuitions about how things might work.

• Finally, games for deep learning allow their players to create narratives about their experiences that they can share with others as part of the formalization process described above. These narratives should have trajectories that allow them to do all sorts of things, including understanding their relationship to the world and to knowledge.

Gee (2003) also pointed out that games are crucial because they connect us with knowledge, with our sense of ourselves, and with others in ways that demand not only attention but passion.

These remarkable properties position games as rational tools that modify the world and permit learning by experimentation and discovery. Kurt Squire's work builds on this, but he points out the aesthetic dimensions of games as important in making them powerful learning environments (Squire, 2002, 2006, 2011). Squire's work heavily underpins resonant design. Some aspects of games cannot be reduced to just rich intellectual experiences, but spill over into our bodies and our hearts. Squire recognizes how much gamers love their games, and the importance of this for learning. Learners almost always do better in their learning if they are deeply interested in what they are to learn, taking responsibility for their own learning. Squire recognized that emotional experiences, such as being caught up in a world, feeling like an expert and a competent actor, can be extremely important. The aspects of a game that cannot be reduced to the logical or

the practical—the aesthetic aspects—can seduce people into caring about the modeled world and tools of the game (see also Hunicke et al., 2004). Players are more likely to try to understand the surfaces and limits of places and problems if they feel a deep connection. Resonant games aim to draw players in, absorbing them with the frames they draw around situations and with their point of view on knowledge and skills. Resonant games are designed with a passionate love for knowledge, modeling that knowledge carefully and in a manner ripe for exploration.

How is this expressed? One argument for how games might express ideas to learners is the idea of procedural rhetoric, which is "the practice of authoring arguments through processes" (Bogost, 2008, p. 125). Rather than explicitly stating a point of view, a game can convey that message through an experience. Games with explicit or "easily read" procedural rhetoric, however, are frequently not fun and generally leave no room for the player to engage meaningfully with the modeled system. Rather, procedural rhetoric usually works best when it is shaping the game without becoming the center of the experience.

This might be in part because of the value of uncertainty and ambiguity. Mastering uncertainty is central to the appeal of games (Costikyan, 2013; Koster, 2013). Similarly, ambiguity enables designers "to suggest issues and perspectives for consideration without imposing solutions. … [It] is a powerful design tool for raising topics or asking questions, while renouncing the possibility of dictating answers" (Gaver et al., 2003, p. 240).

Resonant design employs these types of tools to avoid the control and dogma that many associate with schooling and education, offering autonomy to the player instead. Piagetian scholar of teaching and learning Eleanor Duckworth has written and taught on the topic of "the having of wonderful ideas." She wrote about a Piagetian interview she conducted with a seven-year-old boy named Kevin who, when presented with ten drinking straws cut to different lengths, spontaneously and joyously arranged the straws by length. Other children had needed to be asked to arrange the straws, but not Kevin. She writes:

> It wasn't easy for him. He needed a good deal of trial and error as he set about developing his system. But he was so pleased with himself when he accomplished his self-set task that when I decided to offer them to him to keep (10 whole drinking straws!), he glowed with joy, showed them to one or two select friends, and stored them away with other treasures in a shoebox.

> The having of wonderful ideas is what I consider the essence of intellectual development. And I consider it the essence of pedagogy to give Kevin the occasion to have his wonderful ideas and to let him feel good about himself for having them. … [T]he right question at the right time can move children in to peaks in their thinking that result in significant steps forward and real intellectual excitement; and … although it is impossible for an adult to know exactly the right time to ask a specific question of a specific child … children can raise the right question for themselves if the question is right. Once the right question is raised, they are moved to tax themselves to the fullest to find an answer. (Duckworth, 1996, p. 1)

Is arranging ten straws of different lengths a game? Is playing a game the essence of intellectual activity? Kevin's straws have a lot in common with a game of golf in our opinion. Any given learning activity can be more or less "game-y," referring to the intended and received effects of the activity's elements—for instance, its mechanics, dynamics, and aesthetics (see Hunicke et al., 2004). The straws pose a problem through their affordance of being uneven, but what might be done with them is up to the learner. It is ambiguous what, if anything, is the right thing to do with them, despite a procedural rhetoric that implies order (among other things). Kevin is thus presented with a problem and left alone to tinker with it and have his own idea. While basic, this is a resonant game.

We're emphasizing this because much has been made of the disservice done to games by instrumentalizing them in in teaching and learning—deploying a game as a tool. Designer and scholar Frank Lantz, during the question-and-answer section of a talk given at the 2014 Game Developer's Conference, asserted that to use a game to teach (the questioner specifically referenced *Civilization*) is like using music to help you learn the alphabet: "You can do it, but it's not the main thing we like about music." In this same talk, Lantz states that games should "make us smart, interesting people," but he does not seem to have a mechanism other than osmosis by which this happens (Lantz, 2014). We would argue that the cultural process of players apprenticing themselves to the game and *learning from it* changes them. This usually happens in a community of fellow learners.

One need only look at the work of Squire and his colleagues with and on *Civilization* to see that remarkable teaching and learning can be done with such a game, making the game better than it is in its initial life as a mere consumer product. The game affords and inspires all the marvelous work that Squire did with remedial history students for his dissertation (Squire, 2002) as well as the extensive work done in the Apolyton University

community online (Squire, 2011). Still, we believe that the people doing the teaching and learning around the game are what make it truly great. Lantz's talk manages to emphasize games' unique position, saying that games are the aesthetic form of thinking and doing, learning for its own sake, while allowing us to contemplate these operations about our own minds, but he is unable to see the strange wonder of *Civilization* as a potential educational experience.

Note that while we may be relaxed around the word "games," we definitely did not name this section "simulations." The playfulness of Abraham Lincoln or Gandhi running civilizations for thousands of years is an aesthetic contribution to the overall experience of playing *Civilization*. Living in that world, being drawn into the puzzles of that game, does not mean you have been literally trained to rule a Stone Age civilization into its glorious empire years. It means you have developed what Andrea DiSessa (2001) (and Gee) would call a material intelligence for thinking about the development of a civilization. It means that the game's affordances allowed you to make interesting decisions that, by dint of being complicated and initially murky, drove you to consider the features and surfaces of the problem deeply. It means that you have tested and probed the world and your own mind at the same time in pursuit of victory and knowledge. If you aren't paying attention to your thinking at first, a competitive spirit may drive you to do so in the face of failure. *Civilization* may cause you to ask hard material questions that arise from your play and from your personal needs and experiences.

One of Squire's students in his dissertation study, an African American, became first intrigued by and then obsessed with the question of why African culture could not have become the dominant one globally, ahead of Europe. He worked diligently to answer this question and learned a great deal about the (unfair) distribution of resources around the planet, then wondered if he could create a conquering African civilization despite the disadvantage (and he did) (Squire, 2004). *Civilization*, like Duckworth laying out the uneven straws before Kevin, provided clearly defined goals; visible, measurable feedback; a compelling underlying model of the world; and an environment in which there are consequences to decisions (Squire, 2004). The personal efforts of this student resulted in a wonderful idea and the beautiful phenomenon Lantz is looking for.

Finally, we have to recognize the possibility of draining this richness, this beauty, from games as experiences, particularly in institutional contexts where games might be made mandatory. We must acknowledge that cultural artifacts of all kinds may be used in ways that defeat their initial purpose, that misunderstand them. We must also acknowledge that players of some of the most amazing games may opt to play games in a way that is not fully committed. Suits (1990, p. 58) calls these folks "triflers," saying, "A trifler at chess is a quasi-player of the game, who conforms to the rules of the game but whose moves, though all legal, are not directed to achieving checkmate. … I think it is fair to say that such a person is not playing chess, although it is clear he is operating within the institution of chess." These players are no longer playing the game, but rather are acting within "the institution" of the game instead. In our minds, this is a natural part of play, embodied in the freedom of effort Osterweil has highlighted. Sometimes we don't want to play. Sometimes we wish to compete, and other times we would rather trifle. The material affordance of some aspect of the game might attract our attention, calling for us to play with it in some new way. Educators who are interested in using games for learning must understand that this is also how games and play do their work—players may not notice a particular property before they play in and around a game. The game may not resonate with them until they come to understand the world around that newly intriguing feature of the game through play. That is learning.

Games and School

In 1984 Seymour Papert wrote, "There won't be schools in the future. … I think the computer will blow up the school. That is, the school defined as something where there are classes, teachers running exams, people structured in groups by age, following a curriculum—all of that" (p. 38). In the thirty-plus years since, computers have been "oversold and underused" in education (Cuban, 2001) and, more to the point, have made the bureaucratization of schools easier and more complete. As we write this, schools are being pressed into buying more computers so that students can take PARCC and Smarter Balance standardized tests even though the No Child Left Behind Act, which reauthorized the Elementary and Secondary Education

Act, was itself not reauthorized, and its replacement, the Every Student Succeeds Act, may seriously deemphasize such tests.

Of course, Papert's optimism was founded on changing society for the better, hoping to turn our societal project of education into something more humane, more focused on the good life. And computing is enabling novel educational experiences in many compelling ways. Scholar and activist Ivan Illich wrote about "learning webs" in his *Deschooling Society* (1971), stating that technology would allow for a society in which skills are shared and peers can be matched with one another, and in which individuals could be referred to educational objects and educational experts when needed. These practices have been researched and described by researchers in the digital media and learning community, in works like the *Connected Learning* report and books like *Hanging Out, Geeking Out, and Messing Around* (Ito et al., 2009; Ito et al., 2013). Young people (and others) are seeking knowledge online, sharing knowledge, exploring tools and processes for self-expression, and seeking out mentors when needed. The technologies that permit this have been predicted by progressive educational visionaries, but the social and institutional properties of contemporary education have limited whatever capacity technology may have had to "deschool society."

Many designers, developers, and researchers of educational games have opted to pursue learning communities outside or after schools. We have performed our own case study that illuminated the remarkable challenges inherent in school adoption (Klopfer & Haas, 2012). Yet we remain deeply committed to working with and in schools as they exist. This is a crucial piece of resonant game design—a game cannot fully resonate if it cannot connect with students, educators, and their communities, and if it is not adopted. This is, in part, an equity issue. If we wish to provide quality learning opportunities for young people who need it the most, then we must work with schools, as these students are the least likely to be part of a parent-organized informal learning community or home schooled.

Schools are an important institution, and they have transformed over time, bending to suit political purposes and to accommodate new understandings of what may be best in education. Graham (2007) describes phases in which schools were called on to manufacture an American identity for a nation of immigrants, to educate the whole child, to help children fit into society, and to outachieve other nations. David Tyack and Larry

Cuban (1995) describe a process of "tinkering toward utopia," in which schools have undergone change after change to deliver a great education to all children. Since the federal government was essentially forced to intervene in schooling with the *Brown v. Board of Education* case, the government's work has been principally to bolster achievement and equity. In recent years, we have seen that concern get baked into legislation (the 2001 reauthorization of the ESEA). This movement has led to some excellent outcomes, as scrutiny has been applied to states and school systems that were systematically and deliberately marginalizing students. Yet, regrettable consequences have arisen from the pronounced achievement (i.e., test-centric) focus. There may well arise a new era of school experimentation in response to the recent past and to new legislation. What seems unlikely however, is that schools will disappear, as Papert suggested. We see the role of resonant design as one of anticipating and encouraging a new culture of experimentation within schools.

There are, of course, many challenges to creating successful learning innovations, let alone influencing a learning culture or learning cultures more broadly. Some known risks of innovating in classrooms are that schools and classrooms can coopt, deform, and otherwise marginalize or misuse a new piece of software like our learning games (Collins & Halverson, 2009; Cuban, 2013). And this is to say nothing of the deeply restricted classrooms under the contemporary era of standardization, high-stakes testing, and centralized control. We believe, though, that this is the best use of our efforts—to build a visible practice, drawing from the work of others and our own experimentation to promote dialogue and discussion. We strongly feel that this deliberate, intentional practice is our best hope for changing minds and even promoting a paradigm shift.

Clear or universal answers for the problems with our educational system might not exist, but part of the resonant games model is to develop an understanding of why and how games could be used in the classroom, as well as why and how they might not be appropriate. The changes in the policy environment are encouraging, but they will almost certainly not be a sufficient means to effect a full transformation of these conditions. In the near term, as we write, particularly in the chapter on *The Radix Endeavor*, we are very focused on working with teachers to provide them the support they need to take the risk of adopting our tools. In the far term, we support efforts to further professionalize teachers and grant them the training and

full autonomy accorded to other professionals in society, as well as policies that allow greater experimentation in school culture and philosophy.

Games, Learning, and Design

In this book then, we further elaborate on the ideas that have formed the foundation of our game designs. The Education Arcade's approach to design research with our games and all our software and projects draws principally from the learning sciences and specifically the tradition of design-based research. Learning science is "a design science drawn from an engineering ethos. In an engineering approach, success is seldom defined in terms of theoretical accounts of how the world operates, but by developing satisficing solutions for how things ought to be—innovations that satisfy existing conditions and sufficiently meet the stated goals within prevailing constraints (Simon, 1996)" (Nathan & Sawyer, 2014, p. 23). Design-based research is about creating design experiments with some object in naturalistic contexts:

> Prototypically, design experiments entail both "engineering" particular forms of learning and systematically studying those forms of learning within the context defined by the means of supporting them. This designed context is subject to test and revision, and the successive iterations that result play a role similar to that of systematic variation in experiment. (Cobb et al., 2003, p. 9, in Barab, 2014, p. 151)

This process of developing a learning object with careful attention to existing theory and an intent to report our findings back to the community is our fundamental underlying approach for developing resonant games. It is highly similar to the values at play framework (Flanagan & Nissenbaum, 2014) as well, iterating as much as possible and checking to ensure that the game is faithfully retaining our desired values at each iterative pass through the design process. During these iterations, we may cut systems we like, throw out designs whole cloth, or change our ideas about desired outcomes if the project warrants it. We may make tradeoffs with the principles we are advocating in this book, or we may change the attention given to any specific principle. We might dramatically reduce a multiplayer social emphasis in favor of more opportunities for deep inquiry if appropriate, or we may sacrifice authenticity of content in order to provide a much needed model to prepare for future learning. But it is fair to say that, for resonant design, we are most hoping to connect with the players.

Throughout this book, then, we attempt to tell you not only about the finished product of each game, but something about how it was developed. When we were unable to iterate as frequently as we would have liked, we will give you some idea of what we would have changed and what ideas we could not fully pursue but believe bear further pursuit in other works and forms. In this way, we are trying to develop what Sasha Barab (2014, p. 165) has called, "storied truths," unpacking the ways in which our designs work in enough detail that others may implement those designs or ideas in their own local ecosystems. We hope that you enjoy our stories about our designs, and that you can find something you can use or adapt to help foster play and learning wherever you are.