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Leveling Up: Game Design Research and Practice for Instructional

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Anyone who makes a distinction between games and learning doesn't know the first thing about either.

– Marshall McLuhan

Introduction

Games have been used for learning since at least the Middle Ages, when chess was used to teach war strategy (Institute of Play, n.d.), and they formed the basis of early childhood education with the founding of the Play and Activity Institute by Friedrich Fröbel in 1837 (Friedrich Fröbel, n. d.), later to be termed Kindergarten. So, in a sense, we have been using and researching the power of games for learning for centuries. When games made the leap from analog to digital (first, as arcade machines, then computers, and finally consoles), however, research on their efficacy picked up in earnest. Seminal publications like Patricia Greenfield's *Mind and Media* in 1985 (see chapter 7) and Jim Gee's *What Video Games Have to Teach Us About Learning and Literacy* (2003) promised to usher in an era of research practice founded on sound theory and experimental design. Unfortunately, despite these important signposts on the road to a new discipline, much research focused on the medium itself rather than the instructional theory that accounted for the potential for learning through games. As a result, the demand for guidance on designing games and integrating them into formal learning now exceeds our ability to supply it. There remain critical gaps in our understand of games and learning, including what kinds of problem solving are supported by what kinds of games (e.g., Hung & Van Eck, 2010), the role of player experience in making meaning (e.g., Gajadhar, 2012), validated models for integrating commercial games into the classroom (e.g., Van Eck, 2008), and the conditions under which games may or may not promote aggressive behavior (e.g., the work of Craig Anderson and Christopher Ferguson). These gaps present a serious challenge to the advancement of our understanding of games as formal and informal learning tools. We will leave the bulk of this challenge to you, the reader, as you enter the field and begin your own career. There are some signposts we think can help guide you on this journey, however, which is why we have written this chapter.

We believe that games are very effective learning tools. We believe this to be true for the same reason we believe that any mode of instruction, when designed using instructional design principles and processes, is effective. A recent meta-analysis of games found, among other things, that game-based instruction resulted in a .33 standard deviation improvement in learning when compared to non-game-based instruction in general and, more importantly, that theoretically augmented (well-designed) games accounted for a .37 standard deviation in increased learning compared to nonaugmented games used in instructional settings. To wit: well-designed games promote learning (Clark, Tanner-Smith, & Killingsworth, 2014).

We recognize the potential circularity of stating that well-designed games work because they are well-designed. Yet, the number of published studies that fail to account for design (game and instructional) makes it clear that this is a point that cannot be made too often.

Instructional design mandates that we analyze a given medium for its ability to support desired strategies and outcomes. One of the possible results of such analysis is the decision NOT to employ the given medium. There are plenty of examples of studies that purport to answer whether games are or are not effective for learning, but that is not the central question for any instructional medium. It is far more important to ask when, where, and for whom are they effective, and with what mechanisms can they achieve different learning outcomes. Games are not appropriate for all outcomes, all learners, in all venues, and at all times, any more than textbooks, video, or lecture-based instruction are. As with all media and modalities, games are effective when they align with instructional outcomes and strategies within the constraints of the medium, a given environment, and a set of learners. Why, then, is so much of the discussion about games and learning still centered on *if* games can teach rather than how they can best be *designed* to teach? We argue that three critical explanations, which will form the structure of this chapter, will be helpful in understanding the answer to this question.

In part one of this chapter, we discuss how games involve play and how Western culture devalues play as a serious activity, which is one reason that so many remain skeptical about "if" games can teach. In part two, we discuss how many "serious games" end up being Frankensteinian mashups of game and context rather than true manifestations of games as a medium, thus contributing to the doubt about the *ability* of games to teach. Also in part two, we argue that the true power of games may lie in their ability to promote higher-order intellectual skills like problem solving.

Finally, in part three, we discuss a key challenge facing learning game designers, and one we are happy to report is beginning to be met: assessment. Assessing performance (and its close cousins, eliciting performance and providing feedback) requires us to know how the problem is solved incrementally, over time, and through the application of specific enabling skills (e.g., rules, defined concepts, concrete concepts). This means that we cannot just let students play a learning game and then give them a test—we have to know how knowledge is developed and demonstrated throughout the instruction (game) itself. This need has been met by an assessment design framework called evidence-centered design (ECD; see Mislevy, Steinberg, & Almond, 2003), which we argue is critical for instructional designers who want to work with games.

Part I: Games and Play Theory

The question of what makes a game fun to play is very similar to the question of what makes a joke funny. On one level, we all know the answer, but articulating it well, if at all, is surprisingly difficult. In one episode of the television show, *Star Trek: The Next Generation*, Commander Data decided to confront the question "What makes something funny?" As an android who aspired to become human, this question was very perplexing to him, and he set about answering it as a programmed machine or a very analytical engineer might, by breaking the construct "funny" into all of the conceivable rules. Data erroneously tried to come up with a grand "if/then" tree for "funny" (i.e., if I say this, then say that, in this way, etc., *then* it is funny). In contrast, the best answer, to paraphrase Garrison Keillor, is that something is funny simply because people laugh. We can chuckle at Data's misguided attempt, but many people in the ISD field seem to be following a similar rule-based "engineering" path to try to understand how to design a game that is fun and also leads to learning. Similar to Keillor's definition of funny, a game is fun to play if people enjoy playing it. More specifically, we argue that a game is engaging, or fun to play if it triggers the play phenomenon in the player. So, we must take some time to understand the play phenomenon. Fortunately, much research has been done on play from a multitude of disciplines such as education, psychology, sociology, and anthropology.

Making play an objective of an educational game requires a paradigm shift for most designers—one that is very learner-centered and constructivist in nature. To understand this paradigm, you need to understand the difference between merely playing a game and being "at play." The former can be mandated by a teacher to students or a trainer to a group of employees, and these participants can dutifully "play the game." That is, one can watch and track their behavior or performance from beginning to end and even declare that one or more has won the game. However, these individuals may never have been "at play," meaning that they never entered the conceptual cognitive or cultural space in which play occurs (Huizinga, 1950).

So, what is play? Everyone reading this chapter already knows what play is, and you yourself have probably experienced it within the last 24 hours, even though you may resist, as many adults do, using the word "play" to describe it. It probably happened during your leisure time, although if you are fortunate enough to love your job, it may have happened at work. It was definitely something you wanted to do, and you would say that you did it voluntarily. You found the activity intrinsically motivating and so you were not concerned about "getting something" out of it. You were also doing something actively and possibly physically. Finally, you were likely in a state where you were not conscious of yourself or of your place in the world but rather felt wholly absorbed in the activity. This state also carried a feeling of being very free from risks. You felt free to try new things or to experiment with different ways of doing or thinking—after all, it was only play. Your awareness of time likely disappeared, and you were probably surprised by how much time had passed when the activity had ended (see Pellegrini, 1995; Rieber, 1996; and Sutton-Smith, 1997 for formal definitions and attributes of play). Some of you may have experienced play while engaged in a hobby such as gardening, woodworking, photography, painting, or some craft. Others may have experienced it while caring for a son or daughter and enjoying each other's company. Yet others experienced it while reading a book, playing a musical instrument, or playing a video game. A lucky few have experienced it while writing a chapter in a book!

Educators and other educational stakeholders (e.g., parents, state legislators) are quick to ask—"What good is play? Does it lead to some productive outcome or result?" The seminal work of Jean Piaget remains an important starting point for such questions (Phillips, 1981; Piaget, 1951). Piaget felt that play and imitation were core and innate human strategies for cognitive development. With play, a child could rehearse a newly formed concept to make it fit within what they already knew and understood (assimilation). As a child experiences or encounters new events, activities, ideas, or rituals, imitation is used to build entirely new mental models (accommodation). The child continues in this way to achieve an orderly balanced world while constantly confronting a changing, shifting environment. Just as the mental processes of assimilation and accommodation continue throughout life, so too do play and imitation remain important cognitive tools for people from childhood through adulthood.

There are other examples of research literature, while not overtly aligning with play, that are clearly in the same camp. The research on self-regulated learning (Zimmerman, 1990, 2008) is one example, especially with its emphasis on an individual actively working toward goals within intrinsic motivating activities. However, the attributes of flow theory proposed by Csikszentmihalyi (1990) are the most similar to that of play, especially in the context of game design. For example, flow theory specifically addresses the need to optimize challenge, so as to continually avoid anxiety and boredom. Activities that induce flow have clear goals, coupled with clear and consistent feedback about whether a person is reaching these goals. Another important attribute of flow is that it takes effort to attain a state of flow, requiring a clear and deliberate investment of sustained attention.

The psychologist Brian Sutton-Smith (1997) has proposed many ways to think about play—what he calls the rhetorics of play. Among the most alluring of these rhetorics for educators is the idea that play leads to something productive (i.e., play as progress). However, Sutton-Smith refers to the ambiguity of play in being able to "deliver the goods." Although there are tantalizing reasons for believing that play is by and large a good thing, one should be very careful in attributing positive results directly to it. There is evidence that positive outcomes and play go together (i.e., correlational effects), but much of that evidence is anecdotal rather than empirical, making it challenging to say that play *caused* these outcomes. Another ambiguity of play is that experiencing it itself may be its own reward and that the goal of getting something out of play is misguided. But, the presence of the play state may at least be evidence that the person is in a good state for subsequently experiencing cognitive and social growth, and this alone may be good enough reason to make play a goal for any learning environment.

David Elkind's (2007) theory of play further elucidates the relationship of play and work. He posits three instinctual drives that are the root of all human cognition and behavior throughout a person's lifetime: Love (a person's disposition to express one's desires, feelings, and emotions), work (a person's disposition to adapt to the demands of his or her physical and social worlds), and play (a person's need to adapt the world to one's self and create novel learning experiences).

To become a well-adjusted person living compatibly within a complex social system, one must balance the demands and goals of each of these three elements in ways that change throughout life. In early life, play dominates, but gives way in early elementary years, when work dominates and love and play take on a supporting role. Love dominates as we enter adolescence, and all three become fully separate in adulthood, although each can be manifested in combination with the others. Bringing love, work, and play into harmony with each other at points throughout one's life is an important goal and one that parents and teachers (and instructional designers) should work to facilitate. Unfortunately, for many adults, play is often seen as the opposite of work, making the goal of achieving a balance between love, work, and play elusive.

Elkind's focus on balancing love, work, and play is similar to Csikszentmihalyi's concept of psychological growth during flow (Csikszentmihalyi, 1990), where an individual becomes more complex or advanced by balancing the need to be a unique individual with a unique identity (differentiation) while at the same time feeling connected to other people and social groups (integration). Furthermore, Elkind's theory of the relationship between love, work, and play can even be mapped onto the current interest in "21st-century" skills (e.g., work productively within diverse teams, identify and solve complex problems with innovative solutions, communicate effectively, think critically, use technology efficiently, understand system dynamics, and engage in evidence-based reasoning).

This chapter is about digital, or computer, games for learning. Among those conducting research in this area, the prevailing interest tends to be focused on the immersive games, such as massively multiplayer online role-playing games, or MMORPGs. The technology underlying these highly visual, persistent virtual worlds is very impressive, and the technical sophistication of these "high-tech" gaming environments can only increase, leading to new game genres and models of interaction which we cannot even imagine now. Would-be educational game designers, however, would do well to consider low (i.e., nondigital) and middle-tech (i.e., the span of digital games up to high-tech examples) approaches to gaming in addition to the high-tech games, if only to understand that the fundamentals of a game extend outside of the specific technology of any single game. Regardless of the degree of technology infusion in the game, we believe that the play phenomenon is always eager to emerge.

Having laid a theoretical foundation for learning and play in relation to educational games, we next examine architectural issues, viewed through the lens of instructional design. Specifically, we discuss a model for thinking about immersive game design that incorporates sound learning theory in a framework that is compatible with both learning and game design.

Part II: Blended Theories, Frameworks, and Problem Solving

As we've shown in the last section, there are many theories that inform game research and design. When examining the literature from the mid-1990s through today, however, this has not always been obvious. One of the key pitfalls awaiting new scholars in this area lies in mistaking the medium for the message—in assuming that "new" video games can only be explained by "new" theories. This is not to say that theories from different disciplines are not relevant, nor that the intersection of different disciplines will not produce new theoretical approaches to understanding how games work. The field is evolving rapidly, and our tools must keep up with our evolving understanding. The maxim is that all good research and theory builds upon prior research and theory. Therefore, it behooves the new and experienced scholar to have a core set of theoretical tools at his or her disposal. So, how do we know which theories are most relevant, and how do we synthesize them into a framework for research and design? The answer is, of course, that it depends. Principles of behaviorism (e.g., schedules of reinforcement, stimulus-response latency, and association) help us understand how Jeopardy-style games work for factual information. Constructivist principles (e.g., social negotiation of meaning) help us understand how people make meaning of their experiences in open worlds and MMORPGs. Sociocultural learning theory helps explain how culture mediates and situates knowledge, and of course, many other things like motivation, locus of control, and self-efficacy, help predict how people will experience and perseverate (or not) in game worlds. Those we choose to apply and combine in our design and analysis of games depends on our outcomes, learners, and constraints. The promise of games to promote deep learning of more complex intellectual skills (defined concepts, rules, and problem solving) as well as attitudes and cognitive strategies, is among the most cited benefit of games, yet many who make such claims do not use (or report using) the theoretical tools that lead to such learning outcomes.

A recent report by the Joan Ganz Cooney Center at the Sesame Workshop (Takeuchi & Vaala, 2014) that surveyed 694 teachers from across the United States found that nearly 75% of K–8 teachers reported using digital games in their classrooms, and that more than 40% of them were doing so to meet local, state, and national standards. Yet, the vast majority of K–8 teachers are using what have sometimes been described as “drill and kill” games that focus on lower-level taxonomic outcomes (verbal information and concepts, in Gagné’s taxonomy [Gagné, Wager, Golas, & Keller, 2004], and knowledge and application in Bloom’s taxonomy [1984]) that can be accomplished in a single classroom session. There is nothing wrong with this in and of itself, of course, yet we would argue that there are many instructional strategies and modalities that can address lower levels of learning just as effectively. The true advantage of games as a medium is their potential to address higher levels of learning (e.g., rules and problem solving, or synthesis and evaluation) along with other outcomes (e.g., attitudes, metacognitive skills) that are traditionally difficult to address.

The design of immersive games that promote problem-solving outcomes can be driven by many theories, but there are three primary theories that we think are critical to designing any game for such outcomes. The first is based on situated cognition (e.g., Brown, Collins, & Duguid, 1989; Lave, 1988), which is commonly referred to as situated learning. Situated learning embeds learning and assessment in real-world environments. By "real-world," we mean environments that mimic the real-world contexts in which the goals of the instruction would normally be observed and demonstrated.

The second key concept is that the environment and tasks must also be authentic. This means that the actions *taken* within that real-world context reflect the actions and processes that would normally occur when *demonstrating* that knowledge in the real world. It also means that the environment *behaves* authentically, in that actions taken by the learner result in the kinds of responses by the environment (and the people, tools, and resources within it) that would happen in the real world. This is not to say that the world must be a fully realized simulation of the real world, of course. There are many aspects of the real world that do not apply to a given learning situation (e.g., one need not experience a virtual world with gravity in order to learn how to react to angry customers in customer service training), and research on simulations has suggested that irrelevant details (seductive details) interferes with learning (e.g., Harp & Mayer, 1997). Even relevant information may be problematic if the learner's level of expertise is insufficient (e.g., Adcock, Watson, Morrison, & Belfore, 2010). It is important only that the key elements of the content and process outcomes are replicated in the environment.

While "real world" and "authentic" may sound like synonyms, there are important distinctions between them. Asking a student to solve a word problem about dividing up a *Pokemon* card collection is not a real-world example; it is a problem *about* a real-world problem.

Putting kids in groups with actual *Pokemon* cards and telling them to work out a fair way to divide them so each person has the same value is *almost* a real-world problem—about as close as we can get in school settings. Having those students solve the problem by filling in worksheets or matrices based on provided values is *not* an authentic way of solving the problem; having them decide on the process to use, determine what a fair arbiter of true value is, and build their own value charts *is* as authentic as we can get in the formal educational environments. Research has shown that instruction built on these principles is effective in promoting initial and long-term learning as well as increasing the likelihood of transfer of learning to new contexts.

The third theoretical area is, of course, the research into problem solving itself. As an instructional outcome, problem solving refers to the ability to synthesize multiple rules and defined concepts and apply them to problems that do not have a known solution. It is generally believed that the only way to promote problem solving is, therefore, to present the learner with multiple problems to solve within a given domain. This is often done in the context of instructional strategies that scaffold problem solving, sometimes called problem-centered or problem-based learning. Thus, problem solving may be thought of as both a strategy and an outcome, yet problems are always at the heart of the instruction.

Obviously, formal education cannot create real-world problems for every topic, which is why video games are among the most effective means of providing situated learning environments for promoting problem solving outcomes. Rather than asking students to "pretend as if" they are in the real world, video games *provide* that "real" world. That world can also be programmed to respond authentically in the context of the desired learning outcomes. Problem solving is an oft-cited benefit of videogames but one that is routinely oversimplified. For example, it is important to recognize that there are many different kinds of problems that vary in their cognitive composition, degree of structuredness, and required domain knowledge. Jonassen (2000) has proposed a typology of 11 different types of problems, each of which requires specific design and instructional strategies to promote. It follows that if we must teach (and if learners must bring specific prerequisite knowledge to) each problem in a specific manner in face-to-face instruction, then we must also differentiate and do so for the problems we hope to embed in games designed to promote specific problem-solving skills. Space does not permit a more detailed discussion of problem-solving; see Hung and Van Eck (2010) for more on aligning problem types and game types.

This is hardly a full treatment of any of these areas, of course, but good resources are widely available for those who want to study them further. It is also not necessary to make use of every theory when designing games—as with all instructional design, our strategies rely on our learners, environment, content, and context. There are many different ways to blend these different approaches. One way to do so is a framework called situated, authentic problem solving (Van Eck, 2015), but there are other models that have been used with success as well (e.g., Barret & Johnson, 2010; Borchert, et al., 2010).

We have articulated some of the theories and models that we feel can help guide the design of games for learning, but there are many others. We remind readers that this list is not exhaustive and that a large body of literature on games and learning exists and should be consulted. Our purpose in this chapter is to illustrate some of the key truths we believe must underlie all such models and frameworks. These key truths can be synthesized into several propositions, which we present next.

Learning Should Be Goal-Oriented. According to Jonassen (2002), all good problems share two characteristics. First, they have some kind of goal, or unknown. The goal/unknown requires the generation of new knowledge. Second, all problems should have some value to the learner in solving them. Like problems, games have a goal/unknown which requires the learner to generate new knowledge. Games, (at least, good ones) also have a value to the learner in achieving the goal. So a game that focuses on problem solving will, by definition, be goal oriented.

Learning Should Be Active and Interactive. Problems in the 21st century, like the challenges in games, are solved in a distributed, iterative fashion. Such problems are often ill-structured and nonlinear and require data gathering from a variety of sources. Problems themselves are also rarely presented in a complete fashion but instead often have several elements missing. The problems for a game should be designed as a complete case first, then have key elements removed. Those missing pieces should be distributed across multiple resources. Solving the problems should require that the player seek out different resources throughout the game. Resources provide different types of information depending on where the player has been and what information he or she currently possesses. Thus, the game should provide multiple opportunities for interaction and require active participation for the player to solve the problem. This is a common feature of successful commercial games and ensures that the learner is an active participant.

Learning Should Provide Adaptive Challenge and Support. In order to provide varying levels of challenge and support according to different levels of expertise, designers should carefully organize the problems/scenarios in the game into levels of increasing complexity and decreasing support. Like the problems themselves, support should also be distributed and contextualized. Scaffolding can take many forms within the game, including dialog, interactions with mentor/advisor characters, etc. Challenge and support should also be adaptive in the sense that behavior patterns and actions (like the Evidence Model that we refer to in the final section of this chapter does) within the game may trigger support or challenge options. For example, too much elapsed time since the last action and repeatedly exploring dead-end branches of the game may trigger (authentic!) intervention.

Learning Should Incorporate Feedback. Every action in the game should result in some form of feedback, but the nature of that feedback should again be contextualized and authentic. Speaking to characters should always result in some form of response, either as additional information (in which case the player knows he or she is on the right track) or a canned response like “I don't have anything to add to what I've already said” (in which case the learner knows that it is time to move on). What is key is that the feedback provides contextualized hints and prompts rather than direct answers or instruction, and it is contextually sensitive to the game narrative, problem, and environment.

Part III: Stealth Assessment and Evidence-Centered Design in Games

In games, as players interact with the environment, the values of different game-specific variables change. For instance, getting injured in a battle reduces health and finding a treasure or other object increases your inventory of goods. In addition, solving major problems in games permits players to gain rank or “level up.” One could argue that these are all “assessments” in games—of health, personal goods, and rank. But now consider monitoring educationally relevant variables at different levels of granularity in games. In addition to checking health status, players could check their systems-thinking, creativity, problem solving, and teamwork skills, where each of these competencies is further broken down into constituent knowledge and skill elements. If the values of those skills were to get too low, the player would likely feel compelled to take action to boost them.

One main challenge for educators who want to employ or design games to support learning is making *valid inferences* about what the student knows, believes, and can do—at any point in time, at various levels, and without disrupting the flow of the game (and hence engagement and learning). One way to increase the quality and utility of an assessment is to use evidence-centered design (ECD) which informs the design of valid assessments and yields real-time estimates of students' competency levels across a range of knowledge and skills (Mislevy, Steinberg, & Almond, 2003). Accurate information about the student can be used as the basis for a) delivering timely and targeted feedback, as well as b) presenting a new task or quest that is right at the cusp of the student's skill level, in line with flow theory and Vygotsky's zone of proximal development. ECD will be described in more detail, shortly.

Given the goal of using educational games to support learning in school settings (and elsewhere) we need to ensure that the assessments are valid, reliable, and also pretty much invisible (to keep engagement intact). That's where "stealth assessment" comes in (see Shute, 2011; Shute & Ventura, 2013; Shute, Ventura, Bauer, & Zapata-Rivera, 2009). During game play, students naturally produce rich sequences of actions while performing complex tasks, drawing on the very skills or competencies that we want to assess (e.g., creativity, persistence, spatial abilities). Evidence needed to assess the skills is thus provided by the players' interactions with the game itself (i.e., the processes of play), which lies in stark contrast to the norms in educational and training environments, where the product(s) of an activity are the main focus.

Making use of this stream of evidence to assess students' knowledge, skills, and understanding (as well as beliefs, feelings, and other learner states and traits) presents problems for traditional measurement models used in assessment. First, in traditional tests, the answer to each question is seen as an independent data point. In contrast, the individual actions within a sequence of interactions in a game are often highly dependent on one another. Second, in traditional tests, questions are often designed to get at one particular piece of knowledge or skill. Answering the question correctly is evidence that one may know a certain fact: one question—one fact. By analyzing a *sequence* of individual actions within a quest (where each response or action provides incremental evidence about the current mastery of a specific fact, concept, or skill), we are able to make inferences about what learners know about the instructional outcome overall. Now, because we typically want to assess a whole cluster of skills and abilities from evidence coming from learners' interactions within a game, methods for analyzing the sequence of behaviors to infer these abilities are not as obvious. As suggested earlier, ECD can address these problems.

The fundamental ideas underlying ECD came from Messick (1994) and were then formalized by Mislevy and colleagues (e.g., Mislevy, Almond, & Lukas, 2004; Mislevy & Haertel, 2006; Mislevy et al., 2003). A game that includes evidence-based assessment must be able to elicit behavior from the students that bears evidence about the targeted knowledge and skills (i.e., the competencies), and it must additionally provide principled interpretations of that evidence in relation to the purpose of the assessment. Figuring out these variables and their interrelationships is a way to answer a series of questions posed by Messick (1994) that get at the very heart of assessment design generally, and ECD specifically. In short, the framework requires an assessor to: (a) define the claims to be made about learners' competencies (competency model) (b) establish what constitutes valid evidence of a claim and how to measure that evidence (evidence model) and (c) determine the nature and form of tasks or situations that will elicit that evidence (task model).

In games with stealth assessment, the competency model for a given student dynamically accumulates and represents belief about the targeted aspects of skill, expressed as probability distributions for competency-model variables (Almond & Mislevy, 1999; Shute et al., 2009). Evidence models identify what the student says or does that can provide evidence about those skills (Steinberg & Gitomer, 1996) and express in a psychometric model how the evidence depends on the competency-model variables (Mislevy, 1994). Task or action models express situations that can evoke required evidence.

One effective tool that has been used in such competency and evidence modeling efforts is Bayesian networks (e.g., Pearl, 1988). That is, Bayes nets may be used within learner models (i.e., competency models tied to a particular learner) to handle uncertainty by using probabilistic inference to update and improve belief values (e.g., regarding learner competencies). Examples of Bayes net implementations for student models may be seen in: Behrens, Mislevy, DiCerbo, and Levy (2012), Conati, Gertner, and VanLehn (2002); Kim and Shute (2015); Shute and Ventura (2013); Shute and Wang (in press); Shute, Graf, and Hansen (2005); and VanLehn et al. (2005).

Using ECD and Bayes nets to craft stealth assessments embedded directly in the game along with automated data collection and analysis tools can not only collect valid evidence of students' competency states but can also reduce teachers' workload in relation to managing the students' work (or "play") products. If a particular game was easy to employ and provided integrated and automated assessment tools, then teachers would more likely want to utilize the game to support student learning across a range of educationally valuable skills. Stealth assessment is intended to help teachers facilitate learning, in a fun and engaging manner, of educationally valuable skills not currently supported in school. It is also, of course, intended to facilitate the flow state for students engaged in game play.

Summary and Conclusion

Our goal for this chapter was to begin to connect the dots between games and learning. Toward that end, we first described how well-designed games provide an environment in which people are more receptive to learning, especially as compared to traditional environments like the classroom (see earlier discussion on Piaget's and Sutton-Smith's theories). Then we articulated the need for sound theoretical models and frameworks for games design that tap the true power of games for learning. We suggested that situated, authentic problem solving was one such framework. Our final section on stealth assessment was intended to highlight the need for accurate, dynamic assessment and diagnosis of educationally valuable skills during game play. We discussed how stealth assessment can support instructional decisions while operating beneath the radar in terms of monitoring and measuring these competencies.

In conclusion, well-designed games are a potentially powerful vehicle to support learning, particularly in relation to new competencies not currently embraced by our educational system but needed to succeed in the 21st century. There are simply too few experimental studies examining the range of effects of gaming environments on learning (e.g., Van Eck, 2007). We believe that the new games-for-learning research stream is highly relevant and important to the field of ISD, which can both inform and be informed by the research.

We close as we began with a relevant quote:

"*Games are thus the most ancient and time-honored vehicle for education… We don't see mother lions lecturing cubs at the chalkboard; we don't see senior lions writing their memoirs for posterity. In light of this, the question, 'Can games have educational value?' becomes* *absurd. It is not games but schools that are the newfangled notion, the untested fad, the violator of tradition.*"

– Chris Crawford

Gaming and Learning: Summary of Key Principles and Practices

1. Games-for-learning research should account for prior research on learning in general rather than reinventing the wheel.
2. Good games trigger the play phenomenon in the players.
3. Situated, authentic problem solving is an effective way to ensure that games can support problem solving.
4. There are many kinds of games, and many kinds of problems, and they must be aligned carefully.
5. Assessment of learning in games requires a fundamental shift in our thinking about assessment, from responses to external “test questions” to embedded actions and patterns within games.
6. Good games for learning can use the information from ongoing stealth assessments to provide timely and targeted feedback to players and present new game tasks that suit the student’s current skill level.
7. Good games for learning, like all good learning activities, should be active, goal-oriented (with goals valued by the players), contextualized, and designed with adaptive challenge and support.
8. The fundamentals of designing a good game for learning extend beyond any specific technology for a single game.
9. Principles of instructional design and problem-based learning can support and inform the design of good games for learning.
10. The ability to work creatively and effectively with others toward a common goal is an important 21st century skill that is emphasized in good games.

Gaming and Learning: Application Questions

1. Design a nondigital game with everyday objects found in your home or classroom (e.g., paper cups, paper clips, ping pong balls, etc.). Ask friends to play it, then ask them if they think the game is any fun. Ask them for ideas to improve the game. Using any of their ideas, and others you thought of, redesign the game and ask another group of friends to play this new version. Is the game more fun? Try to list or chart out the design process you experienced. Does the game have any value for learning? If not, what is missing?

2. Choose a learning theory that you feel is compatible with games. What kind of game (MMORPG, puzzle game, adventure game, first-person shooter, etc.) do you think it would be most compatible with? Why? What are the design implications of adopting that theory for a given game? Name one example of a specific design element in a game that was designed according to your theory.

3. Identify an instructional outcome at the level of problem solving and try to come up with a narrative description of a game that could promote that outcome. How would you make it situated? Authentic? Where would it take place, who would be involved, and what would it look and feel like?

4. Using the game idea from number three, above, or for another game idea/outcome of your choice, describe an approach to stealth assessment that could be built into that game. Be specific in addressing how it aligns with your learning outcome,

how you would measure it, how you could integrate it surreptitiously, and how it could be used for assessment, to modify game performance in some way, or both.

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