Playful Learning: An Integrated Design Framework

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Abstract

The design of, and research on, digital games for learning has been hampered by the lack of a comprehensive design framework of game-based learning that incorporates essential elements unique to learning from this genre. Broadening the scope to playful learning, we therefore propose an integrated approach to the design of these learning environments that brings together cognitive, affective, and socio-cultural perspectives to form a comprehensive learning sciences perspective. We first define playful learning and its characteristics as well as the different forms of learner engagement it entails. We then discuss each of the three perspectives, which aspects of playful learning they emphasize, and which they de-emphasize. We then describe key theoretical contributions to the design of playful learning from the three approaches. Finally, we draw conclusions from the emerging model, including suggestions for future research on the design of games for learning.

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Introduction

The use of play in an educational context and for purposes of learning and development is by no means a new phenomenon. However, the growing acceptance of digital games as mainstream entertainment has resulted in a strong interest in the question of how to take advantage of the promise of digital games for educational purposes. Reports on youth's consumption of digital games are compelling, with studies such as the Pew Internet & American Life Project indicating 99% of boys and 94% of girls playing digital games (Lenhart, Kahne, Middaugh, Macgill, Evans, & Vitak, 2008). Equally compelling are reports on how much time youth spend playing digital games, which range from approximately seven to ten hours per week (Lenhart et al., 2008), with more recent estimates putting this number even higher (Homer, Hayward, Frye, & Plass, 2012). Given this level of engagement, and considering the types of individual and social activities games afford, advocates have argued that games are an ideal medium for learning (Gee, 2003, 2007; Prensky, 2003, 2005; Squire 2011).

Meta-analyses of the impact of games on learning have resulted in conflicting findings depending on what criteria for inclusion and exclusion of articles were used, and which outcome variables were considered. Theoretical approaches to empirical investigations of the use of digital games for learning have primarily included cognitive perspectives (Mayer, 2005; Fletcher & Tobias, 2005; Shute, Ventura, & Ke, 2014; Blumberg, 2011; Spence & Feng, 2009) and socio-cultural perspectives (deFreitas et al., 2010; Squire, 2008, 2011; Shaffer, 2006; Steinkuehler, Squire, & Barab, 2012). Depending on which perspective is taken, games are either considered environments that are likely to generate excess amounts of information to be processed by the learner (cognitive perspective), or conversely, considered approaches that provide the rich contextual information needed for learning in the 21st century (socio-cultural perspective).

In this paper we aim to provide a comprehensive theoretical approach to games and learning that incorporates multiple views. To that end we first review cognitive, affective, and socio-cultural perspectives of learning with games, including elements from areas such as developmental psychology, which has perhaps the longest history of considering play an essential method of cognitive development and learning. Together, these perspectives form a learning sciences approach to the educational use of games; a multi-disciplinary approach that captures essential elements of learning with this genre and that can inform both game design and games research.

Elements of Game Design for Learning

Before we discuss the different approaches to learning from games it may be useful to define some of the fundamental elements of game design. Although there is much discussion regarding the definition of what is a game, most agree on the following building blocks of games.

Game Mechanics

Game mechanics describe the essential game play – the activity or sets of activities repeated by the learner throughout the game. These activities can primarily have a learning focus (learning mechanics) or an assessment focus (assessment mechanics); in many cases they focus on both (Plass & Homer, 2012; Plass, Homer, Kinzer, et al. 2013). An example of a game mechanic in the middle school geometry game *Noobs v. Leets* (G4LI, 2013) is when the learner clicks on a missing angle, clicks on a given angle, and then selects the rule she wants to apply to solve for the missing angle (e.g., complementary angle rule). The game mechanic represents the essential behavior that is linked to learning activity in a game. It can be designed for single players or involve social features.

Visual Aesthetic Design

The visual aesthetic design includes visual elements such as the overall look and feel of the game and of the game characters, but also the form of representation of key information in the game. The visual design determines how tools and functions of the game mechanics are visualized, how cues are represented, and how feedback is displayed. For example, in the game *Light Lanes* (CREATE, 2014), in which players have to avoid obstacles to redirect a laser beam to a specific target, obstacle blocks that cannot be penetrated by a laser beam are represented in red color, whereas light reflecting blocks are represented in green color. The visual aesthetic design constitutes the information representation of the multimedia learning aspects of the game.

Narrative Design

The narrative of a game is the storyline that is advanced via features such as cutscenes, in-game actions, dialogues and voice-overs. Unlike most movies or books, games allow for non-linear narratives that advance based on the choices made by the learner. Narratives provide contextual information for learning, connecting rules of play, characters, tasks, and events, but also have a strong motivational function by contributing to a game's stickiness. For example, in the game *Space Ranger Alien Quest* (CREATE, 2013), which was designed to enhance player's executive functions (Sprung et al., 2013), the narrative explains how different aliens like to eat different foods, but then later explains how the rules have changed and different food preferences are in play.

Incentive System

The incentive system of a game includes the many motivational elements that aim to encourage players to continue their efforts and also feedback that attempts to appropriately modify their behavior (e.g., see Kinzer, Hoffman, Turkay, Gunbas, Chantes, Dvorkin, & Chaiwinij, 2012). Incentives can consist of scores (points), stars, badges, trophies, power-ups, and many other rewards. These rewards can either be an intrinsic part of the game play, such as a power-up that gives the player special abilities in the game, or they can be of an extrinsic nature, awarding stars or points that do not directly contribute to the game play, but that may create a meta game when players compete with one another via leaderboards. For example, the game *FactorReactor* (G4LI, 2010) awards rings for each solved problem. These rings are intrinsic rewards because they are essential to the game play – they are needed to execute a step in solving the next problem. The game also awards points, which are a form of extrinsic rewards. Many game designers favor the use of multiple features as incentives in order to address the preferences of different player profiles.

Musical Score

The musical score of a game provides background sounds that are often used to direct the player's attention to specific important events or moments in the game, signal the presence of danger or opportunity, induce positive or negative emotions, or acknowledge the success or failure of a specific task. In many cases, the musical score is accompanied by haptic information (such as vibration) of the game controller. For example, the game *Space Ranger Alien Quest* uses the musical score to provide feedback whenever a player successfully directed a food item to the right alien, or when the wrong food item was given to an alien.

Content and Skills

The final element of learning game design is the subject matter content and skills that the game is designed to teach. We distinguish four functions of games (Table 1), which determine to what extent and with what learning goal this content is covered.

The content and skills that a game is supposed to cover will determine the learning mechanics to be used, the visual design to be adopted, the narrative design, the incentive system design, and the musical score (Plass & Homer, 2012). In other words, the content of a learning game has profound impact on all major game elements and their design.

Not all learning needs require the use of all of these game design elements. In many cases, for example, an incentive system and musical score might be missing and the use of narrative might be minimal or absent. Because much of the argument of using games for learning can be reduced to the playfulness of the learning process that games afford, we will henceforth use the term *playful learning* to describe learning that incorporates game elements, even though such an environment might not be considered a *bona fide* game.

Table 1. Function of Games for Learning (Plass, Perlin, & Nordlinger, 2010)

Function	**Explanation / Main role of the game**
Preparation of future learning	Provide students with shared experiences that can be used for later learning activities, e.g., class discussions
Teach new knowledge and skills	Introduces new knowledge and skills as part of the game play
Practice and reinforce existing knowledge and skills	Provides opportunities to practice existing knowledge or skills in order to automate them
Develop 21st Century Skills	Provides opportunities for teamwork, collaboration, problem solving, creativity, communication, etc.

An Integrated Framework of Playful Learning

Based on our research on games for learning over the past decade we see the need to reconcile the different approaches to game based learning because none of them fully capture the educational potential of games. We therefore propose an integrated framework of playful learning that explains and predicts learning processes in a broad range of genres of playful learning environments for each of the different functions of games for learning shown in Table 1. To that end, we define playful learning as an *activity by the learner, aimed at the construction of a mental model, that is designed to include one or more elements of games for the purpose of enhancing the learning process*. Depending on learning goals, learners, settings, and other factors, designers conceptualize and implement playful learning environments that are either games, or that incorporate game-like elements.

The framework we propose describes what kinds of engagement playful learning environments allow and defines the game design elements that create such engagement. We then explore the theoretical foundations for these game design elements that make them suitable and potentially effective for games for learning.

Playful Learning

Psychologists have long acknowledged the importance of play in cognitive development and learning. Piaget (1962), for example, described play as being integral to, and evolving with, children's stages of cognitive development. According to Piaget, play becomes more abstract, symbolic and social as children mature through different developmental stages. One way that play is seen as contributing to children's cognitive development is by activating their schemas in ways that allow children to transcend their immediate reality. For example, a child can pretend, or “act as if” an eraser is a car, while fully knowing that it is not a car. This type of play allows children to hold in mind multiple representations of the same object, a skill required for the development of symbolic thinking (DeLoache, 1987), one of the most significant developments of early childhood.

The advent of video games led to an interest in the psychological effects of playing digital games. Loftus and Loftus (1983), in one of the first books on the psychology of video games, focused on players’ motivations, exploring what makes video games “fun”. Relying largely on behaviorist theories, Loftus and Loftus point out that in video games, rewards or successes typically happen only occasionally, which corresponds to an intermittent reinforcement schedule – the reinforcement schedule that produces the greatest response rate. Loftus and Loftus also cite work illustrating that good games are neither too easy, which results in the games being boring for players who then quit playing, nor too difficult, which frustrates players who then quit playing. Good games aim for the “sweet spot” where players can succeed, but only with some struggle. In other words, good games aim to be within a player’s *zone of proximal development* (ZPD).

The notion of a zone of proximal development, of course, comes from Vygotsky (1978), who also characterized play as being a “leading factor” in children’s development, and thought that a vital role of play is to create a zone of proximal development for the child. Vygotsky argued that genuine play, which begins around age 3, is always a symbolic and social activity (Nicolopoulou, 1993). In part because of its social nature, play - particularly play with an adult or more capable peer - enables a child to succeed at things that are a bit beyond his or her current ability. In Vygotsky’s words, play allows the child achieve “beyond his average age, above his daily behavior; in play it is as though he were a head taller” (p. 103). We believe this statement, made almost 40 years ago, applies to well-designed games of all types, including the digital games that are played by so many people today.

It is difficult to describe learning goals for a genre as broad as games, since this term captures many different subgenres of games, from casual games and puzzle games to role playing games, real time strategy games, and first person shooters. Each of these genres will result in different choices of how the game elements, presented earlier, are designed. In most cases, however, the designer's goal is to engage learners in ways that are motivating, allow for adaptive learning, and include opportunities for learner self-regulation. We explore these goals below.

Motivation. The motivational function of games is their most frequently cited characteristic. Motivation can be extrinsic or intrinsic (Lepper & Greene, 1978). Extrinsic motivation involves the use of incentive structures that are only peripherally related to the game play, such stars, points, leaderboards, or unrelated badges or trophies. Using this type of extrinsic motivation is often referred to as gamification. In contrast, intrinsic motivation involves the design of game mechanics and activities that learners enjoy or find interesting, i.e., that create a high situational interest (Hidi & Renninger, 2006; Rotgans & Schmidt, 2011). We believe that many of the benefits of playful learning can only be enjoyed when designers aim to increase intrinsic motivation by designing game mechanics that maximize situational interest.

Adaptivity. Creating situational interest is aided by the many ways of making a game adaptive, customizable by the player, or personalized (Andersen, 2012; Leutner, 1993; Plass, Chun, Mayer, & Leutner, 1998; Turkay & Kinzer, 2013). Adaptivity is the capability of the game to engage each learner in a way that reflects his or her specific needs. These needs can be related to the learners' current level of knowledge, to cognitive abilities, to the learners' emotions, or to a range of other variables. The first requirement of adaptive design is therefore to measure the variable the game is supposed to adapt for, such as prior knowledge or self-regulation skills. The next step is to provide an appropriate response to the learner. This may involve a modification of the type and complexity of the problems and guidance presented to the learner (Azevedo, Cromley, Moos, Greene, & Winters, 2011; Koedinger, 2001) or the use scaffolding, guidance, and feedback in a way that responds to the player's in-game actions (Steinkuehler & Duncan, 2008).

Self-Regulated Learning and Graceful Failure. Another characteristic of playful learning is that it allows for graceful failure: rather than describing it as an undesirable outcome, failure is by design an expected and sometimes even necessary step in the learning process (Plass, Perlin, & Nordlinger, 2010; Kapur, 2008; Kapur & Kinzer, 2009; Kapur & Bielaczyc, 2012). The lowered consequences of failure in games encourages risk taking, trying new things and exploration (Gee, 2007; Hoffman & Nadelson, 2010). They also provide opportunities for self-regulated learning during play where the player executes strategies of goal setting, monitoring of goal achievement, and assessment of the effectiveness of the strategies used to achieve the intended goal (Barab, Ingram-Goble, & Warren, Kim, Park, & Baek, 2009).

Types of Engagement

Next to motivation, one of the most frequently cited reasons to consider digital games for learning is that they allow for a wide range of ways to engage learners, see Figure 1. Which of these are implemented depends on the design decisions that reflect the specific learning goal, learner characteristics, and setting. However, often the concept of engagement is ill defined and underspecified. We therefore base our discussion of engagement on the INTERACT model of learner activity (Domagk, Schwartz, & Plass, 2010), which distinguishes different types of engagement: cognitive, affective, and socio-cultural. Many game design features use these different forms of engagement, along with physical/behavioral engagement (Schwartz & Plass, 2014), with the goal of fostering and enhancing cognitive engagement. For example, a kinect-based game can engage the learner physically, via gestures, movements, or embodied actions. Game characters engage the learner emotionally, and social features such as collaborative play support socio-cultural engagement. The goal of all these types of engagement, however, is to foster cognitive engagement of the learner with the learning mechanic. Games that do not achieve cognitive engagement are not likely to be effective in helping the learner achieve their learning goal. Therefore, when designing each of the other types of engagement the question should be, "How does this type of engagement lead to cognitive engagement?"

To address this question, we need to investigate the foundations of playful learning that are expressed in game design elements that aim to generate these different types of engagement. Our analysis of the literature, and our experience in designing games for learning, are summarized as three pillars in the lower part of the framework of playful learning in Figure 1. We discuss these cognitive, affective, and socio-cultural foundations next.

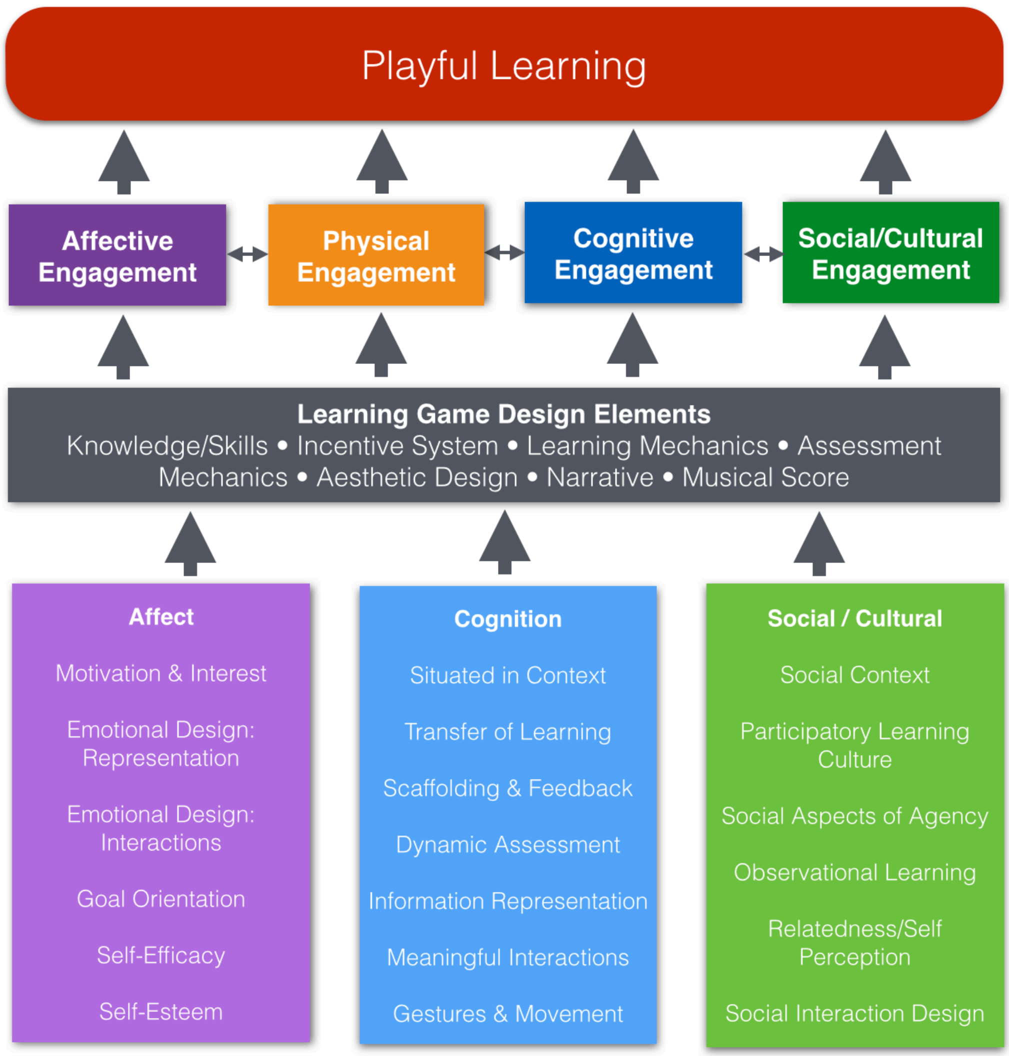

Figure 1. Integrated Design Framework of Playful Learning

Foundations of the Integrated Framework of Playful Learning

Cognitive Aspects of Playful Learning

Overall Approach. The first perspective we will discuss considers game-based learning as a cognitive activity. The goal of learners' cognitive engagement with a game is the construction of mental models (Mayer, 2005, 2014). During this process, learners select what is presented in the game, organize this information as visual and verbal representations in working memory, and then integrate these representations with one another and with prior knowledge (Mayer, 2014). From a cognitive perspective, designers and researchers need to consider which game elements contribute to the cognitive processing of the learning content, i.e., how the content should be represented and how learning mechanics should be designed to engage the learner in a way that facilitates reaching the intended cognitive outcomes. Designers also have to consider the cognitive demand of processing the meaning of the various game elements, i.e., the cognitive load experienced by the learner during game play (Kalyuga & Plass, 2009). In particular, Mayer suggests that designers of learning games should aim to reduce extraneous processing, manage essential processing, and foster generative processing (Mayer, 2014).

Emphasis/Focus. When viewing playful learning from a cognitive perspective, we emphasize the mental processing of the content and the efficiency with which this processing takes place. This means that the design goal of a playful learning environment is to optimize cognitive load. Any game elements not directly related to the cognitive processing of information are considered as requiring non-essential processing, i.e., they are a source of extraneous cognitive load. Thus, a cognitive perspective of playful learning de-emphasizes emotional and motivational elements of learning by subordinating them to the efficiency of cognitive processing. Many of the studies taking this approach focus on single players rather than social play, and on in-game activities rather than related activities outside of the game, i.e., they also de-emphasize social and cultural aspects of games and playful learning.

Research based on the cognitive approach is inconclusive as to the effectiveness of games for learning (Tobias & Fletcher, 2007, 2012). The preferred method of investigation is experimental lab studies, often comparing games with other media, such as PowerPoint slide shows with content presented in form of a game (Adams, Mayer, MacNamara, Koenig, & Wainess, 2012). In fact, many studies on cognitive aspects of learning with games investigate very brief durations of game play in which neither interest, motivation, nor emotion are essential factors (Mayer, Mautone, & Prothero, 2002; Mayer & Johnson, 2010; Mayer, Dow, & Mayer, 2003). From a purely cognitive perspective, the contextual elements of learning, and the situatedness of the learning activities, are also not viewed as essential. Other studies taking this focus investigate the potential of games to improve cognitive and perceptual skills, such as visual perception (Green & Bavelier, 2007), attention (Greenfield, DeWinstanley, Kilpatrick, & Kaye, 1994; Green & Bavelier, 2003), or task switching and multitasking (Chiappe, Conger, Liao, Caldwell, & Vu, 2013; Strobach, Frensch, & Schubert, 2012).

Foundations of Cognitive Aspects of Playful Learning

Situatedness. One of the great potentials of games and playful learning is that they provide opportunities for situated learning. Through games, learning can take place in a meaningful and relevant context by providing information at the precise moment when it will be the most useful to the learner, for example, by giving information needed by learners to solve a problem at the time they are trying to solve it (Gee, 2007). A second, related benefit of games is that they can present information and problem in ways that closely mirror real life, which facilitates transfer of learning (Prensky, 2005).

Transfer of Learning. One of the great challenges for education is teaching in ways that allow students to apply their knowledge outside of the school context. Transfer is generally easier when the novel context is similar to the context of learning, but several factors have been identified as affecting transfer of knowledge (Barnett & Ceci, 2002; Haskell, 2000). Perkins and Salomon (1989) proposed two main ways by which knowledge can be transferred to novel situations: a *low road* which depends on automaticity through repeated practice of a skill, and a *high road* which depends on conscious abstraction and application of knowledge. Games can facilitate both roads to transfer by giving repeated opportunity to practice skills and apply knowledge (*low road*), and by providing different, but related, experiences that facilitate the abstractions need for knowledge to be generalized to novel situations (*high road*). Considering the functions of games outlined in Table 1 above, both the *teaching of new skills* as well as the *practice and reinforcement of existing knowledge and skills* facilitate transfer.

Scaffolding and Relevant Feedback. As games and related digital media have become more complex and more intentionally instructional, there has been an effort to capture the *scaffolding* that occurs naturally during play within the digital environment in order to support learning. The idea of scaffolding was first introduced by Wood, Bruner and Ross (1976) to describe the ways in which an adult or *expert* tutors someone who is less competent to solve a problem or complete a task. Scaffolding takes place when an expert controls aspects of a task that are beyond the learner's capabilities, thereby allowing the learner to complete a task that they would not be able to do on their own. Although Wood et al. do not make the link between scaffolding and Vygotsky's ZPD directly, it is evident that for effective scaffolding to take place, the task or problem being solved must fall within the learner's ZPD (Bruner, 1985; Pea, 2004). In more recent times, the term scaffolding has come to be used so broadly in education that is in danger of losing its meaning. Pea (2004) argues that there are several essential components of true scaffolding, including being dynamically adaptive, which requires an ongoing evaluation of the learner, and fading as learners acquire skills and knowledge. This means that there are two essential components to true scaffolding: an ongoing dynamic evaluation of the learner's acquisition of the skills to be learned, and a progressive fading of supports as the learner progresses. Pea (2004) points out that many of the "scaffolds" in educational technology are actually supports that cannot be faded or removed, resulting in distributed cognition rather than true scaffolding.

Current entertainment games are very successful in scaffolding new players as they learn how to play the game. Often games will start with a *tutorial level* in which players' actions - and subsequent success or failure - is closely monitored. Appropriate feedback and support is given in areas of gameplay where the player is having trouble, thereby providing dynamic feedback to scaffold learning of gameplay. As players succeed in the tutorial level, the supports are removed, thereby *fading* the scaffolding. Although this scaffolding process is relatively straightforward and successful for entertainment games, success of scaffolding has been much more limited in games for learning in part because of the increased difficulty in doing the dynamically assessment required in games for learning.

Dynamic Assessment. Effective scaffolding requires accurate and ongoing assessment of learners' knowledge and skills. Assessment needs to be accurate in order to know which scaffolds will be the most effective, and it needs to be dynamic in order to know when to fade or change the scaffolds. A first step for dynamic assessment is to clearly identify the specific factors to be assessed. This will depend upon specific learning goals as well as other individual-level variables that can affect learning outcomes. Evidence Centered Design (ECD; Mislevy & Heartel, 2005) provides a useful framework for thinking about in game assessments (see Plass et al., 2013). Key information can be obtained from both *process* and *product* data; from both the activities of the learner, and from anything created by the learner within the game (Rupp, Gushta, Mislevy, & Shaffer, 2010). Games for learning are often designed intentionally in ways that require players to engage in specific activities that will provide information about the learner's knowledge or skills. Plass, Homer, Kinzer, et al. (2013) discuss this in terms of the *assessment mechanics* of the game. Accurate in-game assessments not only provide the resources for effectively adapting games to support learners, but may eliminate the need for external evaluation of learning outcomes (Gee, 2003; Shute, Ventura, Bauer, & Zapata-Rivera, 2009).

Information Design: Representation of Information. Another strength of games is their highly visual nature: most games represent key information in compelling visual form. The design of this visual information for purposes of learning can be based on research on multimedia learning and its principles (Mayer, 2014) as well as on principles related to Cognitive Load Theory (Plass, Moreno, & Brünken, 2010). The design of these representations should reflect its function in the learning process to support the selecting, organizing, or integration of information (Carney & Levin, 2002; Plass, Hamilton, & Wallen, 2004). Visual design should also consider the importance of semiotics, i.e., the impact that the choice of signs for the learning content, either via iconic or symbolic representation. Here, studies have shown that iconic representations are particularly helpful for learners with low prior knowledge and for learners at younger developmental stages (Homer & Plass, 2010; Lee, Plass, & Homer, 2006).

Typical of games is that information is shown in multiple representations that learners need to integrate. Research suggests that learning can be facilitated when information is available in more than one format (Moreno & Durán, 2004; Paivio, 1986; Schnotz, 2005), though this depends on the function of the multiple representations (Ainsworth & Van Labeke, 2004). The integration of multiple representations is difficult for many learners (van Someren, Reimann, Boshuizen, & de Jong, 1998), especially when they have low prior knowledge (Seufert & Brünken, 2004), but can be facilitated by the visual design of the learning materials in ways that guides learners visual attention to conceptual links between representations (O'Keefe, Letourneau, Homer, Schwartz, & Plass, 2014).

Interaction Design: Learning Mechanics. The design of the learning interactions within a game, which are referred to as *Learning Mechanics* (Plass, 2011; Plass & Homer, 2012), is the process of mapping learning objectives onto instructional strategies that are based on appropriate learning theories (Homer & Plass, 2014). This mapping ideally uses systematic processes such as Evidence Based Design (Mislevy & Haertel, 2006) or Design Models of Games for Learning (Plass & Homer, 2012) to assure that the resulting core mechanics of a game are suitable for its intended learning goals. However, a recent meta-analysis suggests that few designers have based their game designs on learning theories (Wu, Hsiao, Lin, & Huang, 2011; Kinzer, Hwang, Chantes, Choi, & Hsu, in process). A similar process can be used for the design of assessment mechanics, which aim to provide conditions for learners during game play in ways that evaluate their performance to determine their mastery of the content.

Research on learning mechanics in digital games compares the impact of different mechanics. For example, in the *Noobs v. Leets* Geometry game, two different mechanics were used to solve for missing angles. In one mechanic, players would specify the numeric answer to the problem, such as indicating that the missing angle was 55 degrees. An alternative mechanic asked learners to indicate which rule they would apply to solve the problem, for example, the complementary angles rule (Plass, Homer, Hayward, et al. 2012). Results showed higher learning outcomes for the rule mechanic, and a related study showed higher engagement, enjoyment and situational interest in the game designed with the rule mechanic (Kinzer, Turkay, Hoffman, & Chantes, 2013). Similarly, for the factoring game *Factor Reactor*, one mechanic allowed for individual play, one for collaborative play, and one for competitive play (Plass, O'Keefe, Homer, et al, 2013). Results for this skills game showed higher learning outcomes for the competitive mechanics. Other research has shown that collaborative mechanics can have positive affective outcomes, such as math attitudes (Ke & Grabowski, 2007).

Gestures and Movement. Embodied cognition using digital technologies has been studied for some time (Gee, 2008; Goldman, Black, Maxwell, Plass, & Keitges, 2012; see also Wilson, 2002), and involves motoric engagement and focuses on gestural congruity, i.e., the mapping of a gesture or movement to key features of the content to be learned. In some cases, learners also have the perception of immersion (Johnson-Glenberg, Birchfield, & Snow, 2014). The impact of embodiment on learning has been considered as perceptual effect (Black, 2010), cognitive effect (Gibbs, 2006), or combination of the two (Kwah, Milne, Tsai, Goldman, & Plass, 2014). Games and other virtual environments are especially suited to foster this kind of learning since most gaming platforms now allow for gesture input as well as haptic responses (Chan & Black, 2006; Glenberg, Goldberg, & Zhu, 2009). For example, in a Kinect-based literacy game for beginning readers, in-game activities using gestures and movements enhanced several key literacy outcomes compared to a group without these activities (Homer, Kinzer, Plass, et al., 2014). In addition to their cognitive impact, research has also been investigating the emotional impact of gestures and movement (Isbister, 2011).

Affective Aspects of Playful Learning

Overall Approach. A very different perspective for playful learning considers affective aspects of the learning process. The goal of learners' affective engagement with a playful environment relates to their experienced emotions, attitudes and beliefs, interest, and motivation, and considers how the design of the environment changes learners' affective state via affective engagement. It also considers how affect is related to, and impacts, cognitive, social, and cultural aspects of learning. During this process, learners experience core affect that they may or may not attribute to a source (Plass & Kaplan, in press; Russell, 2003). Learners continued experience of affect, either as attributed affect or unattributed, as mood, influences their cognitive processing and is, in turn, influenced by it (Izard, 2009). The result of this processing is an emotion schema, "the dynamic interaction of emotion and cognition" (Izard, 2009, p. 265), representing "processes involved in the dynamic interplay of emotion, appraisals, and higher order cognition" (p. 261).

The motivating power of digital games is often mentioned as a reason why games would make good learning environments. From an affective perspective, game features designed to motivate students, such as incentive systems, the narrative, musical score, and the game mechanics, lead to higher affective engagement, which in turn leads to higher cognitive engagement, fostering the cognitive processing of the game content (Jakobsson et al., 2011; Delacruz & National Center for Research on Evaluation, 2012). Often the impact of these affective elements is described as inducing a state of flow, which would then result in effortless learning (Csikszentmihalyi, 1990; Brom, 2014; Pavlas, Heyne, Bedwell, Lazzara, & Salas, 2010).

Emphasis/Focus. When viewing playful learning from an affective perspective, we emphasize motivational and emotional aspects of play and their impact on learner engagement. This means that the goal of the design of a playful learning environment is to optimize engagement and stickiness of the game. In fact, an argument advanced from this perspective is that playful learning may re-engage some learners who have disengaged from academic learning altogether, and who cannot be engaged with other methods (Squire, 2008; Griffiths, 2002). As similar argument is made that using *gamification*, i.e., adding motivational features such as incentive systems to an otherwise un-motivating or even undesirable task, may result in higher learner engagement with this task (Deterding, Dixon, Khaled, & Nacke, 2011; Cameron & Pierce, 1994).

Research investigating the affective impact of games uses methods ranging from playtesting to qualitative studies to quasi-experimental designs. These studies investigate either the overall motivational or emotional impact of a game, or the affective impact of specific game design features. In many cases affect is studied as an outcome variable. In some cases, however, affect is induced through the various design features and is an independent variable. Many studies only focus on measures such as self-reports of learners' experienced levels of interest, flow, or emotion, without also measuring learning outcomes. In these cases, researchers are not able to draw the important conclusion whether affective engagement did in fact result in cognitive engagement and related cognitive learning outcomes.

Foundations of Affective Aspects of Playful Learning

Affect includes constructs such as motivation, interest, emotion, attitudes, and goal orientation. For the purpose of this paper, we will focus on three aspects of these broad constructs to highlight their importance for playful learning: motivation/interest, emotional design, and goal orientation.

Motivation and Interest. As we discussed above, much of the argument for the use of games for learning refers to the ability of games to motivate the learner intrinsically, via the content and activities (mechanics) and their presentation. Some of the key elements thought to cause such intrinsic motivation, challenge, curiosity, and fantasy, are core elements of game design (Malone, 1981). When game features such as game mechanics are well designed, they make the task personally meaningful and attainable to the learner, thereby eliciting feelings of self-efficacy and feeling of control of one's own success (Weiner, 1979; Plass, Goldman, Flanagan, & Perlin, 2009). Such incentives generated by core features of a game, such as the game mechanic, that are inherently linked to the learning task, may elicit situational interest in a learner. Situational interest is a fleeting or lasting immediate affective response to certain stimuli or conditions originating from the game, resulting in learners' directing of their attention to the task (Hidi, 1990; Hidi & Renninger, 2006; Mitchell, 1993; Rotgans & Schmidt, 2011; Schraw, Flowerday, & Lehman, 2001). There is indication that over time learners' situational interest can lead to the development of individual interest, i.e., increase their intrinsic desire and tendency to engage in a particular subject matter or activity over time (Hidi & Renninger, 2006).

Research found evidence that game design elements such as game mechanics, the mode of play, and the use of badges can impact the situational interest experienced by the learner. One study, for example, compared two versions of a middle school geometry puzzle game, *Noobs v. Leets*, discussed earlier. Researchers manipulated the game mechanic so that one version used a mechanic in which players solved geometry problems by computing a missing angle, and the other version included a mechanic in which players selected the appropriate solution rule. The study found that the numeric condition was situationally more interesting than the rule condition, suggesting that the selection of the game mechanic has an impact on learners' affect (Plass, Homer, Hayward, Frye, Huang, Biles, Stein, & Perlin, 2012). Another study, also mentioned earlier, compared versions of a game on factoring that either facilitated individual play, competitive play of two players, or collaborative play of two players. Results showed that competition and collaboration elicited greater situational interest than individual play, which suggests that the social mode of play impacted affect (Plass, O'Keefe, Homer, Hayward, Stein,

& Perlin, 2013). Finally, in a study using a version of the *Noobs v. Leets* game that awarded the learner different types of digital badges for the completion of in-game learning-related tasks researchers found that the design of the badges impacted learners' situational interest, in addition to learning outcomes (Plass, O'Keefe, Biles, Frye, & Homer, 2014).

Emotional Design. Models such as the Differential Emotions Theory (Izard, 2007), the Control Value Theory of Achievement Emotions (Pekrun, 2000), and the Integrated Cognitive Affective Model of Learning with Multimedia (Plass & Kaplan, in press), highlight the inseparable relation and mutual influence of cognition and emotion during learning. Emotional design refers to the use of information representation or interaction design to induce emotions that are conducive to learning (Plass & Kaplan, in press; Um, Plass, Hayward, & Homer, 2012). Virtually all elements of game design can be used to induce emotions, and empirical evidence suggests that positive emotions can broaden the scope of cognitive resources (Fredrickson & Branigan, 2005; Isen, 2002) and enhance learning outcomes (Plass & Kaplan, in press; Plass et al., 2014; Um et al., 2012). There is also empirical evidence showing that confusion can lead to enhanced learning (Craig et al., 2004; D'Mello & Graesser, in press; Graesser & D'Mello, in press), and that empathetic agents responding to the player's emotional state impact learning (Cooper, Brna, & Martins, 2000; D'Mello, Olney, Williams, & Hays, 2012; Lester, Towns, & Fitzgerald, 1998).

Research on emotional design has identified two methods of emotion design, through the representation of information and through game mechanics (Plass & Kaplan, in press). Representation of information, such as the visual design of learning materials, impacts learners' emotional state and, in turn, can enhance learning outcomes. Initial research in this area investigated how shapes and colors can be used to induce positive emotions in learners, and whether these positive emotions facilitate learning and enhance comprehension and transfer test outcomes (Um et al., 2012). When decomposing this effect we found that both warm colors and round shapes were individually able to improve comprehension. Round shapes were also independently able to improve transfer, but color alone did not (Plass, Heidig, Hayward, Homer, & Um, 2014). Follow-up research has been investigating how the use of different shapes and colors for game characters can impact emotions in games for learning (Szczuka, Biles, Plass, & Krämer, 2013). Game mechanics are able to impact learners' affect by providing activities with high situational interest (e.g., Isbister, Schwekendiek, & Frye, 2011; Plass, Homer, Hayward et al., 2012; Plass, O'Keefe, Homer, et al., 2013; Plass, O'Keefe, Biles, Frye, & Homer, 2014), or through affective tutors that respond to players' emotions (Baker, D'Mello, Rodrigo, Graesser, 2010; D'Mello & Graesser, 2014).

Other Affective Constructs. Other affective constructs that impact learning in playful environments include achievement goal orientation (Ames & Archer, 1988; Dweck & Leggett, 1988; Elliot, 2005), learners' attitudes toward the subject (Ke, 2008; Van Eck, 2006), empathy (Huang & Tettegah, 2010), and self-efficacy and self-esteem (Pavlas, Heyne, Bedwell, Lazzara, & Salas, 2010; Plass, Goldman, Flanagan, & Perlin, 2009). Research has also shown the impact of playful learning on learners' identity formation (Squire, 2006), including their identity as designers (Squire 2008).

Socio-Cultural Aspects of Playful Learning

Overall Approach. In this section we consider a social/cultural approach to game-based learning. Knowing that learning is often considered to be socially constructed and motivated (Wenger, 1998, 2000; Bandura, 2002; Barab & Duffy, 2000), games can use designs that embed opportunities for social engagement and provide contexts where peers and social interactions occur to maximize learning (Squire, 2006, 2011; see also Ito, Horst, Bittanti, D., et al., 2008). The goal of learning designs that maximize social and cultural aspects of learning relate to how learners can participate in groups, use collective knowledge to meet goals, relate learning to aspects of cultural norms and identities, and use social and cultural influences as motivators for learning through features that are contained within immediate and more distributed game play. Social and cultural aspects of learning are sometimes difficult to separate from the other foundational pillars discussed above, as cognitive and affective aspects of learning interact with and often function within social and cultural contexts (Turkay, Hoffman, Kinzer, Chantes, & Vicari, 2014). Nevertheless, claims that games are dependent upon and maximize social and cultural aspects of play are salient enough that these aspects must be considered separately, while understanding that cognitive, affective, and social/cultural features of gameplay interact, though any one may be either privileged or de-emphasized in any particular game. A large part of the motivational value of games, and the desire to return to play (*stickiness*, as noted elsewhere), lies in anticipated social interaction. This is especially true for players of massively multiplayer games (MMOs), who look forward to game-play in order to interact with others and to participate in group-related activities and *quests* (Steinkuehler & Duncan, 2008). Social interaction within games also influences self-perception, both as a game player and as a learner. Identity formation, both how one is perceived by others and how one perceives oneself, is influenced by social and cultural factors, and these perceptions relate to notions of self efficacy and thus also to learning performance.

Emphasis/Focus. We would be remiss not to note that *games*, as a generic term, is so broad as to be of little utility when discussed within a framework of design, and this is especially true when discussing social and cultural aspects of playful learning. Games not only range across broad genres of field (Humanities, Sciences, Engineering, and so on), genres of contents (second language learning, aspects of arithmetic, e.g., fractions, and so on), and genres of games (first person shooter, MMO, board games, video games, and so on). And, of course, each of the above genres crosses and links with each of the others. Yet, social and cultural factors are influential across these categories.

From a social and cultural perspective, playful learning designs would emphasize motivation and engagement in much the same way as discussed in the section focusing on Affect. A goal of social and cultural factors related to design of games for playful learning thus strives to build opportunities for social and cultural factors to positively influence learning by

creating meaningful, socially-supported learning contexts. Much as in real-world learning, social actions and interactions influence learning and these can be embedded in gameplay.
Numerous studies have relied on Activity Theory (Nardi, 1996a, 1996b) to design games for learning and to explain the social interactions between players and players with artifacts (Jonassen & Rohrer-Murphy, 1999). Activity theory has been attractive because games are dynamic and situations, artifacts, and player expertise all change throughout the course of play. The theory acknowledges that the players and artifacts in games change as conditions change, in both positive and negative directions, and that change is a result of both social factors and the mediation of artifacts (Kuutti, 1996) related to play (see Leont'ev, 1974 for a discussion of the affordances and fluidity of artifacts).

More recently, and related to the notion that artifacts and their affordances are important to social play and players' learning, attempts to address research into social and cultural interaction have used Actor Network Theory (Latour, 1996, 2005), and rhizomatic analyses (e.g., see Banks, 2014; Wohlwend, & Handsfield, 2012; Leander, Phillips, & Taylor, 2010) to document and explore how artifacts interact with social and cultural foci and learning. Such analyses are related to Vygotskian notions of identities, and Moll's Funds of Identities (Esteban-Guitart, & Moll, 2014; see also Moll & Greenberg, 1990), which argue that it is the interaction of artifacts with individuals and groups that determine individuals' perceptions of self and others. Such perceptions include perceptions of oneself as a learner and beliefs about one's ability.
In research related to social interactions, investigating why and how those interactions occur, and how they link to learning, qualitative measures have generally been used. As social and cultural interactions that influence learning are fluid and flexible, traditional experimental methods have not, historically, been the norm. More recently, however, biometric and eye-tracking data, and well as log-file data collected during game play, is allowing insights into movement within and across social groups, and how such movement and interaction affects learning.

Foundations of Social and Cultural Aspects of Playful Learning

Designs for playful learning must acknowledge that games appear to be social experiences for teen players, who discuss their play with others and who often play to foster a sense of community. The Pew Internet & American Life Project (Lenhart et al., 2008, p. iii) found that games are often social activities, reporting that 75% of teens play games with others at least some of the time, that 65% of those teens play with people who are in the same room with them, and that 27% play games with people who they connect with through the internet. Similarly, Ito et al. (2008) have shown how teens are greatly influenced by social interactions as motivators in participatory communities. They note the importance of interest-driven and friendship driven participation in media-related activities, show how interest-driven and friendship-driven participation relates to engagement, and note the various modes of media engagement in which “kids are tinkering, learning, and getting serious about particular modes and practices, which are often supported by social networks.” (p. 76). This interaction and fluidity between interest-driven and friendship-driven social participatory structures imply that designs should take into account activities specifically designed to promote social interaction and friendship, social networking around a specific activity, and social support structures that result in learning around the interaction related to a specific activity (see also Merchant, 2010, 2012; Jenkins, 2009; Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006).

Social Context of Learning. Social contexts facilitate learning, often by allowing players to participate in communities of practice (Lave & Wenger, 1991; Wenger, 1998; Barab & Duffy, 2000; Pearce, Boellstorff, & Nardi, 2011) that involve the beneficial effects of collaboration (Hummel, van Houcke, Nadolski, van der Hiele, Kurvers, & Löhr, 2011; Sung, & Hwang, 2013; see also Stahl, Koschmann, & Suthers, 2006, for an overview history of computer-supported collaborative learning) and the application of distributed expertise (Brown, & Campione, 1994). Games are social spaces when their designs and expectations allow players to feel that they are a part of a community, and can participate in actions and decisions.

While it seems obvious that multiplayer games require social interaction and decision making, even single-player games take advantage of social pressure, through competitive and supportive structures—both of which are factors in social interaction. For example, leaderboards in single player games are a window into how others are doing, and the competitive nature of the social group revealed by the leaderboard can influence how often one plays and how much attention and effort one puts into the game. Thus, while leaderboards provide feedback and generally fall under feedback and assessment design categories, they also indicate social presence (Lee, 2004; Tamborini & Skalski, 2006) as related to a larger group of players. Similarly, badges, cards, and other visible reinforcement and feedback items often form a part of gamification designs (Lee & Hammer, 2011). Although potentially motivating, these can be counterproductive unless they are designed to match closely to intrinsic learning goals rather than positioned as extrinsic rewards for their own sake.

Participatory Learning Culture. Social aspects of playful learning include the blogs, listervs, cheat sites and forums that form part of a game's community, though they reside outside of the actual game itself. Some such venues are created and supported by game publishers (e.g., Sim City; http://forum.ea.com/eaforum/categories/show/232.page), while others spring up from the players themselves (e.g., Simtropolis, with the motto "many cities, one community:" http://community.simtropolis.com/). Such communities help players learn by providing resources and hints to solve puzzles and quests, but are supportive social sites in many ways—not only in gameplay but also in life outside the game. For example, a community within *WoW* provided in-game events and raised funds for a member on learning of his cancer diagnosis (Newman, 2013). Similarly, Leander & Lovvorn (2010) note cultural learning occurred within gameplay of *Star Wars Galaxies: An Empire Divided*. This study showed how a teenaged player in the U.S. established a friendship relationship with a teen in Finland, and that teen's social network, through in-game interactions. These interactions led to the U.S. teen's learning Finnish, face-to-face meetings arranged between the two families, and the U.S. teen's decision to study abroad in Finland for one year. Clearly, an unintended consequence of playing the game was a friendship relationship that grew out of interest (see Ito et al. (2008), but the gamespace surrounding the game itself, which included access to technology and communication technologies, allowed social connections that were motivated from within the game to influence learning outside of it.

Social Aspects of Agency. The above example reminds us that learning is related to goal-directed behavior, and that agency is important in motivation and goal orientation. Bandura (2002) notes that three areas related to agency can result in meeting one's goals: personal agency (exercised individually), proxy agency (where individuals influence others), and collective agency (where individuals form groups and act together). All three types of agency can appear in well-designed games that maximize social aspects of play, but proxy and collective agency appear to be most relevant to massively multiplayer games. Becoming a guildmaster and leading groups in MMO games, becoming a part of a tribe, forming alliances, or participating in group-based quests are examples where proxy and collective agency are aspects of social agency. These aspects move beyond learning of specific skills to learning of more abstract areas within what are termed the 21st Century skills. Through proxy and collective social agency as designed in playful learning games, knowledge of how to work in teams, how to set joint goals, how to reach both personal and community outcomes, and how to collaborate in learning is also being developed through social aspects of gameplay. Collective agency is also related to distributed cognition (Hollan, Hutchins, & Kirsh, 2000) where expertise is provided within socially normed contexts to solve problems.

Observational Learning. In a social sense, videogames affect not only players, but observers of play as well. Isbister (personal communication) has shown that players of motion-controlled games (such as Wii and Kinect-based games) that occur in rooms where others are present soon engage the interest of non-players. In fact, the non-players seem to be equally focused and engaged with what shows on the screen as those who are playing, and often exhibit body movements consistent with the players'. In some cases, observers have been found to learn more from the game than players (deHaan, Reed, & Kuwada, 2010). Observers offer advice and encouragement, and may be considered part of the game's social context. Players know they are performing in the space where observers are present, and the social space of the game-world and the world surrounding the players becomes blurred and merged. Stevens, Satwicz and McCarthy (2008) note that *in-game*, *in-room*, and *in-world* have loose boundaries, and influence each other. As they state, "we do see a reason that young people play games and get them tangled up with the rest of their lives, and this reason is cultural… Video game play is now hunkered down in our culture." (p. 57).

As the social actions in and around a game appear to be related to actions and relationships outside of the play itself, Shaffer and others point out the value of epistemic games, i.e., games that put players in professional situations while they play in ways that result in learning about the norms and expectations of that profession (Shaffer, 2006; Bielaczyc, & Kapur, 2010). These norms and expectations are, of course, influenced by social and cultural contexts, and the actions of individuals are strongly influenced by and incorporate societal expectations and norms. For example, medical doctors have knowledge and skills, but society also expects doctors to act in certain ways, and this is true for every individual in his or her role and context.

Games are uniquely positioned to teach these socially/societally-constructed norms. Game designers, whether by intentional design or through intuition and knowledge as a member of a given cultural and societal group, build-in the social expectations and appropriate actions related to a games' subject. We would argue that being explicit in these aspects of playful learning designs should form a part of social learning in games, and that social enculturation can influence players' preparation for future learning and transfer (Bransford & Schwartz, 1999; Reese, 2007) in terms of contextualizing the application of learning within a given domain. Shaffer, Squire, Halverson, and Gee (2005, p. 4) note, "playing games means developing a set of effective social practices." They go on to suggest that these social practices are developed through role-playing and learning the practices and expectations surrounding professions and events that occur in world outside the game—in their everyday lives. Thus, one effect of the social aspects of games is to facilitate learning to apply knowledge in appropriate ways in circumstances encountered in life. Some have termed this preparation for future learning (see, for example, Reese, 2007; Dede, 2009), where playing a game may not result in learning while playing, but prepares the player for later learning, see Table 1.

Relatedness and Self Perception. Self determination theory (Ryan and Decci, 2000a, b) includes the notion of Relatedness, defined as a sense that one has of being connected to others. As players interact with others during game play, establishing a sense of connection with others in (and out) of the game world becomes important for engagement, satisfaction with the game, and the desire to play again (Ryan, Rigby, & Przybylski, 2006). In fact, Relatedness appears to link to several factors, including sense of presence, as noted by Ryan, Rigby, & Przybylski (p. 359). Relatedness also links to players' abilities to make choices in a game, and an important aspect of choice relates to avatar customization, which in turn leads to strong identification with one's avatar and motivation to play (Turkay & Kinzer, 2014). Because MMOs tend to be rich in content and provide opportunities for interaction between players, the psychological need for relatedness also emerges as an important satisfaction that promotes a sense of presence, game enjoyment, and an intention for future play.

Turkay (2013) also notes the importance of Relatedness, but found that players' awareness of social aspects of gameplay in a MMO game increased over time. That is, social aspects of gameplay were lower and less important early in the game, while payers were learning how to play, and more important as play became more fluid. Participation in-group in-game activities occurred more often once novice-status became diminished. Turkay notes that progress through a game is linked to social status, as one's levels and abilities come to appear higher to other players. Many players do not want to be seen as novices, so may not initially participate in social activities, preferring to be observers rather than active participants until a threshold of ability is reached (Ducheneaut, Yee, Nickell, & Moore, 2006). Once reached, Relatedness becomes more important. However, if participatory overtures are rebuffed, a player's sense of relatedness would decrease, and so would motivation to continue. Thus, from a social, "sense of relatedness" perspective, game designs that maximize clusters of players of similar abilities, allowing cohorts to move together while interacting with more knowledgeable and higher-ability others, can be important design considerations.

Social Interaction Design. The ubiquity of mobile devices such as smartphones and tablets has led to learning games that can be accessed anywhere and anytime, and allow games to be played in augmented reality situations (Schrier, 2007; Squire, 2010) that send players "into the field" to play in authentic situations that incorporate real-world artifacts. Augmented reality games use information from the world as part of gameplay rather than incorporating everything needed to play a game within a self-contained game context. For example, games like *Reliving the Revolution* (Schrier, 2007) use scenes, buildings, and museum artifacts in Boston that are explored by players to play the game and meet its challenges. Included in this category of games are crowdsourced games, which involve large numbers of individuals who, while playing, provide real and useful data to experts solving real-world problems.

While designing for social interaction and a discussion of collaboration and competition has occurred throughout this section, here we focus on designing for large-group play in what might commonly be called crowdsourcing environments. Increasingly, games are designed to be used by large segments of the population in ways that can bring to bear the power of large-group data collection and analysis, often through distributed observations, with the goal of addressing large-scale problems. Crowdsourcing games are seen, for example, in games under the umbrella of Citizen Science, where people from all walks of life, with varying expertise in the specific area being played, participate in a common science-related activity. Popular projects include *FoldIt* (www://fold.it/portal/info/about) and *Citizen Sort* (http://scistarter.com/project/689-Citizen%20Sort) among many others. Ideally, citizen games facilitate the solution of a project's goal by providing individual games to players, who can learn about the domain in which they are playing, while their play provides useful data to a large real-world project (perhaps by tracking migratory bird patterns, providing weather data, or classifying astrological images as part of individual gameplay).

The popularity of these games results in part from the motivation and engagement that is related to group play. For example, the Plass et al. study described above found that competition and collaboration in an arithmetic game designed for middle school students increased their interest, enjoyment, and mastery goal orientation (Plass, O'Keefe, et al., 2013). Yet, the challenge is to design games so that motivation does not decrease over time, and crowdsourcing game designs must take into account the importance of individual rewards and feedback within large-scale collaborative projects. Aspects of gamification, appropriately designed as discussed elsewhere, are often thought to be helpful for such games, but a key ingredient driving players to crowdsourced games is often the knowledge that they are part of a greater good, and this must be clear from the outset. As such, the social impact of participating in such games becomes a key design component in Citizen Science-like game activities.

Discussion and Conclusion

Some Implications

We believe that the most important implication of the *Integrated Framework of Playful Learning* we presented in this paper, and our primary motivation for developing this framework, is the need to view games as complex genres that cannot be understood by taking only one perspective. In fact, as our review has shown, many of the concepts that are important in the context of games, such as motivation, had aspects pertaining to each of the three areas we discussed, and omitting any one of them would result in an incomplete view of this issue. Scholars, researchers, and developers who only take a cognitive perspective, for example, tend to adopt an efficiency paradigm for games and ask whether learning with games is more effective, and less time consuming, than learning from other media. Such a view does not take into account the motivational and socio-cultural aspects of games that may re-engage learners who would otherwise not want to learn about particular subject matters. Likewise, when taking primarily an affective perspective, proponents often adopt a flow paradigm, arguing that the most important benefit of games is to engage players in effortless learning by creating the right engagement just between boredom and frustration (Csikszentmihalyi, 1990). Such a primarily affective perspective does not take into account cognitive aspects of learning, such as the importance of reflection during the learning process (Moreno & Mayer, 2005), which would be incompatible with a flow perspective. Finally, when taking a primarily socio-cultural perspective, which often involves focusing primarily on the acquisition of skills such as collaboration, communication, teamwork, creativity, and systems thinking, proponents often do not incorporate design considerations coming from cognitive and affective perspectives that would assure the appropriateness of the design of the game to meet its intended goals. Our design framework shows how these three different perspectives should be integrated in order to guide the conceptualization and design of learning environments that are able to engage learners on different levels, with the goal to foster cognitive engagement in support of the learning goals.

Future Research on Playful Learning Environments

The framework outlined in this paper leads to several lines of research to investigate how the specific design elements for playful learning that are based on the different foundations of the framework would be able to engage users in playful learning. We have begun this work by taking a design perspective in which the goal of the research is to formulate game design patterns - general solutions to commonly occurring problems (Alexander, 1977) in the design of effective playful learning environments.

One example for such a line of research is the design and study of learning mechanics and assessment mechanics. This would involve the use of learning theory to guide the selection of a learning strategy that is expressed as learning mechanic and implemented as a game mechanic. Value added research would investigate to what extent such a mechanic can be effective to help learners achieve the intended learning outcomes. For example, if a learning mechanic is implemented in two different game mechanics, perhaps using different incentive systems, which is the more effective mechanic, generally or for learners with specific characteristics? Similarly, assessment mechanics would be designed based on measurement theoretical principles and implemented as game mechanics. Research would have to validate such assessments and determine their psychometric properties. Finally, research could investigate the effectiveness of adaptive learning games which, based on the assessment mechanics, would provide individual problems via the learning mechanics. Such research can take advantage of learning analytics and educational data mining. Our framework encourages a comprehensive focus of these studies, with the inclusion of independent and dependent variables for cognitive, affective, social, and cultural perspectives.

Conclusion

In this paper we argue that the combined viewpoints of cognitive, affective, social, and cultural perspectives are necessary for both game design and game research in order to fully capture what games have to offer for learning. Combined, these perspectives form an overarching, learning sciences perspective, which gives enhanced power for the potential of games in education, and for a way of looking at the design of learning games that would make them potentially much more effective than is the case at present. Our integrated approach will allow us to move beyond simple learning goals such as preparation for future learning, to measurable learning within games, and would allow us, for example, to incorporate gaming principles of as part of the design, rather than as an add-on to existing structures, i.e., as gamification. Viewing playful learning as a series of learner engagements on different levels (cognitive, affective, physical, and social/cultural), and treating game design elements as strategies to achieve this engagement based on established cognitive, affective, and social/cultural theories outlined in this paper, can contribute to a more systematic process of conceptualizing and designing games that we hope will contribute to the development of games that have the impact proponents have been advancing for over a decade.

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