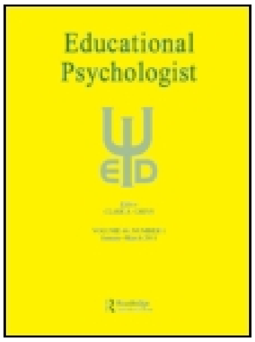

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Foundations of Game-Based Learning

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In this article we argue that to study or apply games as learning environments, multiple perspectives have to be taken into account. We first define game-based learning and gamification, and then discuss theoretical models that describe learning with games, arguing that playfulness is orthogonal to learning theory. We then review design elements of games that facilitate learning by fostering learners' cognitive, behavioral, affective, and sociocultural engagement with the subject matter. Finally, we discuss the basis of these design elements in cognitive, motivational, affective, and sociocultural foundations by reviewing key theories from education and psychology that are the most pertinent to game-based learning and by describing empirical research on learning with games that has been or should be conducted. We conclude that a combination of cognitive, motivational, affective, and sociocultural perspectives is necessary for both game design and game research to fully capture what games have to offer for learning.

What are the psychological foundations of game-based learning? We argue in this article that games are a complex genre of learning environments that cannot be understood by taking only one perspective of learning. In fact, as our review shows, many of the concepts that are important in the context of games, such as motivation, have aspects relating to different theoretical foundations—cognitive, affective, motivational, and sociocultural. We argue that for games to achieve their potential for learning, all these perspectives have to be taken into account, with specific emphases depending upon the intention and design of the learning game.

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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 raised 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 et al., 2008). Equally compelling are reports on how much time youth spend playing digital games, which ranges from approximately 7 to 10 hr per week (Lenhart et al., 2008), with more recent estimates putting this number even higher (Homer, Hayward, Frye, & Plass, 2012). Although there are gender differences in the amount of time boys and girls play digital games (Homer et al., 2012), and in the types of games boys and girls prefer to play (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015), studies have not found significant gender differences in learning or motivational outcomes in educational games (e.g., Annetta, Magnum, Holmes, Collazo, & Cheng, 2009; Papastergiou, 2009). Given this level of engagement that games generate for a broad range of individuals, and considering the kinds of individual and social activities they 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. These decisions were influenced by the authors' theoretical approach to the use of digital games for learning. Among these approaches, two are particularly prominent: a cognitive perspective (Blumberg, 2011; Fletcher & Tobias, 2005; Mayer, 2005; Shute, Ventura, & Ke, 2014; Spence & Feng, 2009) and a sociocultural perspective (De Freitas, Rebolledo-Mendez, Liarokapis, Magoulas, & Poulovassilis, 2010; Shaffer, 2006; Squire, 2008, 2011; Steinkuehler, Squire, & Barab, 2012). Depending on which perspective is taken, games are considered either environments that are motivating but likely to require excess amounts of information to be processed by the learner (cognitive perspective) or, conversely, approaches that provide the rich contextual information and interactions needed for learning in the 21st century (sociocultural perspective).

A discussion of games and learning, and an assessment of their impact, is complicated by the fact that *games*, as a generic term, is so broad as to be of little utility when it is discussed without further qualification. Games range across not only broad genres of field (humanities, sciences, engineering, etc.) and genres of contents (second-language learning, science, history, etc.) but also genres of games (casual game, first-person shooter, massively multiplayer online game [MMO], role-playing, etc.). Of course, each of the preceding genres crosses and links with the others.

A consequence of the fact that the concept of games covers all these genres is that one cannot assume that research results obtained by studying games from one genre can be applied readily to another genre. For example, badges introduced into an MMO may be useful to guide the learner to perform specific learning-related tasks, but when integrated in a casual game they may distract from learning.

In this article we aim to provide a comprehensive theory-based approach to games and learning that incorporates multiple views of learning and of foundations of game design. To that end we first discuss the definitions of game-based learning and the theoretical models that can describe learning with games. We then describe design elements of games that facilitate learning. Last, we summarize how the design of these game elements is based on cognitive, motivational, affective, and sociocultural foundations.

WHAT IS GAME-BASED LEARNING?

Definitions of game-based learning mostly emphasize that it is a type of game play with defined learning outcomes (Shaffer, Halverson, Squire, & Gee, 2005). Usually it is assumed that the game is a digital game, but this is not always the case. A corollary to this definition is that the design process of games for learning involves balancing the need to cover the subject matter with the desire to prioritize game play (Plass, Perlin, & Nordlinger, 2010). This corollary points to the distinction of game-based learning and gamification. What exactly is meant by gamification varies widely, but one of its defining qualities is that it involves the use of game elements, such as incentive systems, to motivate players to engage in a task they otherwise would not find attractive. Similarly, there is an ongoing debate among scholars as to the exact definition of a game, and especially what is not a game (Salen & Zimmerman, 2004). One definition defines a game as "a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (Salen & Zimmerman, 2004, p. 80). Consider as an example the gamification of math homework, which may involve giving learners points and stars for the completion of existing activities that they consider boring. Game-based learning of the same math topic, on the other hand, even though it may also include points and stars, would involve redesigning the homework activities, using artificial conflict and rules of play, to make them more interesting and engaging.

Even though the debate around how games are defined cannot be resolved here, this may not be a problem, as play—the essential activity in games—has long been thought of as a critical element in human development.

PLAY AND COGNITIVE DEVELOPMENT

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. Being able to hold in mind multiple, even conflicting, representations of reality underlies key later developments, such as the acquisition of a theory of mind (Astington, Harris, & Olson, 1990) and emergent literacy and numeracy (Homer & Hayward, 2008). This understanding of the role of play in children's cognitive development has informed our understanding of educational games (see Hodent, 2014), but there has also been great interest in understanding how video games shape cognitive development and learning.

In one of the first books on the psychology of video games, Loftus and Loftus (1983) focused on players' motivations, exploring what makes video games "fun." Relying largely on behaviorist theories, Loftus and Loftus pointed 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 cited 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, inducing what has been described as a state of "flow" (Csikszentmihalyi, 1990). In the context of learning, good games aim to be within a player's *zone of proximal development*.

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 to 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. In the next sections we consider additional reasons for the use of games for learning.

THE ARGUMENT FOR GAME-BASED LEARNING

There are a number of arguments being advanced for why games are effective learning environments. Some of these arguments have little or no empirical support, whereas others are deeply grounded in existing theory and research. We summarize some of the most important arguments next and provide a deeper discussion of the empirical foundations of these in a later section of this article.

Motivation

The motivational function of games is their most frequently cited characteristic. The argument is that games for entertainment have been shown to be able to motivate learners to stay engaged over long periods through a series of game features that are of a motivational nature. These features include incentive structures, such as stars, points, leaderboards, badges, and trophies, as well as game mechanics and activities that learners enjoy or find interesting (i.e., that create a high situational interest; Hidi & Renninger, 2006; Rotgans & Schmidt, 2011). From a game design perspective, it is less desirable to use game features to "enhance" otherwise uninteresting mechanics and more desirable to make mechanics in themselves interesting, but little if any empirical evidence exists for the relative impact of each of these approaches on learning.

Player Engagement

Related 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. Which types of engagement are implemented depends on design decisions that reflect the specific learning goal, learner characteristics, and setting. Because the concept of engagement is ill defined and underspecified, we base our discussion of engagement on the INTERACT model of learner activity (Domagk, Schwartz, & Plass, 2010), which distinguishes among cognitive engagement (i.e., mental processing and metacognition), affective engagement (i.e., emotion processing and regulation), and behavioral engagement (i.e., gestures, embodied actions, and movement). We add a fourth type, sociocultural engagement (i.e., social interactions embedded within a cultural context). For example, a game can engage the learner behaviorally by using gestures as input or inviting players to perform specific physical actions as part of play. Game characters engage the learner emotionally, and social features such as collaborative play support sociocultural 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. All forms of play have the potential to result in all four types of engagement (affective, cognitive, behavioral, sociocultural). However, the actual type of engagement will differ by game and within a game, as different games features elicit different types of engagement in different context and for different learners.

Adaptivity

Learner engagement is facilitated in part 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 situation. This 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 of scaffolding, guidance, and feedback in a way that responds to the player's in-game actions (Steinkuehler & Duncan, 2008).

Graceful Failure

Another argument for game-based 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 (Kapur, 2008; Kapur & Bielaczyc, 2012; Kapur & Kinzer, 2009; Plass, Perlin, et al., 2010). The lowered consequences of failure in games encourage risk taking, trying new things, and exploration (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, Warren, & Ingram-Goble, 2009; Kim, Park, & Baek, 2009). The ability to fail gracefully is connected to many of the previously discussed issues, such as motivation, engagement, and adaptivity. How can these various arguments for game-based learning be described in a more systematic, theory-based way?

A THEORY OF GAME-BASED LEARNING?

Few would dispute that games are learning environments with characteristics that differ to such an extent from those of other genres that they should be classified as a genre of their own. Some advocates go even further and make the case that game-based learning involves processes that differ to such an extent from learning in other forms (such as classroom instruction) that they should be described as a unique model or theory of learning (Gee, 2003; Prensky, 2003).

A review of existing games quickly confirms, however, that the uniqueness of game-based learning can hardly be defined at an epistemological level. Game designers use behaviorist elements, cognitivist elements, and constructivist elements, and often various combinations of them, in the design of games for learning. For example, the game *Angry Birds* challenges the learner to fling birds at pigs that hide under different types of structures. In its essence, the game takes a behaviorist approach by posing a low-level task of maximizing the damage to the pigs. However, the player's response to this challenge involves the selection of a specific type of bird from a set of birds with different (destructive) abilities and allows for some flexibility in the vector (angle and force) in which the birds are flung. The game shows the trajectory of the bird and gives feedback on the damage caused in visual form, in the destruction of structures and bruising of pigs, in auditory form as sound effects, and in the form of points won for each destroyed object or pig. The task itself (directing an object to a target location) is tedious and uninteresting, but the game elements used to implement the task as game mechanic, and the feedback provided, make this a very engaging game that has been played by millions.

Another type of game, *Crayon Physics* (or its cousin *Newton's Playground*), poses different challenges for players. By choosing whether to attempt to solve a problem as elegant, innovative, minimalistic, and so on, players can set their own goals and respond accordingly by creating drawings that guide a ball into a target. The feedback in this game is tied to the task itself—the use of physics to move a ball from its original location to a target location. Few additional game elements are needed to make the task more interesting, and the points awarded are secondary to the satisfaction of having found a solution to the problem.

Finally, MMOs such as *Eve Online* or *World of Warcraft* are player-driven worlds with an almost infinite range of possibilities of play. Players control and customize characters and interact with the environment and with other players' characters in ways that develop an in-game culture and often economy. MMOs allow players to set and pursue their own challenges, develop different identities, and play different roles. These activities involve team collaboration and competition, communication, creation, systems thinking, and problem solving, and it has been argued that those activities can enhance players' socioemotional skills, or 21st-century skills (Denning, Flores, & Flores, 2011).

These three examples represent three very different models of learning, from behaviorist to constructivist. One of the few characteristics they have in common is that playfulness serves as an enriching yet orthogonal dimension—a dimension that can be present no matter what model of learning a game is based on. Trying to develop a model of game-based learning would, therefore, require the construction of a general model of learning that incorporates each of the existing models into one meta-theoretical model. Such an attempt has been made (Gentile, Groves, & Gentile, 2014); the resulting model is not specific to games

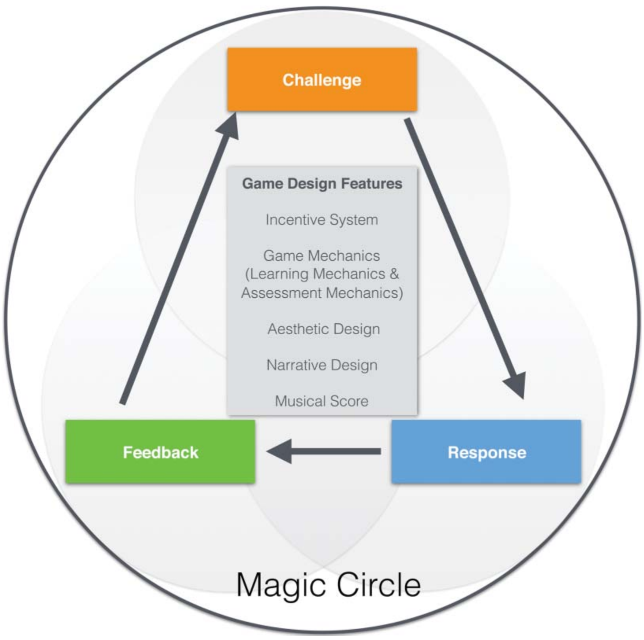

FIGURE 1 Model of game-based learning.

but rather can be used to describe learning independent of the genre of the learning environment used for its implementation.

Instead of a comprehensive theory of learning, we may therefore consider a simple model that describes the basic structure virtually all games appear to have. This structure consists of three key elements: a challenge, a response, and feedback (see Figure 1). A loop is generated when the feedback constitutes a new challenge or prompts the player to provide a different response to the original challenge.

The learning theory that informed the design of a specific game is reflected in the type of challenge the game provides, the type of responses it facilitates, and the kind of feedback it provides. For example, a behaviorist game would provide a challenge with a limited set of choices by which the player can respond, and the feedback received would be corrective, as a right/wrong message. In contrast, a game based on a constructivist approach may allow players to set their own challenges, make available tools with which to construct a response, and provide a system of peer feedback.

The model shows how game design features are at the center of the learning experience, permeating how challenge, response, and feedback are designed. The playful character of each of these three key elements transforms the learning experience in different ways. For example, challenges can be inspiring by using a strong narrative such as in *Portal 2*. Responses can be enjoyable through game mechanics such as slinging birds in *Angry Birds*. Feedback can be playful through game characters or a leaderboard such as in *Little Big Planet*.

Coming back to the observation that learning with and from games is clearly a unique experience, yet a comprehensive model of game-based learning appears to be not feasible, how else can this experience be described? We propose that a more promising method to capture the uniqueness of game-based or playful learning can be found by focusing on how these learning environments are designed. By the time games were adopted at scale for learning purposes, game design had developed into a refined art form (Salen & Zimmerman, 2004) with processes that differ from the design of traditional learning environments in a number of ways. One of these differences is that designers of game-based learning have a unique concern for the quality of the learning experience, which is refined and tested with great effort and care (Isbister & Schaffer, 2008). This designed learning experience incorporates engagement on an affective, behavioral, cognitive, and sociocultural level, creating a *Magic Circle* of playful learning (Plass, Perlin, et al., 2010). This learning experience is often described as a flow experience (Csikszentmihalyi, 1990), although we prefer to think of it as optimal engagement, that is, engagement optimized to facilitate learning. Taking multiple types of engagement into consideration is rare for most other learning environments. These different forms of engagement are facilitated through design features that result in a playful experience, as shown at the top of Figure 2. In this way, games are a unique genre to implement existing models of learning, and playfulness adds a dimension to these existing models. This creates a learning experience that can make games a preferable genre for implementing these models than other, more traditional genres.

Summary

As our discussion in this section shows, a definition of game-based learning, and especially a distinction of games versus nongame environments, even when it seems intuitively possible, is very difficult to achieve on an abstract, generalizable level. Similarly problematic is the attempt to formulate a general theory of game-based learning, as games can be designed based on virtually any model of learning. Instead, we have proposed a simplified model of game-based learning and have argued that one of the distinguishing characteristics of games is the unique concern of game designers for the quality of the learning experience and, in part because of this concern, the fact that digital games are able to engage learners on an affective, behavioral, cognitive, and sociocultural level in ways few other learning environments are able to. We next describe the design elements used in games for learning to elicit this engagement.

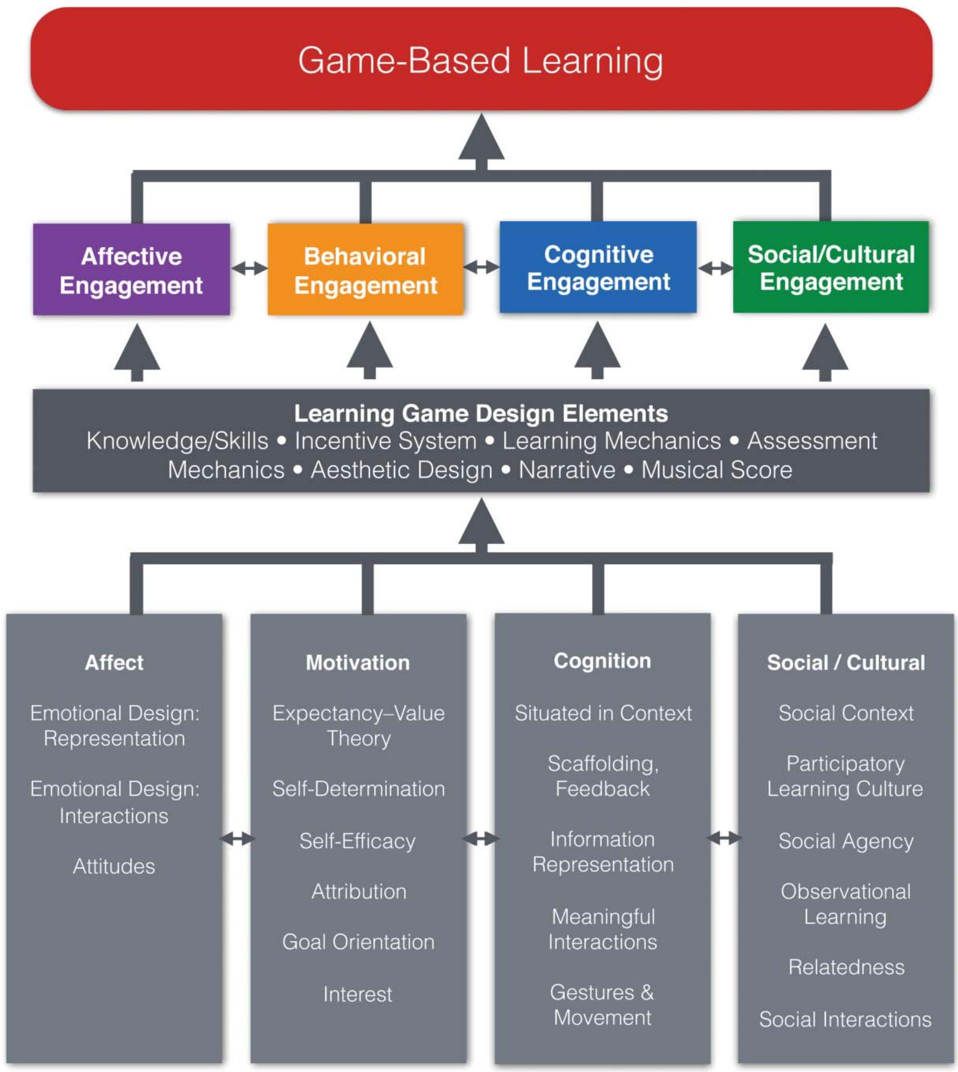

FIGURE 2 Integrated design framework of game-based and playful learning.

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; visual aesthetics; narrative; incentives; musical score; and, because we are discussing games for learning, the learning objectives and related content and skills covered by the game.

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, 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 or assessment activity in a game. It can be designed for single players or involve social features. Mechanics are often used to describe genres of games, such as platformers or first-person shooters.

Visual Aesthetic Design

The visual aesthetic design includes visual elements such as the overall look and feel of the game and 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, which means it has a cognitive function and an aesthetic one. For example, in the game *Light Lanes* (CREATE, 2013b), in which players must 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, whereas light reflecting blocks are represented in green. The visual aesthetic design constitutes the information representation of the multimedia learning aspects of the game. It is also linked to the narrative of the game by expressing its aesthetics.

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 and books, games allow for nonlinear narratives that advance based on the choices made by the learner. Narratives provide contextual information for learning, connecting rules of play, characters, tasks, events, and incentives. They have a strong motivational function by contributing to a game's *stickiness*, that is, the desire it generates for people to return to play. For example, in the game *Space Ranger Alien Quest* (CREATE, 2013a), which was designed to enhance a player's executive functions (Sprung et al., 2013), the narrative explains how different aliens like to eat different foods and why the player needs to help the aliens, and then later explains how the rules have changed and that 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 feedback that attempts to appropriately modify their behavior (e.g., see Kinzer et al., 2012). Incentives can consist of scores (points), stars, badges, trophies, power-ups, and many other rewards. These rewards can be either an intrinsic part of the game play, such as a power-up that gives the player special abilities in the game, or an extrinsic nature, awarding stars or points that do not directly contribute to the game play but that may create a metagame 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 players.

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. A related design feature is the sound of any voice used in the game, for example, the tone or gender of the voice. 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 directs a food item to the right alien, or when the wrong food item is 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. 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.

It may be useful to consider a heuristics of four functions of games that describe to what extent and with what learning goal this content is covered (Plass, Perlin, et al., 2010).

- *Preparation of future learning*. This type of game does not have its own learning objectives but instead provides students with shared experiences that can be used for later learning activities, for example, class discussions.
- *Teach new knowledge and skills*. This type of game introduces new knowledge and skills for the learner to acquire as part of the game play.
- *Practice and reinforce existing knowledge and skills*. These games provide opportunities to practice existing knowledge or physical and basic cognitive skills in order to automate them.
- *Develop 21st-century skills*. Provide opportunities to develop more complex socioemotional skills related to teamwork, collaboration, problem solving, creativity, communication, and so on.

It is difficult to describe learning goals for a genre as broad as games, as this term captures many different subgenres of games, from casual games and puzzle games to role-playing games (RPGs), real-time strategy games, and first-person shooters. Each of these genres will result in different choices of how the game elements are designed. In fact, 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.

What are the foundations of game-based learning that are expressed in game design elements that aim to generate different types of engagement? The design framework we propose (Figure 2) describes what kinds of engagement game-based learning environments facilitate and lists the game design elements that create such engagement. We now turn to the theoretical foundations for these game design elements that make them suitable and potentially effective for games for learning. We discuss these cognitive, motivational, affective, and sociocultural foundations next.

FOUNDATIONS OF GAME-BASED LEARNING

Can existing research inform the design of game-based learning? Although there are multiple areas of psychology that contribute to game design, including theory and research on cognition, motivation, affect, and on sociocultural issues, the extent to which each of these areas can inform the design of games for learning depends on a number of factors, including the content covered by the game, the learning objectives and related function of the game, and the game genre employed. As a result, many findings obtained for specific subject matter areas, game functions, and game genres do not necessarily generalize to other subjects, functions, and genres. However, where possible we describe more generalizable game design patterns, that is, general solutions to commonly occurring problems (Alexander, Ishikawa, & Silverstein, 1977), that can guide the design of effective games for learning. Game design patterns are preferable to guidelines or design principles as they describe solutions on a relatively abstract level and need to be localized and customized in order to be applicable to a specific project.

COGNITIVE FOUNDATIONS OF GAME-BASED LEARNING

When game-based learning is viewed from a cognitive perspective, the goal of learners' engagement with a game is the construction of mental models (Mayer, 2005, 2014). One cognitive theory describes, for example, that learners first 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 consider which game elements contribute to the cognitive processing of the learning content, that is, 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, that is, the cognitive load experienced by the learner during game play (Kalyuga & Plass, 2009). In particular, Mayer 2014 suggested that designers of learning games should aim to reduce extraneous (i.e., unnecessary) processing, manage essential (i.e., necessary) processing, and foster generative processing (i.e., investment of mental effort by the learner).

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 that present the same content as the game (Adams, Mayer, MacNamara, Koenig, & Wainess, 2012). In fact, many studies on cognitive aspects of learning with games investigate brief durations of game play in which interest, motivation, and emotion are not essential factors (Mayer & Johnson, 2010; Mayer, Dow, & Mayer, 2003; Mayer, Mautone, & Prothero, 2002).

There are a number of ways that games can facilitate cognitive processing, of which we describe the situatedness of learning, transfer of learning, scaffolding and feedback, dynamic assessment, information design, interaction design, and gestures and movement.

Situatedness

One of the great potentials of games and playful learning is that they provide opportunities for situated learning (Lave & Wenger, 1991; Wenger, 1998). 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. A second, related benefit of games is that they can present information and problems in ways that closely mirror real life, which facilitates transfer of learning. Although the application of these benefits to games for learning seems logical intuitively, and even though they have been advanced by advocates such as Gee (2007) and Prensky (2005), their cognitive impact in game-based environments has not been sufficiently validated empirically. We later discuss their impact from a sociocultural perspective.

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 needed for knowledge to be generalized to novel situations (*high road*). Considering the functions of games just outlined, both the *teaching of new skills* and the *practice and reinforcement of existing knowledge and skills* have the potential to 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 he or she would not be able to do on their own. Although Wood et al. do not make the link between scaffolding and Vygotsky's zone of proximal development directly, it is evident that for effective scaffolding to take place, the task or problem being solved must fall within the learner's zone of proximal development (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) argued 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 pointed 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—are closely monitored. Appropriate feedback and support is given in areas of game play where the player is having trouble, thereby providing dynamic feedback to scaffold learning of game play. 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 dynamic 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. Similarly, other forms of adaptivity require dynamic assessment. For example, when learning progressions in a game are adaptive to a learner's current knowledge, the dynamic assessment of the success rate of solving the current task will determine which task the learner will be presented with next, for example, by adjusting the difficulty level or deciding whether to move on to the next topic. A first step for dynamic assessment is therefore 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 (Mislevy & Heartel, 2006) provides a useful framework for thinking about in game assessments (see Plass, Homer, et al., 2013, for more detail). 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, et al. (2013) discussed 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 also may eliminate the need for external evaluation of learning outcomes (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). This results in a tension between the desire to reduce cognitive load and the desire to enhance the visual appeal of the information, which is elaborated in the section on affective design factors next. 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, that is, the impact that the choice of signs for the learning content, either via iconic or symbolic representation. Here, studies have shown that iconic representations, for example, icons such as burners to represent heat, 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 & 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) to ensure 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 (Kinzer, Hwang, Chantes, Choi, & Hsu, in press; Wu, Hsiao, Wu, Lin, & Huang, 2012). 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 has shown that the mechanics need to be aligned with the learning goals to be effective. A study with Japanese English language learners showed, for example, that players of a game in which the mechanic was mismatched with the learning goal performed much worse on immediate and delayed measures of vocabulary learning than paired observers of the game play. An indication for the cause of the lower learning outcome of players was that they reported perceiving the game as more difficult than the observers (deHaan, Reed, & Kuwada, 2010).

Other research has compared the impact of different learning 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°. An alternative mechanic asked learners to indicate which rule they would apply to solve the problem, for example, the complementary angles rule (Plass 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 et al., 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, et al., 2013). Results for this skills game showed higher learning outcomes for the competitive mechanics, and 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, that is, the mapping of a gesture or movement to key features of the content to be learned. The impact of embodiment on learning has been considered as a perceptual effect (Black, 2010), a cognitive effect (Gibbs, 2006), or a combination of the two (Kwah, Milne, Tsai, Goldman, & Plass, 2014).

Games and other virtual environments are especially suited to foster this kind of learning because most gaming platforms now allow for gesture input and 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 et al., 2014). In addition to their cognitive impact, research has also been investigating the emotional impact of gestures and movement (Isbister, Karlesky, & Frye, 2012).

Summary

A cognitive approach to game-based learning is primarily concerned with optimizing cognitive processing in the construction of mental models and with the cognitive demand of processing the meaning of the various game elements, that is, the cognitive load experienced by the learner during game play. We described a number of areas in which games can support this processing and described the empirical support that exists for the impact of these mechanisms.

Many of the findings from research on games for learning taking a cognitive perspective are specific to the content, function, and genre of the game under investigation. However, some findings can be generalized more broadly in the form of cognitive design patterns for games for learning. Among these findings is that game mechanics should be aligned with the learning goals of the game, that is, turn them into learning mechanics. In other words, the learning goal should be in line with the core tasks learners execute in the game. Other design patterns describe that when games use multiple representations for important information, scaffolds should be made available that support their integration, and that iconic representations of key information support learners who are younger and learners with low prior knowledge.

Another design pattern from a cognitive perspective is that game elements that are not directly related to the cognitive processing of information, and that require nonessential processing and therefore hinder learning, should be reduced or eliminated. This often includes elements that foster emotional, motivational, and sociocultural aspects of learning, which are viewed as helpful only if they help optimize cognitive processing. However, we next discuss how each of these areas can have benefits that go beyond cognitive processing.

MOTIVATIONAL FOUNDATION OF GAME-BASED LEARNING

When game-based learning is viewed from a motivational perspective we emphasize the ability of games to engage and motivate players by providing experiences that they enjoy and want to continue (Gee, 2003; Ryan, Rigby, & Przbylski, 2006; Zusho, Anthony, Hashimoto, & Robertson, 2014). It is assumed that when playing an educational game, players' interactions with the game will motivate them and will foster cognitive processing of the game content, thereby improving learning (Delacruz, 2012), although some researchers have suggested that the high level of engagement found with entertainment games is unlikely to transfer to educational contexts (Hoffman & Nadelson, 2010). Nonetheless, there have been several efforts to identify the specific elements that contribute to engagement and motivation in games, such as incentive systems, visual aesthetics, game mechanics, narrative/fantasy, and musical score (e.g., Gee, 2003; Loftus & Loftus, 1983; Malone, 1981; Squire, 2011), and to consider their use within educational games. However, in spite of the great interest in this area there have been few efforts to systematically apply motivational theories to understanding learning in games, even though the theoretical and empirical foundation of motivation in education is extensive.

Initial explanations of the role of motivation in learning tended to come from a behaviorist tradition, with an emphasis on the drives, needs, and behaviors of learners (Graham & Weiner, 1996). Similarly, early attempts at explaining motivation in video games also utilized behaviorist constructs, such as mechanisms of reinforcement, to explain motivation and engagement in games (e.g., Loftus & Loftus, 1983). More recent theories take a broader perspective on what motivates students. Eccles, Wigfield, and Schiefele (1998) argued that contemporary theories of achievement motivation can be framed around three questions that students ask themselves when faced with a learning task: "Can I do this?" "Do I want to do this, and why?" and "What do I need to do in order to succeed?" Current motivational theories, including expectancy-value theory (Wigfield & Ecceles, 2000b), self-determination theory (Ryan & Deci, 2000b), self-efficacy theory (Schunk, 1991), attribution theory (Weiner, 2012), achievement goal orientation theory (Ames & Archer, 1988; Dweck & Leggett, 1988; Elliot, 2005), and interest theory (Schiefele, 1991), focus on different components of these questions with different emphases on how various factors shape motivation.

Video games are, in many ways, well suited to address the three questions that frame student motivation (Zusho et al., 2014). Games are designed to ensure players are able to achieve, providing an affirmative answer to first question, "Can I do this?" and to ensure that players know what to do in the game, providing an answer to the third question, "What do I need to do in order to succeed?" One way that this is done is by designing games to allow for graceful failure (described earlier), in which failure to achieve a goal is an experience that allows players to learn from their mistakes and then enabling them to try again. Second, many games have training modes or introductory levels that introduce the game's features and functionality and allow players to practice them. A third way that games help players succeed is by being adaptive: If a player is struggling, most games will decrease difficulty and/or provide scaffolds to help out. Finally, many games have online communities that provide help and support for players, described in more detail next.

It is the second motivational question—"Do I want to do this, and why?"—that is more difficult to address. Theoretical approaches to understanding why students would want to learn something tend to focus on the intrinsic motivation of learners, their specific values and interests, and their achievement-related goals (Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006; Zusho et al., 2014). We briefly review research on motivation that addresses each of these issues next and suggest some ways in which this research has or can be applied to educational games.

Intrinsic Motivation

Most theories make a distinction between intrinsic motivation, in which students are motivated to do an activity for its own sake, and extrinsic motivation, in which students are motivated to do an activity for instrumental or other reasons, such as receiving a reward (Eccles et al., 1998). Contemporary theories of motivation, such as self-determination theory, argue that motivation cannot be viewed as a dichotomy of intrinsic and extrinsic factors but that it operates in a continuum to satisfy innate psychological needs for competence, autonomy, and relatedness (Ryan & Deci, 2000a). From the perspective of the design of games for learning, there is an added layer of complexity in that if the learning and game mechanics are not tightly linked, students may be intrinsically motivated to play the game but not necessarily to learn, which can lead to "gaming the system" in which students find ways to complete the game without necessarily learning the educational content. Motivation elements, therefore, can be considered to be intrinsic or extrinsic to the game as well as to the learning content, depending on how they are designed and how they are perceived.

Core elements of game design, including challenge, curiosity, and fantasy, are thought to be intrinsically motivating for players (Dondlinger, 2007). Challenge, for example, can be very motivating, and games will often *level up*, increasing in difficulty if the player is succeeding too easily, thereby providing an *optimal challenge* to players, which is intrinsically motivating (Malone, 1981). In a study on a game teaching middle school youth how to program, it was found that making the learning task within the game challenging yet personally meaningful and attainable to the learner elicited feelings of self-efficacy and control of one's own success (Plass, Goldman, Flanagan, & Perlin, 2009).

An optimal level of challenge is also key in inducing a state of flow (Csikszentmihalyi, 1990), which prompts some advocates to argue that well-designed educational games result in effortless learning (Brom et al., 2014; Pavlas, Heyne, Bedwell, Lazzara, & Salas, 2010). A more precise way to state this claim may be that players may *perceive* of their effort as low when in fact learners playing a game posing an optimal level of challenge will engage in cognitive processing, which implies the investment of mental effort (Mayer, 2014).

Values and Interests

Several motivational theories focus on the values and interests of learners. For example, expectancy-value theories (e.g., Eccles et al., 1998) identify different motivational components that can provide value to a learning task and focus on the specific outcomes that learners expect and what value they place on those outcomes. Similarly, researchers studying interest argue that students are more likely to engage in activities that they find personally interesting and relevant. A distinction is often made between situational and individual interest (Schiefele, 1991). Situational interest is an immediate affective response to an activity, resulting in learners' directing of their attention to the task (Hidi, 1990; Hidi & Renninger, 2006; Mitchell, 1993; Rotgans & Schmidt, 2011; Schraw, Flowerday, & Lehman, 2001). Over time, learners' situational interest can lead to the development of individual interest, that is, increase their intrinsic desire and tendency to engage in a particular subject matter or activity (Hidi & Renninger, 2006). With well-designed games for learning, there is often the expectation that the situational interest they generate in learners will eventually develop into individual interest in the educational content.

A number of game design elements, such as game mechanics, mode of play, and the use of badges, can affect the situational interest experienced by the learner. For example, a study compared two versions of a middle school geometry puzzle game, *Noobs v. Leets* (previously discussed), to examine the effects of game mechanic on learners' motivation. Researchers manipulated the game mechanic so that in one version players solved geometry problems by computing a missing angle and in the other version players solved the problem by selecting the appropriate solution rule. Students in the numeric condition reported greater situational interest compared to students in the rule condition, suggesting that the selection of the game mechanic has an impact on learners' motivation (Plass et al., 2012). Finally, Miller et al. (2011) presented secondary school students with an online forensic science game. The authors found that after playing through one of three possible cases, students not only showed significant gains in science knowledge but also reported greater individual interest, with a significant increase in the students' interest in pursuing a career in science.

Achievement-Related Goals

Researchers who study achievement goals consider students' goals when engaging in learning activities. In general, two broad goal orientations have been identified: *mastery goal orientation*, in which students focus on learning new skills, mastering material, and learning new things, and *performance orientation*, in which students focus on maximizing favorable evaluations of their competence (Ames & Archer, 1988; Dweck & Leggett, 1988; Elliot, 2005). In general, students with mastery goal orientations tend to have more adaptive patterns of motivation and learning (Midgley, Kaplan, & Middleton, 2001).

Despite the large body of literature on goal orientation, only a few empirical studies have looked at the role of achievement goals in educational games. For example, Plass et al. (2014) examined different versions of a math game on factoring that either involved individual play, competitive play between two players, or collaborative play of two players. Results indicated that in comparison to individual play, competitive and collaborative play resulted in the strongest mastery goal orientation of the students.

Another study (Biles & Plass, in press; Plass, Biles, & Homer, 2016) compared three version the game *Noobs vs. Leets* in which students were assigned to play a version with *performance badges, mastery badges*, or *no badges*. In the two badges conditions, in-game badges were presented to students after completing a level. Whereas the mastery badges were designed to encourage learners based on their own ability (e.g., "You have mastered the triangle rule!"), performance badges were designed to encourage learners by making comparison to their peers (e.g., "You figured out the straight angle rule faster than most other players!"). Although students in the performance badges condition had significantly better learning outcomes that students in the mastery badges condition, this effect was mitigated by a significant interaction between badges and situational interest: Learners with higher situational interest performed better with mastery badges; learners with low situation interest did worse with mastery badges. Overall, these results indicate a need for considering students' achievement orientation and interest when designing educational games, but more research is needed in this area.

Summary

A motivational approach to game-based learning emphasizes that games are able to engage and motivate players by providing experiences that they enjoy and want to continue. A focus on motivation takes into account learners' reasons for wanting to play a game (e.g., their drives, interests, goals, etc.), and investigates the ways in which games can be designed to enhance learners' motivation. Several key concepts from motivational theories are relevant to the design of educational games, including intrinsic versus extrinsic motivation, situational versus individual interest, and mastery versus performance goal orientations. Although theories of motivation can help inform the design of game features that enhance learners' motivation, the establishment of design patterns for motivation that relate to all games for all learners may not yet be possible. Even though we know motivational factors that influence learning, the learning objectives of a game, the target population of players (i.e., their age, gender, educational level, etc.), and even the game's genre can interact to such an extent that much of the research must be considered to apply to a specific population of learners with a specific game. The extent to which design principles can generalize across games may be limited to games with similar learning goals, game mechanics, and learners.

Nonetheless, the research discussed in this section does suggest some general principles regarding motivation that are relevant to the design of games for learning. For example, the three questions that Eccles et al. (1998) suggested organize student motivation (i.e., "Can I do this?" "Do I want to do this, and why?" and "What do I need to do in order to succeed?") are relevant to any learning situation, including educational games. As previously discussed, well-designed games are built in ways to ensure that players know what to do and feel confident that they can succeed (which includes failing gracefully, and trying again). Considerations of *why* individuals would want to play a learning game mean taking into account many factors, including intrinsic and extrinsic motivation of the learners, specific goals of the learners, and learners' situational and individual interest. We know that even within a single class of students who are playing the same game, students will approach the educational game with different goals and motivations and that different approaches may be needed to motivate these different learners. Adding to this complexity, the design elements used to make the game motivating will contribute to learning only if the learning goals are aligned with the game mechanic. This is an example of a design challenge for games that has been addressed by other approaches as well: Taking a cognitive perspective a misalignment of goals and mechanics results in the need to process nonessential information, whereas from a motivational perspective it means the motivating elements are extrinsic to the learning goal rather than intrinsic. Constructs related to motivation often also include affective and sociocultural components, which are described in the following sections.

AFFECTIVE FOUNDATION OF GAME-BASED LEARNING

An affective perspective of game-based learning focuses players' experienced emotions, attitudes, and beliefs and considers how the design of the game environment impacts learners' affective state via affective engagement. It also considers how affect is related to, and impacts, cognitive, motivational, social, and cultural aspects of learning. This consideration of affective aspects of the learning process is one of the ways in which game designers carefully design the learning experience and is often not part of the consideration of the design of other learning environments.

Models and theories 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, 2015), highlight the inseparable relation and mutual influence of cognition and emotion during learning. Theories of affect describe how learners interacting with an environment experience core affect that they may or may not attribute to a source (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).

One way to incorporate affect in games is by taking advantage of the ability of specific game elements, such as the aesthetic design, game mechanics, narrative, or musical score, to induce emotions in players. Here, the game is designed with the goal of impacting learners' experience of emotions such as fear, anxiety, or happiness. Another, less frequently used approach is when games try to assess learners' emotions and respond to them. This is typically used to address boredom and frustration (Craig, Graesser, Sullins, & Gholson, 2004; D'Mello & Graesser, 2014).

When taking an affective perspective on game-based learning, emotional aspects of play and their impact on learner engagement are considered, whether they are facilitating or hindering learning. This means that the goal of the design of a playful learning environment is to optimize engagement and stickiness of the game, often at the expense of the cognitive load that the game induces. In fact, an argument advanced from this perspective is that playful learning may reengage some learners who have disengaged from academic learning altogether and who cannot be engaged with other methods (Griffiths, 2002; Squire, 2008). In contrast, however, some researchers have cautioned that the emotion regulation demands of some games may overwhelm learners, for example, by requiring a high level of empathy, which may hinder learning (Huang & Tettegah, 2010). However, there is evidence that emotion can positively impact learning, which has emerged from research on emotional design.

Emotional Design

Emotional design refers to the use of design features to induce emotions that are conducive to learning (Plass & Kaplan, 2015). 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 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, 2014; Graesser, D'Mello, & Strain, 2014) 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 focused so far on two methods of inducing emotion, through the representation of information and through game mechanics (Plass & Kaplan, 2015). 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. Results showed that round shapes and warm colors induced positive emotions and that these positive emotions facilitate learning and enhance comprehension and transfer test outcomes (Um et al., 2012). When decomposing this effect, it was 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).

Research on game mechanics, another method to impact learners' affect, has shown that different implementations of these mechanics can result in experience of boredom, frustration, or joy in players (Tijs, Brokken, & IJsselsteijn, 2009), though these findings have not yet been related to learning outcomes. Other research has shown that certain mechanics can generate high situational interest, and related positive emotions, that can lead to improved learning outcomes (e.g., Isbister, Schwekendiek, & Frye, 2011; Plass et al., 2012; Plass, O'Keefe, et al., 2013). Game mechanics can also impact emotions through the inclusion of affective tutors that diagnose players' emotions and respond to them, which has been shown to positively impact learning (Baker, D'Mello, Rodrigo, Graesser, 2010; D'Mello & Graesser, 2014). Although these studies investigated the relative impact of different mechanics on affect, they do not allow for the generalization of findings to other mechanics.

A number of other design elements have been linked to players' affect. For example, research on the effects of the musical score in games on players' emotions showed that music impacts affect in a highly complex and varied way (Lipscomb & Zehnder, 2004; Yamada, Fujisawa, & Komori, 2001). Body movements and gestures in video games have been found to impact players' affect, but also in complex patterns that require further research (Bianchi-Berthouze, Kim, & Patel, 2007). The inclusion of a narrative in a video game lead to increased positive arousal compared to a game without narrative (Schneider, Lang, Shin, & Bradley, 2004). Game characters with which players identify lead to positive emotions during play (Hefner, Klimmt, & Vorderer, 2007). Some studies showed that individual game events impact players' emotions. For example, events that were positive and rewarding (e.g., finding an item of value) elicited positive affect, as did some negative game events (e.g., falling off the edge of the platform; Ravaja, Saari, Salminen, Laarni, & Kallinen, 2006). However, none of these studies were conducted with games that had educational outcomes. Consequently, no performance or outcome measures were included.

Summary

An affective approach to game-based learning acknowledges the importance of players' experienced emotions, attitudes, and beliefs. This perspective also acknowledges that the design of the game environment impacts learners' affective state and investigates to what extent players' affect impacts learning outcomes. Similar to our discussion in the section relating to motivation, however, we conclude that even though we know that emotion impacts learning, it does not yet seem possible to establish affective design patterns that directly relate to learning across a broad range of games. In other words, even though research has shown the overall impact of emotion on learning, the goals and objectives of a game, characteristics of the players, and the game genre interact in complex ways in their impact on affect. Existing research either has investigated the overall emotional impact of a specific game and for a narrow range of learners or has studied the affective impact of specific game design features for specific learning objectives, making generalizations difficult.

Studies investigating the impact of design elements such as the narrative, musical score, movement and gestures, or specific game events on players' affect exist, but they often include measures with limited validity, such as self-reports of learners' experienced levels of emotion, and did not measure learning outcomes, which means they do not allow us to answer the critical question of whether affective engagement results in cognitive engagement and related cognitive learning outcomes.

Some of the limited generalizations that can be made come from research on emotional design. Emotional design is an emerging field that investigates how design features such as the visual design of information, the design of game mechanics, or the musical score impact experienced emotions and, most important, learning outcomes. Initial results have shown, for example, that warm colors and round shapes induce positive emotions that enhance learning. Research also shows that affective tutors that respond to players' emotions can enhance learning. However, it still needs to be investigated what kinds of emotions best facilitate learning in general, and what kinds of emotions learners experience over time will optimize their emotional engagement and, as a result, their cognitive engagement.

In short, this section has summarized several theoretical frameworks that researchers have been using to incorporate affective factors into the design of games and to investigate their effectiveness and shows that affective factors have an important role to play to facilitate learning in games. Affective factors cannot be separated from cognitive, motivational, social, and cultural aspects of learning, and our discussion showed their tight integration. Although it is premature to formulate affective design patterns for a broad range of games for learning, research presented in this section suggests that designers should consciously incorporate affective aspects into the design of games for learning. Future research to identify affective design patterns should take into account that affect, cognition, and motivation are related to social and cultural factors, which will be discussed next.

SOCIOCULTURAL FOUNDATION OF GAME-BASED LEARNING

When game-based learning is described from a sociocultural perspective, we acknowledge that learning is considered to be socially constructed and motivated (Bandura, 2002; Barab & Duffy, 2000; Wenger, 1998, 2000). Games can include opportunities for social engagement and provide contexts where peers and social interactions occur to enhance learning (Squire, 2006, 2011; see also Ito et al., 2008). The goal of learning designs that focus on 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 difficult to separate from the other foundational pillars just discussed, as cognitive and affective aspects of learning interact with and often function within social and cultural contexts (Turkay, Hoffman, Kinzer, Chantes, & Vicari, 2014). In fact, even designers who do not intentionally consider social or cultural issues in their design are still influenced by these factors, and their own experience and values impact their design choices even when they are not aware of it (Flanagan & Nissenbaum, 2014).

For example, Western RPGs as a group differ from Japanese RPGs in consistent ways not only because of conscious design decisions but because their designers are influenced by the Western or Japanese sociocultural factors that form their backgrounds. As Stenström and Björk (2013) pointed out, Western RPGs are often open worlds where players create their own characters, whereas Japanese RPGs rely more heavily on narration and player selection of characters. Similarly, Holbert (personal communication, November 4, 2015) noted that Western RPGs often have relatively undefined enemies, whereas Japanese RPGs have well-defined enemies, with characters and enemies that are often based on folklore and historical tales. Such elements and differences do not necessarily appear in games by conscious design but rather reflect designers' embodied backgrounds, histories, and implicit social and cultural norms. Other examples include unconscious use (or non-use) of certain colors or numbers within games, when those colors or numbers have been socially constructed within a cultural group as being lucky or unlucky. Game designers stay away from (or use) those colors or numbers not necessarily by conscious design but because this cultural knowledge is ingrained and thus becomes an automatic and unconscious part of a game's design as a consequence.

However, even though it is difficult to separate social and cultural from the other design factors discussed earlier, 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 doing so, we believe that cognitive, affective, and sociocultural features of game play interact, though any one may be either privileged or deemphasized in any particular game. A large part of the motivational value of games, and the desire to return to play (*stickiness*), lies in anticipated social interaction. This is especially true for players of MMOs, who may look forward to game play because they can interact with others and participate in group-related activities and *quests* (Steinkuehler & Duncan, 2008). Social interaction within games also influences self-perception, where feedback during group play can result in feelings of worth or negativity as a learner. Thus, identity formation is related to how one is perceived by others and how one perceives oneself. This is influenced by social interactions, which influence notions of self efficacy and learning performance.

From a social and cultural perspective, game-based 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 game-based learning thus strives to build opportunities for social and cultural factors to positively influence learning by creating meaningful, socially supported learning contexts. Although sociocultural factors can facilitate or detract from learning, they do not on their own result in learning. Design principles, therefore, deal more with providing motivational opportunities rather than specific content or strategies for instruction. Much as in real-world learning, social actions and interactions influence learning, and these can be embedded in game play. We next discuss some of the theories and approaches related to sociocultural aspects of game-based learning, following a brief overview of the various methods used to address the challenges in studying social interactions in games.

Activity Theory

Numerous studies have relied on activity theory (Nardi, 1996a, 1996b) to describe 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). Because social and cultural interactions are based around interactions with objects, designers must consider how objects within the game can facilitate interactions. An object that requires more than one person to use it, for example, would facilitate social interaction and learning more than an object that does not.

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; Leander, Phillips, & Taylor, 2010; Wohlwend & Handsfield, 2012) 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, as well as log-file data collected during game play, are allowing insights into movement within and across social groups, and how such movement and interaction affects learning.

Designs for game-based 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 and 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 they connect with through the Internet. Similarly, Ito et al. (2008) showed how teens are greatly influenced by social interactions as motivators in participatory communities. They noted the importance of interest-driven and friendship-driven participation in media-related activities, showed how interest-driven and friendship-driven participation relates to engagement, and noted 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 Jenkins, 2009; Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006; Merchant, 2010, 2012). For example, designs that provide profile information when allowing players to select individuals to form a team would maximize the possibility for both interest-driven and friendship-driven social structures.

Social Context of Learning

Social contexts facilitate learning, often by allowing players to participate in communities of practice (Barab & Duffy, 2000; Lave & Wenger, 1991; Pearce, Boellstorff, & Nardi, 2011; Wenger, 1998) that involve the beneficial effects of collaboration (Hummel et al., 2011; Sung & Hwang, 2013).[1] 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.

Although 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, although 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 user-generated content as well as 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., for *Sim City*), whereas others spring up from the players themselves (e.g., *Simtropolis*). 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 game play but also in life outside the game. For example, a community within *World of Warcraft* provided in-game events and raised funds for a member on learning of his cancer diagnosis (Newman, 2014).

Similarly, Leander and Lovvorn (2006) noted that cultural learning occurred within game play of *Star Wars Galaxies: An Empire Divided*. This study showed how a teenage player in the United States established a friendship relationship with a teen and that teen's social network in Finland, 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 1 year. Clearly, an unintended consequence of playing the game was a friendship relationship that grew out of interest (e.g., Ito et al., 2008), but the game space 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 aforementioned example reminds us that learning is related to goal-directed behavior and that agency is important in motivation and goal orientation. Bandura (2002) noted 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 MMOs. 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 game play. Collective agency is also related to distributed cognition (Hollan, Hutchins, & Kirsh, 2000) where expertise is provided within socially normed contexts to solve problems.

[1]See also Stahl, Koschmann, and Suthers (2006) for an overview history of computer-supported collaborative learning and the application of distributed expertise (Brown & Campione, 1994).

Observational Learning

In a social sense, videogames affect not only players but also observers of play. Isbister (personal communication, May 13, 2012) found 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 nonplayers. In fact, the nonplayers 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 et al., 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 become blurred and merged. Stevens, Satwicz, and McCarthy (2008) noted that *in-game, in-room*, and *in-world* have loose boundaries and influence each other. As they stated, "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 have pointed out the value of epistemic games, that is, games that put players in professional situations while they play in ways that result in learning about the norms and expectations of that profession (Bielaczyc & Kapur, 2010; Shaffer, 2006). 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 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 game's subject. We would argue that being explicit in these aspects of game-based learning designs is both important and necessary, as contextualizing learning within a given domain's expectations and norms leads to social enculturation and can additionally influence players' preparation for future learning and transfer (Bransford & Schwartz, 1999; Reese, 2007).

Shaffer, Squire, Halverson, and Gee (2005) noted, "Playing games means developing a set of effective social practices" (p. 4). They went 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, e.g., Dede, 2009; Reese, 2007), where playing a game may not result in learning while playing, but prepares the player for later learning.

Relatedness and Self Perception

Self-determination theory (Ryan & Deci, 2000a, 2000b) 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 et al., 2006). In fact, relatedness appears to link to several factors, including sense of presence, as noted by Ryan et al. (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 being important to satisfaction that promotes a sense of presence, game enjoyment, and an intention for future play.

Turkay (2013) also noted the importance of relatedness but found that players' awareness of social aspects of game play in an MMO game increased over time. That is, social aspects of game play 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 noted 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 and 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 game play 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* and *Citizen Sort* 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 game play).

The popularity of these games results in part from the motivation and engagement that is related to group play. For example, the Plass, Homer, et al. (2013) study described earlier found that competition and collaboration in an arithmetic game designed for middle school students increased their interest, enjoyment, and mastery goal orientation. 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 understanding what motivates players of such 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.

Summary

A sociocultural perspective on game-based learning acknowledges that learning is socially constructed and motivated. This perspective also acknowledges the opportunities for social engagement and contexts that games can provide when social interactions occur and investigates to what extent these interactions are able to enhance learning. In much the same way as was discussed in the sections relating to affect and motivation, however, although we know that sociocultural factors influence learning, establishing sociocultural design patterns that directly relate to learning across a broad range of games may not yet be possible. That is, although we know that sociocultural factors influence learning, the goals of a particular educational game, the targeted population of players (as related to age, gender, educational level, cultural background, etc.), and the game's genre interact to the extent that much of the research in this area is specific to a given game and generalizable game design patterns that would apply to all games cannot yet be provided. To the extent that generalizations can occur, these are limited to learning goals and game mechanics that might be similar across games.

The areas discussed in this section suggest that designs that establish social and cultural factors to influence learning can be generalized to a degree within game mechanics. For example, in MMOs with game mechanics that require group participation to meet goals, designs that seek to incorporate or maximize sociocultural aspects would not simply allow players to form groups. Rather, they would also build in requirements for individuals within groups to interact on a more personal level and share insights, knowledge, and suggestions so as to establish friendship and interest ties. Similarly, game mechanics that require communication between individuals as part of game play should provide not just a structure where communication can occur across individuals. To incorporate social and cultural aspects, communication structures would need to include design patterns that allow meaningful communication in ways that build collective knowledge and trust to meet shared goals.

Design patterns within games that include leaderboards that maximize the effect of social and cultural influences on learning would personalize leaderboards so that they become less pointed toward isolation and more toward providing information that enculturates the player/learner into an understanding that learning is a growth process. For example, leaderboards that provide only scores can suggest inferences like "I'll never be able to get to that level!" and make players feel alone. Conversely, leaderboards that provide information about leaders that show leaders' growth over time to their high score suggest "I started at the lowest level and look where I am now—you can do this too!" The second design socializes a player into a community that shows growth and success rather than showing only scores that might be perceived as unattainable and isolating an individual's performance as unique.

In short, this section has summarized several of the theoretical frameworks researchers and designers have been using to incorporate social and cultural factors into the design of games and to investigate their effectiveness, and it shows that social and cultural factors have an important role to play in facilitating learning in games. Social and cultural considerations cannot be separated from cognitive, motivational, and affective factors, and our discussion in this section showed several of these connections by pointing to theories and studies that were also mentioned in previous sections. Although generalizable design patterns for all games are not yet possible, the research and theories presented in this section suggest that incorporating sociocultural aspects to positively influence learning should be something that designers should consciously incorporate into their design of games for learning.

DISCUSSION

We believe that the most important implication of the arguments presented in this article is the need to view games as complex genres that cannot be understood by taking only one perspective of learning. In fact, as our review has shown, many of the concepts that are important in the context of games, such as motivation, have aspects relating to each of the areas we discussed, and omitting any one of them would result in an incomplete view of games and their potential for learning. Scholars, researchers, and developers who take only 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 sociocultural aspects of games that may reengage learners who would otherwise not want to learn about particular subject matters.

Likewise, when taking primarily a motivational perspective, proponents often argue that the most important benefit of games is to engage players in effortless learning by creating the right level of engagement, just between boredom and frustration (Csikszentmihalyi, 1990). Such a focus on players' motivation does not take into account cognitive aspects of learning, such as the importance of reflection during the learning process (Moreno & Mayer, 2005).

Finally, when taking a primarily sociocultural 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 ensure the appropriateness of the design of the game to meet its intended goals. Above, we have advocated for and shown how all four different perspectives should be integrated 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.

Our call is for more systematic research grounded in the foundational learning theories of the framework just described that takes into account the unique features of games and game-based learning. Given the well-developed design processes for games in general, which show that the design of games includes both systematic and artistic aspects, the goal of the research should not be to formulate prescriptions but instead to provide game design patterns—general solutions to commonly occurring problems (Alexander, Ishikawa, & Silverstein, 1977)—that can guide the design of effective game-based learning environments but that have to be localized and customized to be applicable to a specific project (Plass, Perlin, et al., 2010). The design framework outlined in Figure 2 leads to several lines of research that should be investigating how specific theories can be implemented through specific design elements, how these designs can lead to specific types of engagement in learners, and how these types of engagement facilitate learning. Results of these studies should be reported with special consideration of the specific game genre for which they were obtained. Based on our review we encourage a comprehensive focus of these studies, with the inclusion of independent and dependent variables for cognitive, affective, motivational, social, and cultural perspectives.

Some Implications

In this article we have argued that games are their own medium of learning but that this does not mean there should be a comprehensive theory of game-based learning. Most media do not have their own learning theories, and no generally accepted comprehensive theory of learning exists. Games can implement any learning theory, and we outlined some arguments of why they potentially do so better than other media. These arguments point to the unique attribute of games: Special care is taken in their design, which involves facilitating engagement on multiple levels (cognitive, affective, behavioral, and sociocultural), and placing much more emphasis on users' experience. Both of these attributes of games are possible by using the game design features described earlier. Our discussion of the psychological foundations of these game design features, which include a cognitive foundation, affective foundation, motivational foundation, and sociocultural foundation, illustrates that many existing theories can be used to inform the design of games for learning.

Often the argument is made that the motivation provided by games is their most important feature with regard to their potential for learning, but we believe that it is at least as important that games are able to facilitate the kind of learning engagement—on a cognitive, affective, and sociocultural level—that promotes learning in ways other media cannot. In fact, it can be argued that much of the reasoning of using games for learning can be reduced to the playfulness of the learning process that games afford. We may therefore consider the concept of *playful learning*, which describes learning that incorporates game elements, even though such an environment might not be considered a game. Playful learning can be defined as an activity by the learner, aimed at the construction of a mental model (a coherent representation of the information in memory), 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 incorporate gamelike elements. The most significant distinction of playful learning from games is that in playful learning, some game elements may be missing. The most significant difference to gamification is that playful learning focuses on the activity by the learner as a playful task, whereas we define gamification as adding game elements to an existing task that may be unengaging, tedious, or boring.

CONCLUSION

In this article we argued that the integrated viewpoints of cognitive, motivational, affective, and sociocultural 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 more effective than is the case at present. Such an 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 playful learning principles as part of the design, rather than as an add-on to existing structures, that is, as gamification. Viewing game-based and playful learning as a series of learner engagements on different levels (cognitive, affective, behavioral, and sociocultural), and treating game design elements as strategies to achieve this engagement based on established cognitive, affective, motivational, and sociocultural foundations as outlined in this article, can contribute to a more systematic process of conceptualizing and designing games. We hope this will result in the development of games that have the impact proponents have been suggesting for over a decade.

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