

Designing for Game-Based Learning: The Effective Integration of Technology to Support Learning

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Abstract

The use of games and game structures in educational contexts is growing in popularity. An increasing number of technologies have been developed to meet the needs of designing a course as a game. This article discussed the design process in game-based learning and reviewed the research on structuring a course with a focus on feedback, goals, and interaction. In addition, we presented the best practices and technologies to support the integration of badges and leaderboards into game-based learning. With the intentional and systematic design of game-based learning, instructors and designers will increase the impact of game attributes and elements on student achievement and motivation. Further investigation of game-based learning attributes and elements is needed to provide detailed knowledge on the compatibility with current technological tools.

Keywords

attributes, badges, best practices, elements, feedback, game-based learning, integration, interaction, leaderboards, goals, technology, tools

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Introduction

The widespread use of games in the social lives of youth has fueled educators' interests in developing and investigating game-based learning (GBL) tools (Ebner, & Holzinger, 2007; Huizenga, Admiraal, Akkerman, & Dam, 2009; Van Eck, 2006). Educators are exploring methods to integrate games and game structures into formal learning environments. However, there is very little guidance on how to design a course as a game (An & Bonk, 2009; Fang & Strobel, 2011; Kim, Park, & Baek, 2009). The purpose of this article is to systematically break down the process of designing a course as a game and to discuss technologies or tools to facilitate GBL in learning environments.

The use of games as a framework to design a curriculum gained popularity with the publication of Lee Sheldon's book, *The Multiplayer Classroom* (2012). This book describes case studies in higher education where the use of game levels, quests, guilds, and challenges are applied to traditional learning contexts. GBL can be described as "specific problem scenarios [that] are placed within a play context" (Tsai & Fan, 2013, p. 115). In contrast to the use of digital games in education, GBL requires the instructor to consider how the best practices found in games integrate within the traditional curriculum design process.

Although few studies rigorously examine designing a course as a game (Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, & Fernández-Manjón, 2008), it is a systematic process rooted in best practices in instructional design and game studies. In the design of traditional coursework, instructors are asked to consider three elements, from broad to narrow in scope (Figure 1). This backward design begins with identifying goals and learning outcomes, what evidence will meet those goals (i.e., assessment), and which instructional activities will help students achieve the goals (Wiggins & McTighe, 2005). This closely matches the best practices in conceptualizing GBL as broad attributes, more narrow game elements, and associated learning activities.

Game elements can be defined as a set of common blocks shared by games, but not necessarily critical conditions of games. In other words, not all games include all elements (Deterding, Dixon, Khaled, & Nacke, 2011). Game attributes are defined as features and characteristics inherent in its structure and are likely to initiate and maintain interest in gaming activities (Hull, Williams, & Griffiths, 2013).

When implemented together, instructional design and GBL mirror in structure, but decisions in one area lead to the iterative refinement in another. For example, a learning objective that includes skill-based teamwork may lend itself to a collaborative game framework with opportunities for social interaction or the selection of a built-in badging tool may lead to the creation of thematic assessment units. Overall, learning activities are designed to align directly with assessments, game elements, learning goals, and game attributes (Figure 1).

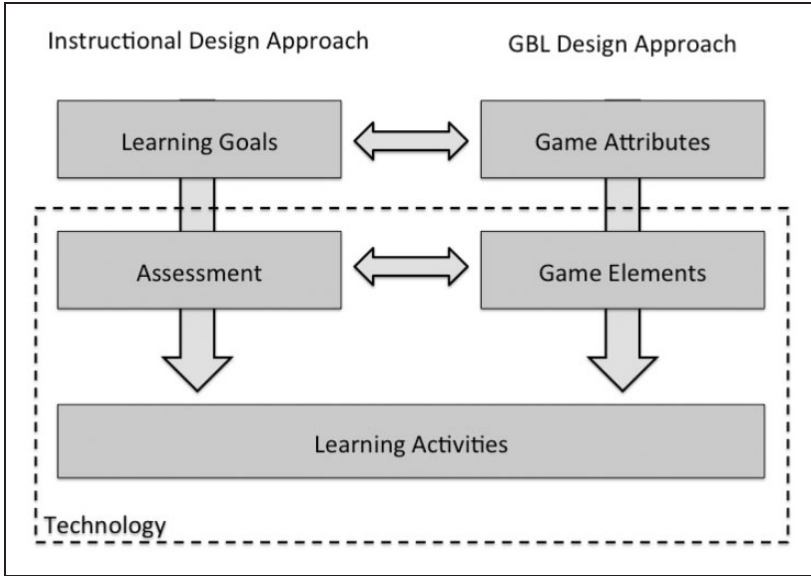


Figure 1. Game-based learning design process.

Although this framework is based on theoretical underpinnings of goals, learning standards, and research-based game structures, technology plays a role when determining how to assess, engage, and interact with content. Current technological tools provide *room* for creating authentic learning environments where content *comes to life* and eventually increases student engagement and motivation (Ertmer & Ottenbreit-Leftwich, 2013). In terms of assessment, technology enables instructors to provide relevant and meaningful feedback to students in a timely manner (Puzziferro & Shelton, 2008). Traditional classroom practices may provide such affordances, but technology provides accuracy, appeal, and access to learning for both learners and instructors.

Game Attributes

There is very little agreement on what defines a game and what game attributes are the core of all gaming experiences. For the purposes of this article, we reviewed 31 publications published between 2003 and 2014 that made attempts to define common attributes of games in education (Figure 2). Although interaction, learning, and challenge were most frequently mentioned, this article will focus on feedback, goals, and interaction for the alignment to common technology applications as well as frequent discussion as top attributes in other research articles (Liu, Cheng, & Huang, 2011).

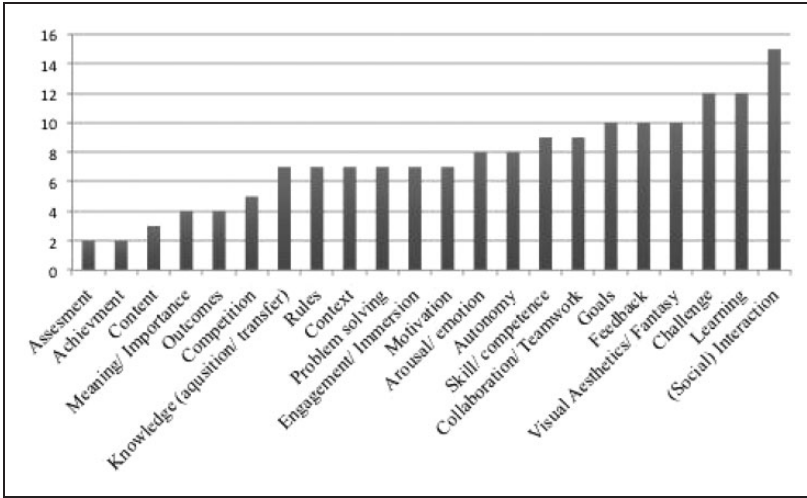


Figure 2. Frequency of game-based learning attributes addressed in 31 publications between 2003 and 2014.

Feedback

Feedback is one of the essential attributes of good instructional games (Ak, 2012; Turkay, Hoffman, Kinzer, Chantes, & Vicari, 2014; Van Eck, 2006; Wouters & Van Oostendorp, 2013). Feedback allows students to reflect on their learning strategy and initiates a loop of decision-making evaluation (Turkay et al., 2014; Van Eck, 2006). Feedback in GBL affects learning positively by allowing students to try, fail, and try again if they do not succeed, which is not common in traditional classroom-based learning (Turkay et al., 2014). Immediate feedback is also found to create positive emotions, which help in increasing students' motivation and eventually improve results (Domínguez et al., 2013). Recent research suggests that feedback provided through games should not only support reflective thinking, as recently suggested by Turkay et al. (2014), but should also aid learners in constructing knowledge by focusing on relevant information from their point of view (Kiili, 2007; Wouters & Van Oostendorp, 2013).

On the other hand, feedback that is delayed, untimely or out of context, can affect learning negatively by lowering student motivation levels (Domínguez et al., 2013), as students may misinterpret their performance level and ability (Turkay et al., 2014). Additionally, the findings of a study conducted by Ronimus, Kujala, Tolvanen, and Lyytinen (2014) suggest that lack of feedback in GBL did not help learners understand the relation between the gaming elements and the learning objectives.

Goals

Goals are also one of the main attributes that define GBL (Ak, 2012; Charsky, 2010; Erhel & Jamet, 2013; Hainey et al., 2013; Ronimus et al., 2014). Setting clear and attainable goals for activities in GBL is a significant factor in integrating games into education since it positively affects learners and instructors (Pivec, Dziabenko, & Schinnerl, 2003; Shah & Foster, 2014). It helps instructors understand reasons behind student engagement (Erhel & Jamet, 2013). Clarity of goals also increases self-efficacy and strengthens peer relationships by fostering relatedness (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014). Furthermore, it provides learners with a basis for situated learning of curricular content (Shah & Foster, 2014), opportunities to explore different aspects of the game, and control over the amount of learning taking place (Charsky, 2010). Additionally, having clear and achievable goals encourages students to explore and think both linearly and laterally (Gee, 2005).

The instructor plays an important role in utilizing goals in a manner that allows for seamless integration between GBL and education. According to Shah and Foster (2014), it is essential for instructors to be transparent with learners in terms of how learning goals can be achieved through GBL. Instructors are also required to be able to realize if there is a fit between the GBL approach and learning goals (Shah & Foster, 2014).

Goals in GBL are usually long term and are more complex than traditional classroom-based learning goals (Charsky, 2010). Erhel and Jamet discern this complexity by categorizing GBL goals, digital GBL specifically, in terms of understanding reasons behind student engagement into two categories: mastery goals and performance goals. Mastery goals are concerned with students' preferences to establish new skills, gain new knowledge, or develop new sets of abilities. Performance goals are rather concerned with exhibiting and validating "one's ability to succeed, particularly by surpassing others while expending as little effort as possible," (Erhel & Jamet, 2013, p. 157). Their study predicts that learners may achieve GBL goals efficiently if the instruction method corresponds to one of the aforementioned goal categories (Erhel & Jamet, 2013). The complexity of GBL goals provides students with the opportunity for helical thinking, which can be defined as the process of obtaining a certain amount of knowledge (Liu, Cheng, & Huang, 2011) and advancing students toward achieving their ultimate learning goals through applying this knowledge by "completing a number of different quests, setting and achieving sub-goals" (Charsky, 2010).

Interaction

Interaction is another attribute that defines GBL (Ak, 2012), and its consideration in game design is one of the features of good learning games (Ak, 2012; Gee, 2005). Social interaction enhances user experience, increases attention and

engagement (Takatalo, Hakkinen, Kaistinen, & Nyman, 2011), and makes game play complex in terms of interactivity similar to what takes place in real-time education settings (Paraskeva, Mysirlaki, & Papagianni, 2010). Additionally, social interaction in GBL provides context for the attributes previously discussed: feedback and goals (Gee, 2005). Pivec et al. (2003) suggested that social interactions in GBL elicit emotions and behaviors from learners in response to the feedback provided, which eventually helps them to cope with problems that emerge and understand the whole idea of the game.

Different forms of social interaction take place among learners: cooperative, competitive, and social. These interactions are essential for integrating GBL in educational settings and have a significant impact on learners' socialization (Domínguez et al., 2013).

Motivating Game Elements

After determining which game attributes best match learning goals, appropriate game elements can be included in the course design. Game elements are the tools and techniques that students directly experience and are influenced by the design choices selected as well as the game attributes. These include rewards, levels, badges, leaderboards, challenges, redo or do-overs, hidden items, bonus items, and surprising changes in game play. The challenge is how to integrate these techniques effectively using best practices in game design. In the following sections, we review the research behind two popular tools, badges and leaderboards, and discuss the technologies that support integration.

Badges

Badges can be defined as a symbol of student achievement while working on fulfilling learning goals (Nah, Zeng, Telaprolu, Ayyappa, & Eschenbrenner, 2014). As an example of game mechanics, badges are strongly intertwined with game dynamics. Game dynamics create a threshold for applying game mechanics such as badges.

Badges enhance decision making and engagement for learners through providing extrinsic motivation. They are also well appreciated by high-achieving learners because they provide positive reinforcement and by competitive learners as they prefer quantity to quality of rewards (Tu, Sujo-Montes, & Yen, 2015). Using badges in *gamified* environments motivates learners by creating highly engaging, skill-related, and sequential sets of learning tasks (Nah et al., 2014). According to Gibson, Ostashewski, Flintoff, Grant, and Knight (2013), badges can create a sense of competitiveness, achievement, and status when combined with leaderboards and points. As badges have mastery and performance elements instilled within, they may be used for setting focused subgoals to enhance student achievement (Dickey, 2005). Furthermore, they could be organized into

mastery and performance goal categories (Abramovich, Schunn, & Higashi, 2013), which employ the points system to quantify the criteria for receiving a badge (Figure 3).

Current technological tools provide learners with options to display their awarded badges at a privacy level of their choice, which enhances their status and feeling of autonomy and control of their learning experience (Tu et al., 2015; Gibson et al., 2013). They also provide an authentic setting for awarding group badges, which enhances the community feel in gamified learning environments by motivating learners to collaborate and complete tasks as a group (Tu et al., 2015). The process of awarding or receiving badges can be easily performed using websites, online application, and social media (Table 1). Credly, for example, is a website that allows users to create an account, develop, verify, and assign badges to learners. The website is also easily connected with social media sites such as Facebook and Twitter, which allows for customized personalization of privacy settings to consider learners' preferences.

Leaderboards

Another method of recognizing student performance is through the use of leaderboards. Used frequently in both games and sports, a leaderboard is a visual ranking of accomplishments. This public display of scores can promote competition and social interaction between players. Leaderboards provide learners with an opportunity to interact cooperatively, socially, and competitively by engaging them in a community of people with similar interests (Shi, Cristea, Hadzidedic, & Dervishalidovic, 2014). Cooperative and social interactions take place when students at the top of the leaderboard reach out to mentor or help students at the bottom of the leaderboard. Meanwhile, competitive interaction



Figure 3. Example badges in an undergraduate course using the Blackboard Learn course management system.

Table 1. Game elements and technology applications.

Game element	Affordances	Implementation	Tools
Badge	<ul style="list-style-type: none"> • Enhances decision making, engagement, and achievement • Provides positive reinforcement • Creates a sense of competitiveness and status 	<ul style="list-style-type: none"> • Include a variety of badges for points, skills, and behaviors • Make sure badges align to learning outcomes 	<ul style="list-style-type: none"> • Achievements (Blackboard Learn) • 3D Gamelab • Mozilla open badges • Edmodo
Leaderboard	<ul style="list-style-type: none"> • Promotes social interaction • Authenticates attainment of learning goals • Provides meaningful feedback 	<ul style="list-style-type: none"> • Routinely change leaderboard criteria • Make sure leaderboard criteria are meaningful to and align with learning outcomes 	<ul style="list-style-type: none"> • Gamegogy Leaderboard • 3D Gamelab

occurs when top achievers race for the highest score or achievement, and this acts as a motivation for low achievers to push themselves to have a place among the high achievers (Cummings & Ross, 2011; Shi et al., 2014). Leaderboards can also authenticate attainment of learning goals and provide learners with contextual feedback (Kuntz, Shukla, & Bensch, 2012).

Research on educational use of leaderboards shows some negative consequences for student learning and engagement. After an initial period of excitement, students may be negatively impacted by their position on the board. Those in the middle may realize they have little chance of reaching the top. In essence, the board motivates those who are already successful in the course (Nicholson, 2013). In a controlled study on the short-term impacts of a leaderboard, female students had mixed results when women dominated the leaderboard versus men (Christy & Fox, 2014). Additionally, a recent study by Hanus and Fox (2015) revealed that some game mechanics (rewards, badges, and leaderboards) may cause negative effects on students' academic performance if not used carefully and in a manner that *makes sense* for learning goals and objectives (Hanus & Fox, 2015). Few studies examine the use of leaderboards separate from other game element, making it difficult to assess overall effectiveness on course goals. In addition, the use of leaderboards in these studies discussed previously was focused on overall course scores and did not follow best practices.

Leaderboards can be engaging and effective when intentionally designed to match learning goals. For example, competency-based courses align well with social leaderboards. In this model, individuals can all be winners if they meet skill goals (Seaborn, Pennefather, & Fels, 2013). Leaderboards can also be designed to focus on small teams or the relative position of the individual (rather than ranking from the top). In traditional ranked boards, leaderboard performance goals should change periodically to encourage the belief that each student has a chance at winning. This can be achieved, for example, through ranking overall points in one month, attendance in another, and bonus or fun items in another month.

Although there are several tools to help businesses develop and maintain online leaderboards and points systems, there are few dedicated to education. The integrated 3D GameLab system developed at Boise State University is one of the integrated systems for education, with badges, leaderboards, points, levels, and challenges. For Blackboard users, the developers at Jacksonville State University created the Gamification Leaderboard module (Figure 4). This module must be integrated at the organization level and integrates with any column in the built-in Blackboard grade book.

For those using Google spreadsheets to keep track of student data, a quick Internet search provides instructions on how to set up a spreadsheet with either a pivot table or script and then allow students to see the leaderboard. There is a clear need for more leaderboard functions to be integrated into

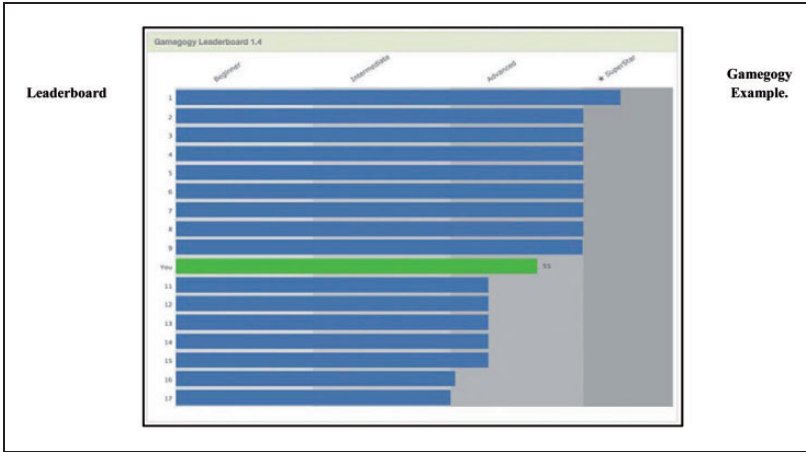


Figure 4. Gamegogy leaderboard example.

existing course management systems and stand-alone systems with multiple features.

Conclusion

Designing a course with GBL can be an effective way to engage and motivate students to achieve learning goals. By pairing the instructional design process with GBL, instructors will set the foundation of game attributes and game elements that align with learning activities. Not all courses designed with GBL have the same base structure; it is important to recognize the range of attributes that can all make an effective learning experience.

GBL is an emerging educational approach that motivates deeper understanding and research for expanding its use and potential. The elements, attributes, and technologies discussed in this article are not fully inclusive. The list for each of these factors in GBL is extensive. Therefore, further research studies are needed to focus on investigating the relationship and compatibility between GBL elements, attributes, and emerging technologies.

Declaration of Conflicting Interests

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