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Gameplay Engagement and Learning in Game-Based Learning: A Systematic Review

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In this review, we investigated game design features that promote engagement and learning in game-based learning (GBL) settings. The aim was to address the lack of empirical evidence on the impact of game design on learning outcomes, identify how the design of game-based activities may affect learning and engagement, and develop a set of general recommendations for GBL instructional design. The findings illustrate the impact of key gaming features in GBL at both cognitive and emotional levels. We also identified gaming trends and several key drivers of engagement created by the gaming features embedded within GBL, as well as external factors that may have influences on engagement and learning.

Keywords: game-based learning (GBL), gameplay, engagement, learning, motivation

Engagement affects learning and motivation (Guthrie & McCann, 1998; Smith, 2012; Swan, 2003) and has been the subject of an increasing number of studies on educational games (Bouvier, Lavoue, Sehaba, & George, 2013; Clark, Tanner-Smith, Killingsworth, & Bellamy, 2013; Connolly, Boyle, MacAuthor, Hainey, & Boyle, 2012; Markey, Leeder, & St. Jean, 2011; Prensky, 2003). This effect occurs because it was observed that games can engage players to learn (Dickey, 2005; Whitton, 2011), can include multisensory settings, and can stimulate players' ability to think and create meaning (Ermi & Mayra, 2005). The main findings to date emphasize the importance of both enjoyment and motivation to sustain players' engagement.

Many studies on games played for entertainment purposes only have investigated the attributes and causes of enjoyment, motivation, and engagement. As noted by Boyle, Connolly, Hainey, and Boyle (2012) and Connolly et al. (2012), engagement in games is related to a wide range of elements inherent in the games (e.g., design), as well as to the attributes of players. These elements and attributes include motivation to play (Koo, 2009; Lee & LaRose, 2007; Yee, 2006), players' characteristics (Sell, Lillie, & Taylor, 2008), the personalities of the players (Teng, 2008), players' genders (Chou & Tsai, 2007), players' ages (Eglesz, Fekete, Kiss,

& Izso, 2005), game type (Lee et al., 2007), and game characteristics (Lucas & Sherry, 2004).

Many studies on games played for entertainment purposes only (Jennet et al., 2008; Ravaja, Turpeinen, Saari, Puttonen, & Keltikangas-Jarvinen, 2008) suggest that gameplay is an experience that is both emotional and physical and that engagement in games can be reflected in players' emotions and thoughts. Engagement relates to how players experience a game (Ravaja et al., 2005), how they feel connected emotionally and cognitively to a game's features, and how they act within a game to achieve their goals (Csikszentmihalyi, 2008; van Reekum et al., 2004).

Despite the extensive research on gaming, few empirical studies have explored how engagement affects learning in game-based learning (GBL) environments. Many of the studies on this topic are limited to understanding the nature of engagement in games for entertainment purposes (and not those designed with learning in mind) and the outcomes; in such studies, learning outcomes are not assessed. Thus, this review investigates how engagement is characterized in games and how it can affect learning.

Research Background

Recent reports, systematic reviews, and literature reviews have considered motivation, engagement, and learning in games (All, Castellar, & Van Looy, 2013, 2014; Barnett, Cerin, & Baranowski, 2011; Bouvier et al., 2013; Boyle et al., 2012; Clark et al., 2013; Connolly et al., 2012; McClarthy et al., 2012; Perrotta, Featherstone, Aston, & Houghton, 2013; Ulicsak, 2010; Williamson, 2009). Although the topic of engagement in games is rather new (Boyle et al., 2012), studies in this area usually draw on the field of psychology. These studies have built on well-received theories, such as the concept of flow (Csikszentmihalyi, 2008), the theory of self-determination (Deci & Ryan, 1985), the theory of uses and gratifications (Schramm, Lyle, & Parker, 1961), or the model of technology acceptance (Davis, 1989). These theoretical frameworks have helped further explain the psychological aspects underlying the use of digital media (Lucas & Sherry, 2004; O'Brien & Toms, 2008; Vorderer & Bryant, 2006), including emotions in games (Boyle et al., 2012).

Evidence on the educational effectiveness of games has been unconvincing to date (Connolly et al., 2012; Young et al., 2012), which may be due to the small number of studies on comparable GBL interventions and incomplete information on the study design (All et al., 2013, 2014; Clark et al., 2013). It is agreed that conclusive results require both gaming and learning characteristics to be considered (Connolly et al., 2012; Tuzun, 2006) and require a deeper understanding of the intricate links between learning and game mechanics for engagement (Connolly et al., 2012; Perrotta et al., 2013). Hence, this review concentrates on the gaming elements that affect engagement and learning in games.

In this study, we sought to identify and illustrate the opportunities offered in games for engagement and learning. The questions that guided this review were the following: (a) What elements can provide opportunities for students to become engaged in GBL activities (b) How do these elements create engagement and thus influence learning and motivation in GBL activities?

Method

Data Collection

Electronic Databases Searched

The electronic databases searched in this review included those identified as relevant to psychology, education, gaming, technology, and social science: Academic Search Complete, the Directory of Open Access Journals, Emerald Journals, ERIC, IEEE Xplore Digital Library, ISI Web of Knowledge, JSTOR, Library, Information Science & Technology Abstracts, PsycINFO, Science Direct, and Wiley Online Library. This search was then filtered to focus on peer-reviewed journals published between 2003 and 2013. When built-in search filters were available, the search results were further filtered to include publications in the fields of psychology, education, gaming, technology, and social science and studies that included respondents who were in primary or secondary school.

Search Terms Structure

This review focused on three areas: (a) types of games, (b) games' technical features, and (c) the impacts of these games. Therefore, the search terms used included terms related to factors, relations, outcomes, and impacts of gameplay in relation to engagement and learning. First, the search terms helped find articles related to GBL, since many of the terms included the keyword "game" (e.g., educational OR learning OR serious games OR game-based learning OR GBL). Second, the term "games" also referred to a variety of games and gaming approaches, methods, and concepts designed for educational purposes (e.g., simulation OR persuasive OR pervasive OR augmented reality OR puzzle OR board OR card AND games OR gamification). Third, the term "games" also addressed different types of platform and delivery for games (e.g., video OR computer OR digital OR online OR augmented reality OR virtual reality games).

Fourth, the terms for outcomes and impacts were refined to include terms that identified publications where the impacts on instruction and motivation were considered (e.g., impacts OR effects OR outcomes OR affect AND learning OR skills OR knowledge OR instruction OR strategies AND motivation OR engagement OR behavior OR emotion OR enjoyment). Fifth, to help focus the search only on studies assessing factors or gaming aspects in relation to their impacts and outcomes, terms such as "factors," "link," and "features" were included in the search query (e.g., factor OR link OR elements OR features OR characteristics OR attributes AND challenge OR control OR curiosity). Furthermore, search terms that identified the context where the game-based activities were conducted were included (e.g., empirical OR evidence OR research OR data AND school). Where the database search structure limited the number of keywords and key terms, searches were conducted using "educational games" and "games for learning" as keywords and "engagement," "effects," and "link" as additional key terms to refine the search results.

Selection Criteria

Overall, articles were selected if they explored elements and/or factors that support GBL and provided empirical evidence of game elements or design strategies that have

an impact on learning. The exclusion criteria identified articles presented as reviews and reports, research studies conducted in preprimary and higher education settings, and studies that used approaches other than GBL. The criteria illustrated in Table 1 were used to select appropriate studies for the review.

Data Analysis

Coding of Papers

The papers meeting the inclusion criteria were coded using a data extraction standard that was developed based on previous research in this field to categorize games, engagement, and learning outcomes.

Categorization of Games

This review uses existing classification methods for games (Adams, 2010; Grace, 2005). Adams' interpretation of a game world as an artificial place where a game event occurs implies two categories for educational games: (a) game worlds that stimulate and sustain students' participation and motivation and that provide freedom of navigation (Chen, Liao, Cheng, Yeh, & Chan, 2012) and (b) game events embedded in the game world to create specific experiences (Chen et al., 2012; Liao, Chen, Cheng, & Chan, 2012). Categories and subcategories for game worlds and game events are presented in Table 2.

Game world category. The categories for game worlds were based on video game design settings, such as game genre, platform, and game technical features. The game types and genres were categorized based on Grace's (2005) descriptions. These descriptions differentiate between types and genres; however, it is worth noting that game types and game genres are constantly changing and developing, as new Internet-based games are emerging (Lee et al., 2007). Platforms were categorized based on how the game was delivered to the players; this includes the software, the hardware, and the environment. Game technical features are related to players, gameplay, and gaming approaches, strategies, methods, techniques, and platforms.

Game event category. Game events are important for setting the learning goals and objectives. Game events are concerned with how learning content, activities, and experiences are incorporated into (and blended in) a game world in a flexible but robust way (Chen et al., 2012). In this study, game learning content was classified based on learning topics (e.g., subjects). The purpose corresponded to whether the game was designed to support the acquisition of knowledge/skills or to promote motivation.

Categorization of Engagement Elements in GBL

The concept of intellectual engagement for learning can help assess GBL activities. It includes both cognitive and emotional aspects (Willms, Friesen, & Milton, 2009) and is grounded in human psychology (Boyle et al., 2012, Connolly et al., 2012; Damasio, 1994; Dolan, 2002; Prinz, 2004). The gaming elements

TABLE 1

Inclusion and exclusion criteria

	Inclusion criteria: Paper to be included if it meets the following criteria:	Exclusion criteria: Paper to be excluded if it meets the following criteria:
Study design	Includes empirical evidence from experimental studies, observational studies, or mixed-method studies	Includes evidence from nonempirical studies, such as theory building, reviews, and reports
Participants	Aged between 8 and 14 years	Ages younger than 8 or older than 14 years
Intervention	• Use of games to acquire knowledge/content understanding; to apply and enhance skills; or to promote engagement, learning, and motivation	• Use of learning tools or technologies other than game-based approaches to acquire knowledge/content understanding, to apply and enhance skills, and to promote engagement and learning
	• Games that possess both commercial properties as well as educational design and values • Commercially available games used or modified for the purpose of learning	• Games are purely for entertainment and commercialization purposes, such as violent games that have no educational value
Learning and motivational outcomes in correlation to gaming (requires at least one for inclusion)—to examine empirical evidence of games quality and/or environment on impacts and outcomes of playing games in relation to engagement and learning	Learning and motivational outcomes: • Acquisition of knowledge/content understanding • Application and enhancement of skills • Change of behavior/attitude • Emotional impact/subjective feeling Gaming qualities or conditions: • Motivating factors • Individual differences • Educational/learning features	

related to engagement assessed for this study were therefore categorized into four key elements that addressed both cognitive and emotional aspects of engagement:

TABLE 2

Game world and event dimensions

		Game world	Description	Subcategories
1.	1.1	Game type	Description of the gameplay	Puzzle, simulation, action (fighting, shooting, racing, driving, and sports), adventure, strategy, RPG, logical, and first-person shooters (FPSs)
	1.2	Game genre	Description of the narrative content of the game	Drama, mystery, crime, fantasy, horror, and science fiction
	1.3	Game platform	Medium or methods of delivery	Computer, video, online/Web-based, networked, mobile, board and card (nondigital), augmented reality, VR, second life, 2D/3D, hypertexts, console/handheld, and multi-mouse
	1.4	Game technical features	The gameplay modes, approaches, and strategies that encompass some gaming elements or a mixture of concepts, methods, techniques, and platforms	Single-/multiplayer, linear/nonlinear, synchronous, sequential, gamification, persuasive, pervasive, alternate reality game, immersive, collaborative, competitive, and context-aware learning
		Game event	**Description**	**Subcategories**
2.	2.1	Game learning content	Subject or content areas or skills	Mathematics, languages, science (biology, physics, and chemistry) social science (geography, history, and economy), general knowledge, and public awareness (health, poverty)
	2.2	Game purpose	Learning objectives	Knowledge acquisition, content understanding, skill acquisition, and motivation

(a) motivational elements (i.e., elements that influence players' thoughts, actions, and reactions regarding meaningful gameplay and learning); (b) interactive elements (i.e., elements that provide players with opportunities to participate and be involved in gaming activities); (c) fun elements (i.e., elements that provide a sense of enjoyment and excitement to the player); and (d) multimedia elements (i.e., elements that engage the player through physical and/or multisensory interaction). Engagement elements in GBL settings were categorized using this classification, in line with the literature, so as to capture key elements that create a dynamic experience and entertainment (Fullerton, 2008) and to identify game

TABLE 3

Main gaming elements and underpinning attributes that offer the possibilities of players being cognitively and emotionally engaged in gameplay

	Description	Attributes
1. *Motivational elements* (Usefulness)	Elements that influence players' thoughts, actions, and reactions regarding meaningful gameplay and learning	Objectives (e.g., race, escape, construct, explore, and solution), rules, choices, progress, boundaries, outcomes (e.g., win/lose, ranking, and reward), and adaptation
2. *Interactive elements* (Interactivity)	Elements that provide players with opportunities for participation and involvement in gaming activities	Procedures, role-play, resources (multiple objects, multiple media, and people), and conflicts (e.g., dilemmas and obstacles)
3. *Fun elements* (Playfulness)	Elements that trigger players' sense of enjoyment and excitement	Challenges (goals, feedback, and control), play, premise/fantasy, immersion, story/narration, characters, objects, and mystery
4. *Multimedia elements* (Attractiveness)	Elements that attract players' physical attention	Sensory stimuli (graphics, animation, video, text, and audio)

attributes related to learning (Bedwell, Pavlas, Heyne, Lazarra, & Salas, 2012), as shown in Table 3.

Categorization of Learning Outcomes and Experiences

Bloom's (1956) taxonomy is a well-accepted methodology for categorizing learning outcomes, especially for the design of curricula (Maher, 2004). The original taxonomy has been extended by Anderson and Krathwohl (2001) and subsequently revised (Chen et al., 2012) to include affective (rather than cognitive) learning outcomes. Hence, learning outcomes were categorized along cognitive and affective learning domains.

In addition to learning outcomes, GBL settings and methods were classified into learning experiences. This classification was informed by the work of Silver and Perini (2010), which originated from Kolb's (1984) experiential learning theory. Categories for learning experiences were also informed by other concepts, methods, and theories, including the principles of engagement (Guthrie & Cox, 2001), the phases of coherent and cohesive instructions (Swan, 2003), and the classification of outcomes (Connolly et al., 2012), as shown in Table 4. Although cognitive learning experiences are related to learning and the skills or abilities acquired by learners, affective learning experiences relate to behavioral changes and the motivational aspects as a result or a cause of learning. In summary, and as

TABLE 4

Classification of learning experiences and outcomes.

Learning phases		Description	Learning experiences	Outcomes
Cognitive learning			Cognitive activities	Learning outcomes
1. 1.1	Knowledge acquisition	Learners actively make sense of content	For example: Searching, browsing, scanning, and skimming	Information-searching skills, and content skill/knowledge acquisition
1.2	Practicing and processing	Learners explore content more deeply and master essential skills and knowledge	For example: Observing visuals (e.g., graphics, animation, and simulation) or intensive reading	Content understanding
1.3	Knowledge application	Learners apply learnt strategies or skills through activities or tasks	For example: Analyzing, synthesizing, summarizing, and inferring	Learning skills (analyzing, synthesizing, summarizing, and inferring), subject area skills, and problem-solving skills
Learning phases		Description	Learning experiences	Outcomes
Affective learning			Emotional experiences	Motivational outcomes
2. 2.1	Knowledge anticipation	Learners are "hooked" into learning by individual differences	For example: Interest, curiosity, readiness, expectation, and perception	Motivational outcomes (e.g., willingness to learn)
2.2	Reflection	Learners personalize what has been learnt and experienced and use it to regulate own learning	For example: Ideas, insights, skills, knowledge, confidence, pleasure, displeasure, and boredom	Behavior change

illustrated in Figure 1, cognition and emotions are central to engagement and learning. This model implies that emotions and thoughts both play a role in engagement and the learning process.

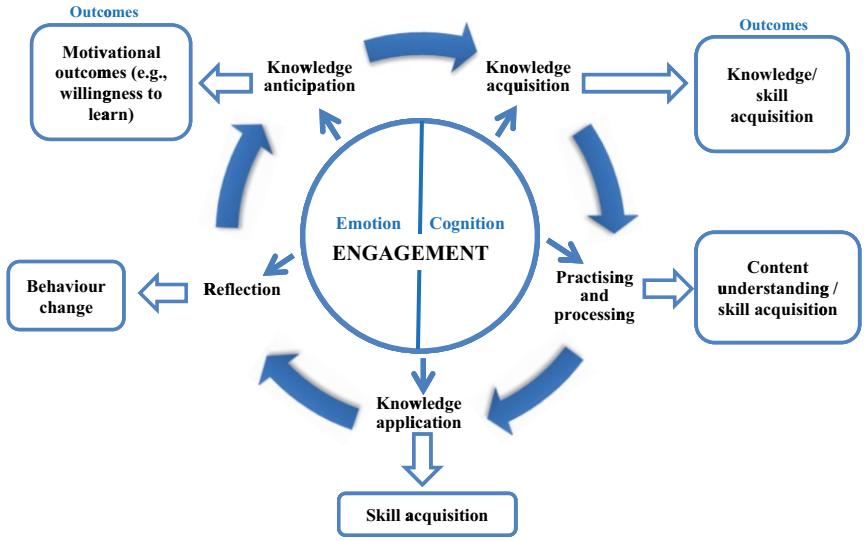

FIGURE 1. *Learning phases and outcomes in relation to engagement.*

Coding of Methods

The methodology followed for each of the papers included in this study was as follows:

1. The study design was coded as experimental, observational, or mixed-method. Each study design was further coded, as shown in Table S1 (available in the online journal).
2. Studies were coded as controlled or without control groups.
3. Data collection was coded into "collected by a single method" or "collected by using various methods and instruments."
4. Data analysis was coded based on the statistical methods used and other analysis types for pattern behavior, such as path analysis.
5. Measurement was coded as "multiple measurement," "pre- and posttest design," or "postobservation."
6. Samples were coded according to their estimated size, based on the work of Comrey and Lee (2009), who suggest ranges from very small (1–99) to very large (500 and above). This being said, it is accepted that large samples are usually better as they provide more-precise results (Diamond & Jefferies, 2009; Dytham, 2011).
7. GBL settings were coded based on whether the data was set up in a real-world environment (e.g., at school or at home) or in a laboratory (where the study could be better controlled). Although the results obtained in natural or real-life settings are more generalizable (Robson, 2002), experiments in laboratory settings help observe real behaviors and to provide a

richer understanding of the participants and the data collected (Matthews & Ross, 2010).

8. The quality of reporting was coded to assess whether the descriptive information on the study was sufficient, partly sufficient, or insufficient. Necessary details include information on the participants such as age, gender, socioeconomic background, technological exposure, and academic background. Details were also required regarding the intervention, such as the game types, game genres, the features of the games, and the contents and purposes of the games employed.

Quality of the Studies

The review included quality assessment of all papers included. Each paper was given a score ranging from 1 (i.e., the weakest form of evidence) to 5 (i.e., the strongest form of evidence) for the study design, based on a classification and design hierarchy adapted from the Centre for Reviews and Dissemination (CRD) Report 4 (cited in Deeks et al., 2003), as illustrated in Table S2 (online only). According to most design hierarchies, the randomized controlled design is the most reliable design (CRD, 2009; Crowther, Lim, & Crowther, 2010; Dreyer et al., 2010; Wells & Littell, 2009). Nonrandomized comparison group designs that use parallel cohorts (Wells & Littell, 2009) generate better-quality evidence than that produced by observational designs, such as cohort studies and case-control studies (CRD, 2009). Case studies usually rank low and are the least strong studies in evidence hierarchies (Wells & Littell, 2009). Mixed-method studies were included in the design hierarchy because they are recognized as the third major approach or study design (Johnson et al., 2007, as cited in Gray, 2009). They combine traditional views of quantitative and qualitative studies to triangulate findings (Bryman, 2008) and thus provide high-quality evidence.

The study design controls threats to the validity of the results (Bryman, 2008; Robson, 2002); therefore, the study design quality and data validity are linked. However, grading studies using a design hierarchy is inadequate for quality assessment because it does not account for the quality variations among studies with similar designs (CRD, 2009). Thus, the papers were further assessed for validity and were scored from high (5 points) to low (1 point) on each of the criteria specified in Table S2 (online only). Possible scores ranged from 5 to 30, where 5 is a low score and 30 is a high score.

Results

Articles Identified by Search Terms and Inclusion/Exclusion Criteria

Table 5 shows the number of papers in each database, as identified by the search terms. It shows quite a number of papers (3,174) investigating educational games in relation to engagement and learning. However, very few papers (91) investigated GBL for primary schools with children aged between 8 and 14 years. Table 5 shows the number of papers included and excluded in each database based on the criteria described in Table 1. The highest number of papers relevant for review was found in the Science Direct database. These included published

TABLE 5

Total number of papers identified by database and number shortlisted as relevant for review

Database searched	Number of papers identified in search	Number of papers meeting inclusion criteria	Number of papers extracted		Number of papers for review
			Not meeting inclusion criteria	Duplicates	
ERIC	12	5	7	0	5
Academic Search Complete	18	10	8	8	2
PsycINFO	20	4	16	4	0
ISI Web of Knowledge	11	2	8	1	1
Wiley Online Library	249	8	241	—	8
JSTOR	48	1	47	—	1
Emerald Journals	343	2	341	—	2
Science Direct	1,241	42	1,199	3	39
ACM Digital Library	268	11	257	7	4
IEEE Xplore Digital Library	964	29	935	—	29
Total	3,174	114	3,060	23	91

conference papers from the IEEE Xplore Digital Library, Wiley Online Library, ERIC, JSTOR, Academic Search Complete, and ISI Web of Knowledge.

Table 6 shows that among the 91 papers reviewed, 55% investigated GBL initiatives in primary education, 15.4% investigated GBL in postprimary education/junior school/middle school, 8.7% investigated GBL for both primary and postprimary students, 15.4% investigated GBL for postprimary and high school students, and only 5.5% investigated a sample that included participants from both primary schools and higher education. This result suggests that 78.1% of the papers looked at outcomes specifically for primary and postprimary education.

As described in Tables S2 and S3 (online only), each paper was ranked and given a quality score. Scores for each criterion were added, and the papers were then assessed as being of poor, fair, or high quality based on the predetermined categories. Figure 2 shows a histogram of the scores allocated to each paper. The mean rating was 15.03 and the modal rating was 15. Papers rated over 15 were considered as providing methodologically above-average-quality evidence of the impact and outcomes of GBL. The papers were classified based on three categories: poor (5–10), fair (11–15), and high (16–30). Accordingly, 34 papers (37%) were assessed as being of high quality, 47 (52%) papers were considered

TABLE 6

Number of papers and participants' educational levels and age groups

Participants' education level	Age group	No. of papers	Percentage
Primary education/elementary school	8–12	50	55
Postprimary education/middle school/junior high	13–14	14	15.4
Primary and postprimary education	8–14	8	8.7
Postprimary/middle school to high school	13–17	14	15.4
Wide range of ages from primary and postprimary (middle school/junior high) to high school and higher education	8–17 and older	5	5.5
Total		91	

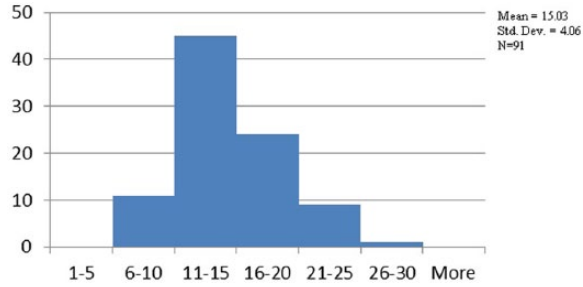

FIGURE 2. *Histogram of quality scores for included papers.*

as being of fair quality, and 10 (13%) papers were considered as being of poor quality.

Type of Study Design Used in Papers

Table S4 (online only) shows the number of papers that investigated games that aim to improve knowledge or skills or change behavior. Knowledge and skill acquisition are measured by "academic achievement, cognitive performance, knowledge gain or skills and performance, such as capacity for problem solving or critical thinking" (Perrotta et al., 2013, p. 11). Behavior change is measured by students' motivation, personal feelings about learning, and change of behavior in relation to what they have learnt (Anderson & Krathwohl, 2001).

Table S4 (online only) shows the total number of each study design that was employed in the papers selected. Most of the studies (n = 41; 45%) were experimental, with 38 papers employing quasi-experimental studies and only

three randomized controlled trials (RCTs). In total, 27 (30%) papers reported on observational studies, with 10 employing case series, 6 employing pre- and posttest case series, 5 employing case-control studies, 3 employing cohort studies, and 3 employing surveys. Moreover, 23 (25%) papers reported on mixed-method studies, among which 17 papers included participatory designs and six included mixed designs.

Table S4 (online only) shows that the highest quality papers were experimental studies. These included 23 quasi-experimental studies, 3 RCTs, and 5 observational studies (i.e., 2 cohort studies, 2 pre- and posttest case series, and 1 case-control study). Only two papers featuring mixed-method studies were assessed as high-quality papers.

GBL as a Teaching and Learning Approach

The results in Table S4 (online only) include 45 (49%) papers on games used to support skill acquisition (19 of which were of high quality) and 43 (47%) papers on games employed for knowledge acquisition (15 of high quality). Only three (4%) papers reported on games employed to support behavior change. This suggests that games are essentially employed to support the acquisition of skills or knowledge.

Although GBL seems to focus on the acquisition of skills or knowledge, the results in Table S4 (online only) indicate that most papers (49; 54%) focus on the impact of GBL at both the cognitive and affective levels and show that the design of GBL solutions is concerned with matching players' core cognitive and affective requirements. In total, 26 (29%) papers solely focus on cognitive learning outcomes; 16 (17%) papers focus solely on affective learning outcomes.

Methods of Measuring Impacts of Gameplay and Study Scale

Table S5 (online only) illustrates the methods employed to measure the impact and effectiveness of gaming on engagement and learning. The results show that most papers (36; 40%) analyze the impact of engagement and learning through the gaming platforms, either by measuring the impact of gameplay on a particular platform or by comparing the impact of gameplay between two platforms. In total, 27 (30%) papers assess technical features, 20 (22%) assess game types, four (4%) assess game genres, four (4%) compare nongame or traditional approaches to GBL, and one (1%) compares the impact of constructing and playing a game on learning and motivation.

As described in Table S3 (online only), one of the criteria for generalizability was the sample size. Table S6 (online only) shows the sample size and scale for each study, as well as the corresponding classification for each study. Table S6 shows that the majority (64; 70%) of the papers report on very-small-scale studies with fewer than 100 participants. Nine (10%) papers report on small-scale studies (i.e., between 100 and 199 participants), five (6%) report on medium-scale studies (i.e., between 200 and 299 participants), six (7%) report on large-scale studies (i.e., between 300 and 499 participants), and five (6%) report on very-large-scale studies (i.e., more than 500 participants). However, two (3%) papers do not

specify the number of participants involved, instead specifying the number of schools that participated in their studies.

Game Variables

Game Type

Table S7 (online only) identifies the papers based on the game types employed in their studies. Role-playing games (RPGs) were the most popular game type (38), followed by puzzle-based games (25), action-adventure games (6), competitive games (6), simulation-based games (6), problem-solving games (4), and strategy games (3). Three papers combined several types of games.

Table S7 (online only) also provides information on the reasons for employing specific types of games. RPGs were the most frequently employed for both skill acquisition (20) and knowledge acquisition (17), followed by puzzle-based games, among which 13 were used for knowledge acquisition and 12 for skill acquisition. Overall, 68% of the games that were employed for skills and knowledge acquisition were either puzzle games or RPGs.

Game Genre

Table S8 (online only) identifies papers based on the game genre used in their studies. Fantasy games, including fictional places and characters, was the most popular genre (29) employed in GBL. Most papers (42) do not specify the game genre. This is perhaps because classifying games into genres is often seen as a subjective practice (Pinelle, Wong, & Stach, 2008) or because the terms "game genre" and "game type" can be used interchangeably to describe the gaming narrative, gaming content, or gameplay (Grace, 2005).

Game Platform

Table S9 (online only) shows that the most popular platform for GBL is a desktop computer (42), as 46% of the game platforms for GBL were computers. Online delivery (15) was the second most popular GBL platform. In total, 13 papers report on the use of virtual reality (VR) in GBL. Three papers report on the use of network gaming, with one on a commercial social network (Facebook) and two on a local eLearning network. Handheld devices, such as mobile phones (3), PDAs (2), iPod Touches (3), consoles (1), and tablets (1), were also used for GBL delivery. Although GBL was delivered through what are often considered technically complex platforms, such as augmented reality (1), nondigital delivery platforms, such as board and card-based games (1), were still represented as significant for GBL delivery. Two papers report on studies that include a combination of two platforms; one used hypertext and 3D, while the other employed multi-mice and augmented reality for gaming.

Table S10 (online only) shows that most of the RPGs (15) and puzzle games (16) employed were computer based. In total, 49% of the RPGs and puzzle games were played on computers. Online delivery was the second most frequently used platform for RPGs (15), followed by puzzle games (3). VR was also employed for RPGs in 5 of the 13 papers, followed by simulation (2).

Game Technical Features

Table S11 (online only) shows the different gameplay modes incorporated in GBL. The most common play mode was single player (20), followed by collaborative and cooperative play (18). Eight papers report on games that provided a combination of single- and multiplayer modes. In total, 28 papers do not specify the gameplay mode, probably because it was not considered an important factor in their studies.

Table S12 (online only) shows some of the theoretical approaches used to support engagement and learning during GBL activities. The most frequent approaches used were problem-based activities, scenarios, or quests (11). Among these 11 studies, 7 used these approaches for students to acquire skills, and 4 studies did so for students to acquire knowledge. Incorporating mini-games (built with or without learning in mind) between learning tasks was the next most popular GBL approach (4), with two papers reporting on its use for skill acquisition and two reporting on its use for knowledge acquisition. Other GBL theoretical approaches included the integration of concepts (1), the use of an integrated framework (1), and the integration of concepts taught during classes into gaming activities (1) to improve knowledge. One paper reports on the integration of quizzes and learning tasks into the storyline (1) to improve skills. Other papers focus on gameplay conditions, such as interactive cards (1), used to change behavior, which involved adapting simple activities such as guessing and testing (1) and dragging and dropping (1).

Table S13 (online only) illustrates the different learning tools (e.g., worksheets, built-in journals, and posting templates) and gaming aids (e.g., physical body interaction systems and multi-mice) used for GBL activities. Among the 14 papers reporting on the use of learning tools and gaming aids, 11 specifically report on learning tools and three on gaming aids. Two papers report on games' built-in journals, and 9 address other learning tools (spatial learning tools, repertory grids, open-ended concept maps, posting templates, concept maps, multiple built-in objects, paper and pencils, and worksheets). Two papers report on physical body interaction systems, while one paper compares embodiment interactive video games and mouse click games (MCGs) as gaming aids.

Game Learning Content

This review shows that game-based approaches for primary education have been applied to a wide range of topics, including science, mathematics, and language learning, as illustrated in Table S14 (online only). Table S14 shows that science (23) was the topic most frequently explained through GBL activities, followed by mathematics (18), language learning (14), study skills (10), social studies (10), integrated subjects (e.g., math/English/science; English/Chinese characters; English and computer science), science, technology, engineering and mathematics (STEM; 4), health education (3), social skills (2), software engineering (2), speech and music (1), and sport (1). One paper reports on a study using a variety of games to explore gender preferences for multiple games for learning in general.

Table S15 (online only) shows the different types of games used for learning purposes. Puzzle-based games (4) and RPG-based games (5) were employed to

support basic English communication skills. Puzzle games (6) were frequently used to support the learning of mathematical concepts and skills, followed by RPGs (5) and problem-based games (4). RPGs were the game type most frequently employed to support the learning of general scientific concepts (6) and physics (4). Simulation-based games (4) were the second most frequently used games for general scientific concepts.

Gaming Elements for Engagement and Learning

One of the key objectives of this review was to identify the elements that influence engagement and learning in gameplay and the impact of these elements. We have explored a wide range of outcomes associated with emotional and cognitive engagement through gameplay. Table 7 shows the different categories and key features of GBL approaches, analyzed across the games. The table shows the features found in the games studied and their impact on both cognitive and emotional engagement, as well as how these translate to learning and motivation. Some articles report on multiple elements and features. Some articles report on both emotional and cognitive impacts of gameplay, and some report on both positive and negative outcomes. Thus, the number of papers and the number of reports of impacts and outcomes (as shown in brackets in the table) are not the same.

Multimedia Elements in GBL

Table 7 shows a small number of examples of how multimedia features can be used in games. This review suggests that visual elements such as graphics and animation are the most frequently used in GBL for content presentation (Tan, Goh, Ang, & Huan, 2013) and feedback (Ke & Abras, 2013; Liao, Chen, Cheng, Chen, & Chan, 2011; Lin & Chiou, 2010; Tuzun, Yılmaz-Soylu, Turkan, Inal, & Kızılkaya, 2009). Ke and Abras (2013), however, found that visual graphs seem too abstract for most students, as students may not be able to acquire math-related knowledge from them unless prompted to do so. In a high-quality paper, Rosas et al. (2003) demonstrate the capacity of visual aspects to improve attention, concentration, and self-esteem. Tan et al. (2013) found gender differences in terms of how the interface appealed to the users, finding that boys seem to want more graphics and animations than girls do. Lu, Fan, Liu, and Chuang (2010) show that audio can help in language learning, as most of the student participants recited and practiced actively, linking sounds and pictures, hence strengthening their reading.

However, video clips were not as effective because students paid little attention to videos, embedded text messages, and narratives (Admiraal, Huizenga, Akkerman, & ten Dam, 2011). Students do not seem to favor long, text-rich context (Ramirez, Almonte, Tugade, & Atienza, 2010), as this may be relatively more demanding for students with reading difficulties or those from a different language background (Ke & Abras, 2013). The mental capacity involved in using and interpreting visualization makes it challenging, especially when the content is rather crowded and hence difficult to interpret (Ke & Abras, 2013). Ke (2008a) found that students were less engaged and lost interest and determination over time as they became familiar with the game's sensory stimuli.

TABLE 7

Gaming elements and gameplay impacts and outcomes

Elements of engagement	Gameplay impact on engagement		Learning and motivational outcomes		
	Emotional engagement	Cognitive engagement	Positive	Negative	Papers
Multimedia elements: Attractive gaming features for attention to gameplay and learning					
1. Visuals	X (3)	X (2)	X (3)	X (3)	7
3. Text	X (2)	X (2)	—	X (3)	3
2. Video	X (1)	—	—	X (1)	1
4. Audio	X (1)	X (1)	X (2)	—	2
Fun elements: Playful gaming features for enjoyable gameplay and learning					
5. Virtual characters/ environments	X (12)	X (9)	X (12)	X (2)	21
6. Challenges	X (7)	X (12)	X (10)	X (4)	11
7 Control/choices	X (7)	X (2)	X (7)	X (2)	9
8 Narrative/storyline	X (7)	X (3)	X (5)	X (3)	9
Interactive elements: Gaming features for participation and involvement in gameplay and learning					
9. Role-play	X (6)	X (4)	X (7)	X (2)	13
10 Obstacles	X (1)	X (2)	X (2)	—	6
11. Quests	X (3)	X (2)	X (3)	X (1)	7
12. Problems/scenarios	—	X (1)	X (1)	—	4
13. Mini-games (educational/ noneducational)	X (1)	X (3)	X (1)	X (3)	4
Motivational elements: Supportive gaming features for meaningful gameplay and learning					
14. Scaffolding	X (13)	X (12)	X (15)	X (9)	17
15. Rewards	X (7)	—	X (6)	X (1)	14
16. Built-in learning tools	X (9)	X (7)	X (11)	X (5)	12
17. Offline help tools	—	X (2)	X (2)	—	1

Fun Elements in GBL

Virtual Characters and Environment

This review identified 21 papers (as shown in Table 7) featuring virtual characters and environments. The use of avatars as intelligent agents (Miller, Chang, Wag, Beiwr, & Klisch, 2011) within GBL involved emotional engagement from the participants and supported affective learning. The results presented in these studies show that by means of virtual characters and environments, students

became more motivated (Hess & Gunter, 2013) and wanted to play more (Liao et al., 2011; Tuzun et al., 2009); they felt immersed (Chee & Tan, 2012; Sadler, Romine, Stuart, & Merle-Johnson, 2013) and confident (Jong et al., 2008; Tan et al., 2013) and developed self-efficacy (Sadler et al., 2013) and collaboration skills (Echeverria, Amestica, et al., 2012). Avatars engaged students cognitively, as the students acquired knowledge by interacting through and with avatars (Hokanson et al., 2008; Meluso, Zheng, Spires, & Lester, 2012; Miller et al., 2011; Sadler et al., 2013). However, many players were not engaged by the explanations provided by the characters (Wrzesien & Raya, 2010), and several had difficulties moving within the virtual environment (Virvou & Katsionis, 2008).

Narratives/Storyline

Table 7 shows that nine papers address the use of narratives. Tan et al. (2013) found that narratives help students to relate to the story and the characters; narratives also help students to understand the situation depicted in the game and motivate students to explore and complete more missions. Fantasy games seem to draw students' attention (Lu et al., 2010; Ke & Abras, 2013); they also make activities less boring (Lu et al., 2010) and fully engage students (Ke & Abras, 2013). However, Echeverria, Barrios, Nussbaum, Amestica, and Leclerc (2012) found that very few students did not appreciate the game introduction part of the narratives (i.e., briefing); they also found no significant differences in terms of learning outcomes regarding whether the game was based on fantasy or not. Students had some difficulties in recognizing the storyline and therefore did not take the story seriously as part of the gameplay (Admiraal et al., 2011).

Challenges

The results illustrated in Table 7 show that the concept of challenge is the most commonly cited (and assessed) in GBL studies. When playing games that included challenges, students were more curious about the content area and developed an understanding of the topic (Tan et al., 2013); it seems that, in the presence of challenges, the students felt that although the game was difficult, it was still fun. As a result, the students were engaged (Ke, 2008a; Simkins, Egert, & Decker, 2012). When facing challenges, the students explored the environment and were less frustrated by difficult tasks (Sadler et al., 2013); their knowledge of the subject and their identification of appropriate strategies to solve specific issues also seemed to improve as a result of challenges (Rubin-Vaughan, Pepler, Brown, & Craig, 2011). In a high-quality quasi-experimental study, Rosas et al. (2003) report that in the presence of challenges, students compete with and support one another, as well as work in teams.

Ke and Abras (2013), however, observed that although students were engaged at the beginning of GBL activities, they were reluctant to continue, as they found it impossible to win the game (in this case, too much challenge acted as a deterrent rather than a motivation). Bottino, Ferlino, Ott, and Tavella's (2007) high-quality longitudinal study found that low achievers found it difficult to succeed in the game, although the level was set according to their skills. Meanwhile, higher achievers quickly became frustrated after making mistakes, and they wanted to correct their mistakes before resuming the game.

Role-Play

Table 7 shows 13 papers featuring role-play. Several papers demonstrated that role-play and immersive features are linked, and the evidence on the impact of role-play on engagement and learning is mixed. Miller et al. (2011), Barab, Pettyjohn, Gresalfi, Volk, and Solomou (2012), Lai and Wen (2012), and Zheng, Young, Wagner, and Brewer (2009) show that significant improvement in students' content knowledge, skills, and motivation can be achieved through role-play. Kebritchi, Hirumi, and Bai (2010), Ke (2008b), and Hokanson et al. (2008) only found this improvement in knowledge gain through RPGs. A number of studies suggest that role-play conveys responsibility and tasks to students and that it provides opportunities to participate in the virtual activities of the environment (Liao et al., 2011; Miller et al., 2011; Sung & Hwang, 2013).

Control and Choices

Table 7 shows nine papers addressing how players' control and choices affect GBL activities. Tablets' touchscreens and keyboards allow richer interaction opportunities compared with using a mouse on a desktop computer (Echeverria, Amestica, et al., 2012). Students generally enjoy using their mobile phones to learn and feel comfortable and confident with a game where they can manipulate objects through the phone interface (Guazzaroni, 2013). They enjoy having the ability to choose their own characters and also seem frustrated by linear games (Ke & Abras, 2013). However, Ramirez et al. (2010) argue that by giving the choice to skip instructions, limited attention is paid to in-game instructions that contain important learning content. With physical body interaction control, students' attention is enhanced; they are willing to participate, interact, and learn (Lu, Fan, Liu, & Chuang, 2010); they have high motivation and attitudes; and they gain high scores in posttests (Yang, Chen, & Chen, 2007).

Conflicts

Conflicts are rules, procedures, situations, or items designed to provide challenges (Fullerton, 2008), and they are conveyed in many ways in GBL. As shown in Table 7, the conflicts explored in the studies reviewed include obstacles (6), quests (7), scenarios or problem solving (4), and mini-games (4). Consistent with Fullerton (2008), Hou (2012) found that obstacles help provide a learning condition where students are forced to employ their skills or range of skills for mastery level. He also argues that obstacles are a better element to trigger learning than problem solving and the use of items or tools as conflicts in GBL. However, problem solving encourages the identification and application of several solutions to a particular problem and provides opportunities for students to explore and find clues for solutions, improving their problem-solving skills (Cheng & Annetta, 2012; Shih, Shih, Shih, Su, & Chuang, 2010). In a survey on mathematics-based gaming, Lowrie and Jorgensen (2011) found that girls favored explorative play, but they found no gender differences in preferences for problem solving or social modes.

Lim (2008) found that most of his participants were immersed with the quests and proceeded with the optional quests, as they would search for other websites to

gather in-depth information. The co-questing goal provides a broader context for students to experience language enrichment (Zheng et al., 2009). Ke (2008a) found that mini-games did not cognitively engage her student participants, as the students avoided deep thinking and learning, selected easy tasks, and became better gamers. However, mini-games that require the students' capacity to understand and remember the spatial relations among objects could overall improve the students' spatial abilities (Yang & Chen, 2010).

Competence-Supporting Features in GBL

Scaffolding

Table 7 shows 17 papers related to scaffolding, including feedback, hints, clues, and backtracking. In a high-quality RCT, Tzeng and Chen (2012) used praise of the students' abilities or of their efforts to support different types of gameplay for games based on addition or guessing. Both types of praises led to improved self-efficacy, but praise was more positively received by the students who played the addition game than those who played the guessing game. Tan et al. (2013) reveal that immediate feedback with animations and graphics seems to be appealing to students. Wang (2008) adapted online hints that show students how to analyze information, think more, and actively try to find other references when they find conflicting information among references.

Sun, Wang, and Chan (2011) introduced three scaffolding features (i.e., frustration control, critical features, and demonstration) integrated with commercial off-the-shelf (COTS) games to assist students with mathematics and reasoning skills. The results indicate that scaffolding decreases the necessary time completion for puzzles and decreases the frustration often caused by successive unsuccessful attempts, but students tend to rely on technology to find their mistakes and correct them (Sun et al., 2011). Wong, Boticki, Sun, and Looi (2011) introduced blended nontechnology scaffolding: teacher and social scaffolding. While teacher scaffolding supported players in dealing with obstacles or frustrations during gameplay, social scaffolding increased players' interaction and collaboration. Ke (2008a, 2013) addresses tutor scaffolding with mixed results. Ke (2008a) observed that a tutor was essential to offline support, especially for students with lower prior knowledge. Meanwhile, Ke (2013) observed ethnic and other differences among students. While Native American students were more determined to acquire knowledge without much assistance from the tutor, students at urban schools were more active in requesting assistance and content instructions from the tutor.

Rewards

Table 7 shows 14 papers related to rewards. Feedback in gameplay can also be a reward (Li, Cheng, Lou, & Tsai, 2012; Sadler et al., 2013; Tan et al., 2013). With reward systems, students are motivated to explore and complete more missions, as their enjoyment and satisfaction levels are increased (Tan et al., 2013). As observed, students like to compare their scores throughout activities (Cheng, Wu, Liao, & Chan, 2009; Ke & Abras, 2013). This shows their concerns about perceived performance (Cheng et al., 2009) and their engagement in challenging themselves to achieve higher scores (Ke & Abras, 2013). Rewards also

encouraged students to beat their classmates' scores and willingly make multiple attempts (Gillispie, Martin, & Parker, 2010). However, when students were rewarded on an unreasonable scoring basis, they played for the sake of scoring higher (Gillispie et al., 2010).

Learning Tools

Table 7 shows 13 papers related to a variety of learning tools. Two of these papers refer to built-in journals with different functions. One of the journals allowed players to reflect their ideas, and the other allowed players to review game dialogues and concepts. Tan et al. (2013) found that while a built-in journal makes it possible for students to share their knowledge, students also found that it interrupted the gameplay. By contrast, built-in journals that allow players to review game dialogues and concepts help players to review objectives and learn concepts (Gillispie et al., 2010). Jong et al. (2008) introduced a technique whereby students could post templates; they found no differences in students' attainment regardless of the posting template. Ke (2008b) found that a pen-and-pencil drill was used by the more-advanced students to solve mathematical problems; worksheets also allow for more reflection (Panoutsopoulos & Sampson, 2012).

Discussion

This review focused on identifying the complexity of gaming elements in GBL for engaging gameplay and learning experiences. The review investigated what elements provide opportunities for students to become engaged within the gameplay created in GBL and how these elements create engagement and affect learning and motivational outcomes. The discussion section includes four sections. The first part discusses the papers included for and excluded from full review; it also provides a context and background for the review and GBL research-based initiatives. The second part looks at research designs and methods in GBL studies. The third part of the discussion focuses on the use of games for learning and identifies gaming trends and general ideas about integrating gaming principles into learning instructions within GBL. Finally, the fourth part discusses the complexity of GBL by itemizing the gaming elements and features that affect engagement and learning.

Papers Included for and Excluded From Full Review

A total of 3,174 papers were identified using our search terms. This confirms that a large number of peer-reviewed papers were published between 2003 and 2013 on GBL and that games are increasingly seen as an influential educational resource. However, many of these studies did not meet our inclusion criteria. Most of the papers that were excluded focus on higher education or adult learners; this indicates that GBL initiatives for primary education were overlooked or underrepresented. As mentioned by Perrotta et al. (2013), studies on GBL usually focus on secondary school. This may be because of the fact that there is little consensus between researchers and among teachers as to how games could be used for educational purposes (Williamson, 2009) in primary education.

Our inclusion criteria identified 91 papers providing empirical evidence on the impact of GBL in relation to engagement and learning, focusing on primary

school pupils aged between 8 and 14 years. The flaws found in the papers mostly concerned insufficient details on study participants and game conditions; this could prevent the accurate assessment of the effectiveness of the interventions (Clark et al., 2013). Nonetheless, Hemingway (2009) argues that flawed studies may carry important information, as long as the flaws do not undermine the findings.

It is important to note that there may be differences in the way educational levels and age groups (e.g., primary, aged between 6 or 7 and 11 or 12 years; postprimary, aged between 12 and 13 and 14 or 15 years; and high school, aged between 15 or 16 and 17, 18 or 19 years) are categorized across countries. Meanwhile, although this review focused on GBL initiatives within primary, postprimary, or both primary and postprimary education, some considerable exceptions remain for studies that combine participants from postprimary and high school education or from a wider range of levels and ages, involving participants anywhere between primary and higher education (as shown in Table 6). This review combined all these papers to extract and analyze the gaming elements that affect engagement and learning outcomes. However, it was noted that the primary disadvantage associated with this strategy is that it could be difficult to interpret the evidence provided by these studies because the outcomes are sometimes more significant to specific levels of education (i.e., are less generalizable).

This review differs from previous reviews in several ways. Whereas Connolly et al. (2012) focused on games for learning with individuals over the age of 14, Boyle et al. (2012) focused on entertainment games, and Clark et al. (2013) focused on digital game-based learning, in contrast, the current review focused on individuals from 8 to 14 years old and educational games (both digital and non-digital) in an attempt to target papers that address engagement and interest in games for learning within primary and post primary education. Although the search revealed only a small number of papers investigating GBL in primary education, they do confirm an increased interest in studying GBL for this age group (Bottino et al., 2007; Clark et al., 2013) across Europe, Asia, North America, and South America.

Although the selected papers focus on the impacts and outcomes of gameplay on engagement and learning, consistent with other reviews (All et al., 2013, 2014; Boyle et al., 2012; Connolly et al., 2012), the papers are very diverse in terms of their scope; they address different aspects of engagement with gameplay and also reflect the different theoretical frameworks and methodologies employed. Hence, it may be difficult to assess the effectiveness of interventions for GBL studies. Nevertheless, the variation shows the interdisciplinary nature of the field, the numerous backgrounds of the researchers involved, and the researchers' wide range of interests in the field of GBL (Connolly et al., 2012).

Research Designs to Study the Impact of GBL on Engagement and Learning

Consistent with Connolly et al. (2012), there was a lack of RCTs, with only three papers using this methodology. This is because it is difficult to select appropriate conditions for a meaningful and comparable control because of the complexity of gaming systems (Perrotta et al., 2013). GBL is based on both entertainment and learning; it offers novel entertainment experiences (Boyle

et al., 2012) and uses a mode of delivery that is usually combined with other approaches (Lau, Lau, Wong, & Ransdell, 2011). Moreover, research procedures cannot always be performed with children because of complex ethical issues and requirements (Hill, 2011; Markopoulos, Read, MacFarlane, & Hoysniemi, 2008).

Where RCT evidence is lacking, nonrandomized data (Martin & Bateson, 2007), additional research (Lau et al., 2011), and other designs are included for more—informative and—appropriate studies (Boyle et al., 2012) so that independent effects can be established (Lau et al., 2011) for GBL as a teaching and learning approach. This review demonstrated that most study designs are quasi experimental, surveys being the less common approach (Connolly et al., 2012). Quasi-experimental trials were conducted to observe differences based on interventions whereby users played specific games with different characteristics and in different conditions. Similar to Boyle et al. (2012), this review determined that surveys were generally used to assess students' gaming motives and gameplay patterns in relation to engagement, learning, and motivation. Most reports focused on subjective views and self-reporting of experiences; these could be made more relevant if they were linked to quantitative data to explain and confirm the findings.

In GBL studies, observational designs are valuable to observe students' playing patterns. Observing gameplay longitudinally (Bandura, 1986, cited in Tuzun, 2006) decreases the risk of misinterpreting short-term changes in behavior. However, there were few cohort studies, with only three papers. This suggests a lack of studies following students' progress to show if the games really maintain their impacts and outcomes over time. This is important, as participants may require more-diversified sets of knowledge and skills over time. Therefore, new or more-advanced gaming mechanics may be required than were possible when the intervention was imposed at the time of the study.

Participatory design was not represented in any of the other reviews. This review showed that GBL studies usually employed participatory design to assess variables related to the effectiveness or appeal of a game in the early stages of game design; this was used to evaluate students' appreciation and use of games and employed a mixed-method design. The strength of this design is that, as testers and informants, participants are observed and asked questions for input and feedback to help detect problems with gaming features and to improve their learning experiences in the gameplay. This means that users' involvement in GBL initiatives is used to understand how children are engaged in the gameplay. However, human–computer interaction (HCI) is rarely applied to GBL research. The review revealed that participatory design, which was mostly (17) found in very-small-scale studies, as shown in Table S6 (online only), may not always result in generalizable findings. Small sample sizes are used in such research because they provide a convenient study sample. Hence, the results may have limited relevance and generalizability.

In conclusion, GBL studies have been conducted for many reasons and have employed various design principles and approaches. Although the need for different design types in GBL studies is clear, the inherent challenges, including practicality, should not be underestimated when conducting school-based research. Even the most rigorous research techniques have their limitations. Nevertheless,

the findings of the papers included in this review were encouraging and compare favorably (in their design) to other studies related to engagement, motivation, and learning.

Gaming Trends in GBL for Engagement and Learning

Role-Playing Instils a Sense of Immersion

The results demonstrate that RPGs have been highly regarded. A high-quality RCT study by Jennet et al. (2008) on immersive experiences in entertainment-based gameplay (Connolly et al., 2012) suggests that immersion is experienced when role-playing is part of the gameplay. RPGs are considered to support and improve engagement and learning, and role-play serves as a major source of immersion in GBL.

Play engages players emotionally (Ermi & Mayra, 2005; Fullerton, 2008) and is positively linked to motivational and learning outcomes (Barab et al., 2012; Liao et al., 2011; Miller et al., 2011). These effects could be situational, have a permanent effect and serve as the basis for behavior change (Krapp, Hidi, & Renninger, 2009).

Overall, role-playing provides opportunities for involving players in the gameplay regarding participating in learning activities (Fullerton, 2008; Prensky, 2001). Several studies have shown that students focus on the task when role-playing (Barab et al., 2012; Liao et al., 2011; Miller et al., 2011), interacting with multimedia elements (Ramirez et al., 2010), or interacting with gaming aids, such as multimice and physical body interaction systems (Lu et al., 2010; Yang et al., 2007).

Massively Multiplayer Online RPGs (MMORPGs) Can Offer a More Engaging Experience Thanks to Multiple Elements

This review also demonstrated that RPGs are mostly played online in GBL studies to incorporate collaborative learning and to support skill acquisition. Although studies on entertainment games have demonstrated that online games are mostly played by those with specific personality traits, motivations, and attitudes (Chang & Zhang, 2008; Jeng & Teng, 2008; Wan & Chiou, 2007), MMORPGs could offer a wide range of engaging (and possibly personalized) experiences to learners.

Overall, the findings suggest that multiple elements, such as learning resources, chat spaces, and built-in learning tools for knowledge sharing and collaboration (Jong et al., 2008; Suh, Kim, & Kim, 2010) in gameplay, all of which support and enhance learning, must be in place for MMORPGs to be effective in GBL. Although the evidence presented by Jong et al. (2008) and Suh et al. (2010) is limited to games designed for the acquisition of the English language and persuasion skills, the idea is that when specific gaming elements are incorporated into MMORPG-based environments, more meaningful gameplay and learning experiences could be provided and experienced.

However, networked games also include potential drawbacks that may negatively affect gameplay and learning (Suh et al., 2010). Despite these concerns, the studies on networked games demonstrate such games' capacity for facilitating social learning, including peer learning (J.-P. Hwang, Wu, Huang, & Huang,

2012), reflection through dialogues with teachers (Chee & Tan, 2012), and significant levels of interaction (Hung, Hwang, Lee, & Su, 2012). Guazzaroni (2013) further reveals that augmented-reality games provide opportunities for gaining effective socially constructed knowledge and for experiencing active learning, as these games provide different media in real time while providing interactions with peers, which creates new knowledge.

Competitive Play for Active GBL

Competition was identified as a gameplay element that could emotionally and cognitively engage players and could have a significant impact on learning and motivation. Table S11 (online only) shows nine papers addressing competitive play. Though M.-Y. Hwang, Hong, Cheng, Peng, and Wu (2013) found that girls have a higher cognitive load and more competition anxiety than boys do, research on genders and gameplay has shown that children of both genders enjoy competitive play and that girls are more supportive of one another in competitions (Jenson & de Castell, 2008).

Competition is one of the six established uses and gratifications for playing computer games (Lucas & Sherry, 2004). This suggests that learning could become engaging and rewarding if perceived as being competitive, as competing may have been the reason for playing in the first place. Meanwhile, as cited in Boyle et al. (2012), Klimmt et al. (2009) found that among the primary determiners of appeal for multiplayer browser games, competition was a less important motive for playing such games, while the most appealing was the socializing aspect. This could make collaborative play a better choice than competitive play for GBL.

Collaborative Play and Learning in Complex Gaming Environments

The results in Table S11 (online only) show that most games in the examined GBL studies offered both competitive and collaborative play. In total, 27 papers addressed collaborative play, with mixed results. Regardless of the collaborative features or learning conditions, self-efficacy and the acquisition of content knowledge can be achieved (Meluso et al., 2012). Regardless of the platforms employed, students can significantly increase their conceptual understanding (Echeverria, Amestica, et al., 2012). However, boys significantly outperform girls in augmented-reality applications (Echeverria, Amestica, et al., 2012). This confirms that boys do enjoy an advantage over girls in gaming activities that allow them to manipulate resources actively to achieve longer term goals (Kinzie & Joseph, 2008).

Nonetheless, Jenson and de Castell (2008) found that, regardless of gender, players' competencies underline and inform game preferences. Therefore, both genders and individual differences should be considered in GBL design (Facer, 2003; Klug & Schell, 2006), including a wide range of students' preferences, abilities, expectations, and backgrounds, for engagement and learning to occur.

Meanwhile, a study using an alternate reality game that incorporated collaborative and competitive learning revealed that although the students were motivated to play, they were not motivated to learn (Connolly, Stansfield, & Hainey, 2011). Through the complex gameplay, the students could develop cooperation,

collaboration, and teamwork skills. However, some parts of the gameplay were too complex and hard to follow for the students. These complex rules and procedures could hinder content learning, as more focus is given to understanding how to play (Bopp, 2006). However, the alternate reality game initiative implies there is a trend toward complexity in game mechanics in GBL.

Playing an Intelligent Fictional Hero in Transformational Play

Transformational play was not mentioned in any of the previous reviews. In this review, it was found that one high-quality quasi-experimental study (Barab et al., 2012) implemented the idea of transformational play within GBL. The gameplay involved strategic learners solving dilemmas, which entailed associating decisions and actions in the game with actual consequences. The findings, which compare the game-based approach and the story-based approach, further explain the positive results. They suggest that achieving a goal in the gameplay brings awareness of their roles and responsibilities because students feel they have an important role to play and thus must focus their attention on the tasks.

Puzzle-Based and Simple Gaming Mechanics for Engagement and Learning

The puzzle-based games studied were mostly designed as single-player games and came second after RPGs as the most frequently reported game type in GBL. In total, 24 (26%) papers reported on puzzle-based games, with 9 high-quality papers, including 2 high-quality RCTs. One of the major selling points of puzzle games in GBL is their clear educational relevance (Connolly et al., 2012). Most puzzle-based games do not have complex goals and compelling narratives as compared with other more sophisticated games, like RPGs, simulation games, and action-adventure games. Puzzle games have simple mechanics (Sherry & Pacheco, 2006). Drawing on Csikszentmihalyi's (2008) concept of flow (Fullerton, 2008), they are easy and engaging enough and can be played for a few minutes at a time; they are also easily learnt (Klopfer, Osterweil, & Sallen, 2009).

Key Elements and Features in GBL

VR and Multimedia Elements for Playful Learning and Discoveries

The review showed that several studies have considered the roles of avatars, virtual environments, narratives, animations, and graphics in facilitating highly entertaining and interactive learning. These features are frequently employed in GBL, mostly in RPGs and simulation-based gaming.

The findings suggest that the learning experience is considered more sensory and playful if the learning content is accessible through a selection of virtual characters, environments, narratives, and multimedia elements. These elements are integrated to facilitate attention and to promote the player's interest, which in turns triggers his/her engagement, providing opportunities to observe and browse visuals but not to read. However, these features are essential because they make it possible for students to experiment and make discoveries (Gee, 2007; Swan, 2003).

Challenges and Conflicts for Gameplay Enjoyment and Learning Motivation

The results from this review also indicate that many GBL approaches have emphasized challenges and conflicts to support and enhance students' competence (Deci & Ryan, 1985; Fowler, 2013). Studies have demonstrated that by offering challenges, gameplay can be both enjoyable and motivating, as challenges are almost inherently motivational (Allen, 2007). Conflicts such as obstacles, scenarios, and puzzles are designed within GBL environments to challenge players. These conflicts force the players to make effort by employing their skills and knowledge. Being able to overcome the conflicts gives players a sense of achievement (Fullerton, 2008).

The findings also imply that challenges may sometimes cause more frustration than enjoyment for students (Bopp, 2006; Simkins et al., 2012). The results from this review indicate that challenges could threaten engagement and learning if they do not match students' abilities (Tan et al., 2013). The results suggest several ways for challenges in GBL to offer engagement: clear goals, unambiguous feedback, and a good sense of control that meets students' knowledge levels, and skills. These methods enable students to realize the challenges they need to face, focus on the learning objectives, and experience playability, enjoyment, and attraction to the game (G.-J. Hwang, Wu, Huang, & Huang, 2012).

Control and Choices Facilitate Attention and Interests

Control provides opportunities for players to be more engaged in the activities they choose to complete (Calvert, Strong, & Gallagher, 2005; Gee, 2007). The findings of a study conducted by Echeverria, Amestica, et al. (2012) on platforms imply that (a) the amount of control is synonymous with engagement and can enhance students' emotional interests and (b) the gaming platform employed makes a difference to the amount of control available in a specific gameplay scenario.

In one study, the students who had played a game in the school labs and at home were more motivated than those who had just played it in the school labs (Kebritchi et al., 2010), probably because the latter group of students were frustrated by the controlled environment and time limits, which decreased the students' motivation (Tuzun, 2006). However, Calvert et al. (2005) note that teacher control may facilitate learning, as adults can direct children toward important tasks.

Scaffolding Helps Support Gameplay and Learning

Scaffolding is critical for competence-supporting gaming features (Peng, Lin, Preiffer, & Winn, 2012) and sustainable engaging experience in GBL. This review demonstrates that interactive support tools have been employed in many forms and under several conditions to motivate students and help them to progress through gameplay. This review showed evidence that feedback and many forms of support tools are inherent to GBL, as users are on their own and need support to achieve their goals. This is supported by Killi (2005), who argues that educational games should provide unambiguous and immediate feedback, feedback on progression toward goals, and feedback on the state of the game.

The findings imply that students need multiple support measures for motivation and learning in gameplay. A lack of support and rewards for improvement decreases students' engagement (Ke & Abras, 2013) because they expect more rewards as recognition of their efforts and achievements (Tzeng & Chen, 2012). Built-in technology scaffolding benefits students' learning (Suh et al., 2010). However, the use of scaffolding, as a tool to support students' competency, has its limitations. The support tools must be designed in such a way that leads students to employ the right knowledge and skills, in order to support and enhance their learning (Gillispie et al., 2010; Wang, 2008).

Learning Tools and Gaming Aids for Competency Support

This review included several studies that incorporated digital and nondigital learning tools to support the acquisition of knowledge and skills in gaming. Research has shown that built-in learning tools in GBL are an important element to support learning. This suggests that learning tools could be featured in games to promote learning, even simple tools such as paper-and-pencil exercises and worksheets (Ke, 2008b; Panoutsopoulos & Sampson, 2012). However, there are gaming activities that could be conducted without appropriate support, knowledge, and skills (Jong et al., 2008) or without tools that detract from engagement (Tan et al., 2013).

Conclusions

The conclusions cannot be about the ineffectiveness of GBL in supporting and extending learning because it was difficult to analyze comparable interventions and the diverse aspects of studies on GBL for effectiveness. The list below summarizes the findings of our review.

1. Most research shows that gaming provides opportunities for players to have something to gain from the gameplay.
2. GBL helps students to develop skills and knowledge and strengthens their ability to handle the learning experiences provided by the games.
3. By reviewing the gaming elements that produce enjoyment and motivation, it becomes clearer what makes students engaged and disengaged with gameplay and learning. This was demonstrated by players acting as enthusiastic, confident, and strategic learners to access and understand content and to achieve their goals, triggered and supported by multiple elements.
4. Most critically, in the GBL context, engagement is related to students' cognitive and emotional involvement in the gameplay.
5. There is a thin line between the ability, motivation, and enjoyment that encourage students to go beyond the requirements to meet extended goals.

Limitations

This review was limited by the search location within electronic databases accessible via the library system. The search was also limited to papers published in peer-reviewed journals between 2003 and 2013 to cover the most recent research. The review concentrated on empirical evidence in relation to the impact

of GBL on engagement and learning outcomes, focusing on students aged between 8 and 14 years. During the quality assessment, authors were not approached for clarification on any insufficient information due to time constraints. The categorization of the papers according to quality was determined by mean scores. However, it was noted that the use of two standard deviations could have resulted in a more objective assessment of the quality of the papers.

Recommendations

Clearly, the papers indicate there are no specific rules to gameplay experiences. The impact of gameplay, in terms of engagement and learning, depends on players' individual differences (i.e., gaming proficiency, personality, preferences, and emotional state). Thus, engagement, when it comes to learning, may be seen as a personal process. Therefore, it is crucial to consider all the elements that influence the gaming and learning experience to maximize the impact of GBL. Based on the evidence from high-quality papers, the following three recommendations were formulated.

Promoting Gameplay and Learning

Game design must be accompanied with multiple learning tools and interesting tasks and materials that facilitate and help students to explore and complete gaming and learning activities in accordance with their needs and abilities. Many of the papers (Admiraal et al., 2011; Barab et al., 2012; Hou, 2012; Hsu, Wu, & Huang, 2008; Huizenga, Admiraal, Akkerman, & ten Dam, 2009; G.-J. Hwang, Wu, & Chen, 2012; Liao et al., 2011; Meluso et al., 2012; Miller et al., 2011; Sadler et al., 2013; Sanchez & Olivares, 2011; Suh et al., 2010) illustrate that multirole-play or collaborative role-play works effectively when coupled with learning tools and interactive elements and materials (Lennon & Coombs, 2007; Liu & Chu, 2010) to motivate and help learning. When presented with such tools, students are encouraged to work collaboratively to understand the learning tools provided (Hung et al., 2012; Sung & Hwang, 2013; Virvou & Katsionis, 2008) and to meet their individual and collective goals within the game.

Motivating Gameplay and Learning

The elements in GBL must be fully incorporated into the learning activities to provide a sense of enjoyment and motivation that is rewarding for students. Gaming activities must match students' gender, game type preferences, and preferred mode of gameplay, as well as their abilities and the games' learning tasks (Clark et al., 2011). Challenges and conflicts must match students' abilities and knowledge (Bottino et al., 2007); they must provide equal opportunities for self-efficacy (Cheng et al., 2009; Tzeng & Chen, 2012), avoid causing frustration (Ke & Abras, 2013), and keep pupils focused (Rosas et al., 2003).

Supporting Gameplay and Learning

Gameplay must be supported with appropriate feedback and scaffolding; these can be provided in various forms depending on students' learning requirements (Ke, 2013; Sadler et al., 2013; Sun et al., 2011; Wang, 2008) so that the students can complete tasks and solve problems. Moreover, GBL

initiatives and research require long-term collaboration protocols involving researchers and practitioners (Reeves, 2006), with significant emphasis placed on the input of practitioners and researchers (Herrington, McKenney, Reeves, & Oliver, 2008). Considering this principle, the active contribution of the participants to the research design is important: Researchers should collaborate fully with participants to identify matters that contribute to (or decrease) engagement and should propose suitable elements to foster engagement and learning.

In conclusion, it is important to remember that these recommendations will not ensure effective GBL because of the limitations in this review. However, they may help others to learn from the outlined elements that affect engagement and learning. By understanding how these elements influence engagement and learning, we can provide better opportunities for engagement and learning within GBL environments. Therefore, we need to pay attention to the vast array of elements and relevant factors to ensure they maximize the potential for engagement in GBL environments, particularly for primary school students.

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