Review

Reconceptualizing pedagogical usability of and teachers' roles in computer game-based learning in school

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At present, methods for the optimal use of two approaches to computer game-based learning in school to enhance students' learning, namely, computer game play and game design, are obscure because past research has been devoted more to designing rather than evaluating the implementation of these approaches in school. In addition, most studies emphasize human-computer interaction; little work examines teacher-student interaction. This article aims to uncover the pedagogical usability of these approaches, in terms of the purpose, value, and alignment with school curricula, by reviewing and reconceptualizing them from the view of a wide array of scholarly work. To address these, the pedagogical functions of game play and game design are first reviewed and then reconceptualized. The findings indicate that game play is purposeful in acquiring specific knowledge or skills; game design is best for integrated and critical learning. Game play supports transited and transacted curriculum development, whereas game design promotes the transformative curriculum. Particular situations in school that apply to these two approaches, along with highlights of teachers' roles in their implementation, are also discussed.

Key words: Educational games, computer games, game play, game design.

INTRODUCTION

Computer game-based learning has been increasingly developed as a tool to motivate and promote students' learning and thinking. So far, two approaches to game-based learning have been considered: game play-based learning (GP) and game design-based learning (GD). For GP, a group of scholars (Gee, 2008; Juul, 2003; Kinzie and Joseph, 2008) have remarked that playing with digital games offers a well-rounded package of pleasurable, spontaneous, and "immersive" experiences. These experiences are also goal oriented and so could be utilized for learning with the involvement of a set of specific rules to challenge learner-players. In addition,

McFarlane et al. (2002) teased out the perspectives of students, parents, and teachers on how games could contribute to learning and found that most parents and teachers have faith that computer games add value to both entertainment and learning. However, the study also pinpoints the issue that parents and teachers are not sure of what GP's critical elements are in enhancing learning nor of its optimal usages.

Moreover, various scholars (Druin, 1999; Kafai, 1995, 2006; Lim, 2008; Prensky, 2008) propose another approach to GD by drawing on the constructionist (Papert, 1991) notion that learning is optimized by full ownership and production. Scholars (Kafai, 2006; Lim, 2008) have suggested that it is only when students are charged with the responsibility for designing their own computer games that ownership of learning will be best fulfilled by self-meaning making. It is also argued that game play

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remains instruction based (instead of constructing a product) in that students follow and complete designed tasks and that it only promotes learning of specific skills or content knowledge acquisition. However, there is still a deficit of work that guides teachers in its pedagogical implementation in the school setting.

The purpose of this paper is to discover the pedagogical usability of GP and GD, in terms of their purpose in school, their value of use, and their alignment with school curricula. To do this, the literature regarding the pedagogical functions and implementations of GP and GD will be reviewed, synthesized, and reconceptualized. This is approached in a threefold manner. First, GD and its rise from GP are introduced as it is a less familiar approach compared to GP. Second, the pedagogical functions of GP and GD are reviewed. Based on the reviews, reconceptualizing efforts are made to give rise to an understanding of their pedagogical usability. Third, teachers' roles are unpacked to guide teachers' pedagogical implementations.

GAME PLAY-BASED LEARNING (GP) AND THE RISE OF GAME DESIGN-BASED LEARNING (GD)

GP has been greatly elaborated as a vehicle for learning by adopting either educational games or entertainment games. Compared to traditional didactic instruction by rote memory, GP empowers players by active engagement situated in the games' virtual realities. Here GP is elaborated in its broadest scope, embracing various types of games such as win-loss games and non-win-loss simulation games such as SimCity. A number of specific characteristics of learning that emerged in GP are elaborated greatly by underlining their comple-mentarities to other curriculum activities. These characteristics include problem-solving skills, thinking abilities, and identity transformation (De Freitas and Oliver, 2006; Gee, 2008; Gros, 2007; Kiili, 2007). Regardless of its benefits to student learning, its usability in school implementations in terms of why, when, and how to use it are still vague. This paper will unpack and reconceptualize GP by reviewing the literature, before moving on to that; though, it is necessary first to introduce GD.

Game design by learners has been proposed by the various scholars (Druin, 1999; Kafai, 1995, 2006; Lim, 2008; Prensky, 2008) and is believed to draw on the constructionist (Papert, 1991) notion that learning is optimized by full ownership and production. Scholars have suggested that it is only when students are charged with the responsibility for designing their own computer games that ownership of learning will be best fulfilled by self-meaning making. It is further argued that GP remains instruction based (instead of constructing a product) in that students follow and complete designed tasks and that it only promotes learning of specific skills or content

knowledge acquisition (Kafai, 2006; Lim, 2008).

It is notable that GD here refers to students' involvement in designing game topics, narratives, and tasks with the assistance of a game design research team as another approach to promote student learning. In turn, it is different from simulation-based games (such as SimCity), in which the contexts have been partially fictionalized by game programmers and allow for simu-lation only by providing a wide array of choices based on histories.

Druin (2002) defined four distinct roles that youths can play in the game design process:

1. Youth-as-user,
2. Youth-as-tester,
3. Youth-as-informant, and
5. Youth-as-design-partner.

While youths-as-users allow professional game companies to improve future technologies, youths-as-testers try out the technology before the software is released for research or commercial purposes. Youths-as-informants do not have an equal stake in the design process, and their contributions to the design process are more restrained or "sporadic" (Druin, 2002, p. 21) and contribute only to selected stages of the design process such as special effects, game challenges, and characters' behaviors (for example, in the ECOi project of Scaife and Rogers, 1998). In this article, we focus on the youth-as-design-partner role to fully empower student involvement in game programming in light of constructionist notions of learning by producing.

Table 1 lists major projects with the aim of involving youths in game design. These projects have as the purpose of involving students as designers (youths-as-design-partners) to promote youths' learning. Generally, researchers can choose to use low-tech prototyping, high-tech prototyping, or a combination of these. Most design research projects (Druin, 1999; Druin et al., 1997; Robertson and Good, 2005; Scaife and Rogers, 1998) use low-tech prototyping with children so that children can express their ideas more easily through various art materials. High-tech prototyping involves game design software to write stories, such as KidPad and Neverwinter Nights, which allow the flexibility of continuity or discontinuity in the creation process. In short, no matter how GD has been greatly developed in order to enhance students' learning, its pedagogical usability to school implementations, including why, when, and how to use is still ambiguous and not consolidated yet.

PURPOSES

It has been a growing concern that the effective adoption of GP and GD in the school context is unclear because they have been elaborated without taking into account the contextual and practical constraints of the school

Table 1. Projects about youths as designers.

Projects	Aims	Extent of designing
Kafai (1995)	1. Use Logo Writer software so that older students (fourth graders) could design a game that taught younger students about fractions 2. Study student designers' thinking and learning over a longitudinal period	HI-FI prototyping Cooperative inquiry and contextual inquiry (adult as researcher)
Druin et al. (1997)	1. Describe children's "dream" KidPad environments through storytelling (via visual, verbal literacy) 2. Develop new research methodologies that include children (participatory design) 3. Develop new technologies for children	HI-FI prototyping Cooperative inquiry, where both adults and children were researchers Technology immersion Participatory design
Druin (2009)	Allow children to build fanciful animals to act out the stories that they compose	LO-FI prototyping HI-FI prototyping
Robertson and Good (2005)	During a four-day workshop, create 3-D role-playing games for secondary school youth designers	LO-FI prototyping HI-FI prototyping Cooperative inquiry
Robertson and Howells (2008)	Explore the educational benefits reaped by elementary youth designers who used game-making software in the classroom context	HI-FI prototyping

setting (Nielsen, 1994). For example, more research work is derived from designing perspectives in the lab either to critique or inform the design of the programs in terms of learnability and playability (Aarseth, 2003; Kebritchi and Hirumi, 2008; Kafai, 2006). Such work has limitations in informing school curriculum designers and teaching practitioners of proper implementations (when and how to implement) other than adoption. Although, some researchers (Ang et al., 2008; Chee et al., 2011; Squire, 2006) have collaborated with teachers in the implementation of GP and GD, such collaboration is researcher driven, with insufficient emphasis on practical constraints and pedagogical usability to teachers in school.

In addition, according to our practical experience in schools, while teachers credit GP and GD especially for improved problem solving, thinking, and cooperative learning skills, they have difficulty tying them in with curricula. They raise concerns about the lack of holistic views that could align this kind of learning to the widely scoped teaching and learning demands of current schooling.

Moreover, researchers (Lim, 2008) have indicated that a number of teachers resist using digital games in light of the generation gap between digital natives (youths) and digital immigrants (adults). Teachers are also concerned about their roles in GP and GD, namely, what kind of scaffolding they have to provide when there is already learning instruction embedded within the virtual gaming environment.

This paper is aimed at overcoming the gaps in the pedagogical implementations of GP and GD in school contexts by addressing the purpose, value, and alignment of the approaches with school curricula. The effort is made by reviewing and reconceptualizing the findings of a wide array of literature.

UNPACKING AND RECONCEPTUALIZING THE PEDAGOGICAL USABILITY OF GAME PLAY-BASED LEARNING (GP) AND GAME DESIGN-BASED LEARNING (GD)

In this section, by reviewing the literature, we unpack the pedagogical functions of GP and GD in the general context of learning design, first, by understanding the purposes of the activities, the ways to facilitate learning and the effects of the activities on students' learning outcomes of these two approaches.

After each unpacking, the pedagogical usability of the approach, catering to school implementation, is reconceptualized by addressing the approach's objective and value for school usage as well as its alignment with school curricula.

The purpose of activities

***Unpacking game play-based learning* (GP)**

This is to gain content knowledge or skills by situated learning. Whereas traditional schooling often creates decontextualized learning experiences for learners, authors (De Freitas and Oliver, 2006; Gros, 2007) have highlighted the significance of GP in providing situated learning. Unlike traditional schooling practices, the knowledge content is not acquired at the beginning of the learning process; rather Gee's (2008) situated learning matrix experience suggests that the game player first connects himself or herself to the game context by situating himself or herself in the game. Afterward, the player is presented with game objectives. To accomplish his or her objectives, the player learns the game content (knowledge and skills) embedded in the game.

***Unpacking game design-based learning* (GD)**

This is to apply and produce knowledge cross-disciplinarily. Various youth-designed game studies (Druin, 1999; Kafai, 1995; Owston et al., 2007; Robertson and Howells, 2008) have revealed that learning is both multimodal and cross-disciplinary. For example, Kafai's (1995) game design project required student-designers not only to design a fraction game but also to package and advertise the game so subjects such as language arts, mathematics, visual arts, and programming came into play. In Owston et al.'s (2007) study, youth-designers even initiated blending all their subjects into the "game shell." Furthermore, in Pelletier et al.'s (2010) study, the various semiotic tools gained from media or other cultural resources (such as museums or local conventions) were also integrated.

Reconceptualizing the objective of usage in school

Game play-based learning (GP) for learning desired knowledge or skills

GD for an integrated view of specific content knowledge. Analogously to the preceding, we reconceptualize that GP can be applied as a tutorial tool to learn any desired knowledge content or acquire problem-solving skills. In an immersive environment, learners repeatedly practice their skills in deciding on a game action and repeating the process. The desired knowledge and skills are acquired after assessing the game consequences to solve problems presented in the game context (De Freitas and Oliver, 2006; Gee, 2005; Kiili, 2007; Pivec et al., 2009). Conversely, GD can be adopted in school purposefully for integrated learning. GD requires the application of knowledge by interpretation and creation. Hence the process of learning is dialectical and recursive, revolving

around multimodal thinking and producing. Therefore we suggest that GD can be applied in assisting with integrated and multidisciplinary learning, using either IT software (for example, KidPad, Neverwinter Nights) to facilitate the sketching of narratives or a research team in collaboration with teachers.

Ways to facilitate learning

***Unpacking game play-based learning* (GP)**

Cyclical learning through the process of doing-thinking-understanding. GP is commonly understood as a cyclical process. Learners repeatedly practice their skills (from learning the game skills, deciding on a game action, and repeating the process after assessing the game consequence) to solve the problem(s) presented in the game context (De Freitas and Oliver, 2006). By repetitive doing, thinking emerges to reach a new understanding.

Another learning benefit of the cyclical process of learning in GP (Gee, 2005; Kiili, 2007; Walker and Shelton, 2008) is the promotion of problem-based learning with given tools or resources. Walker and Shelton (2008) highlighted the following four steps to characterize problem-based learning in GP:

1. There are "authentic and well-created" problems and activities present in games to steer learning;
2. Learners are "self-initiated" to study the problem and plan ways to solve it;
3. The programmed game context guides game players to source out the tools and knowledge needed to assist them in resolving the problem; and thereby
4. The targeted learning of certain content knowledge is enhanced.

Furthermore, the cyclical learning process in GP also enhances identity transformation. Pivec et al. (2009) explained how players experience multiple role-playing in gaming (such as being an architect or a scientist in the game context), which facilitates learning through identity transformation in a self-oriented world. Sharritt (2008) indicated that through dialogue, experience, images, and actions among the roles (characters) gamers play, gamers are able to experience various roles and identities leading to various possibilities with symbols and actions. In addition, Chee (2007) has also remarked that video games embody learning through the process of higher-order thinking that is transferred between current and future realities (being-becoming) while role-playing.

***Unpacking game design-based learning* (GD)**

Critical thinking process involves reinterpreting and re-creating. A number of researchers (e.g., Scaife and Rogers, 1998) who completed projects that involved youths in GD emphasized that GD requires students to

make interpretations of a phenomenon or of ways to apply knowledge from multiple views. By assuming a multiplicity of roles as experts, learners, teachers, designers, and players, Kafai (1995) remarked that the application of knowledge has expanded by integrating the acts of inquiry, illustration, and instruction. Moreover, Sanford and Madill (2007, p. 451) highlighted that critical thinking also emerges naturally in the process of producing the game narratives, with examination and possibly reconstruction of identity and power in "violence, war, inequity, racism, sexism." In other words, it energizes youths to reconstruct values and cultures. According to Sanford and Madill (2007), playing digital games does not instinctively simulate reflection or critical thinking with regard to the social values and assumptions instilled in these games, unless players are taught to identify and critique them.

In addition, the critical thinking process in GD also promotes a social-bounded orientation among teachers, students, and game programmers to reciprocate one another. With youth design of games, researchers such as Druin (1999, 2002) have pioneered collaborative approaches that attempt to treat adults and youths as equals by removing the authorial role in the learning environment. Druin (1999, 2002) called for progressive collaborative approaches by which youth-designers' activities are nondirected and exploratory, whereas adult researchers or teachers follow and support the desires of youth-designers rather than dictating their activities. In such instances, the teachers, adults, and youth researchers work hand in hand through observations and note taking toward the common goal of designing the game (Druin, 1999; Kafai, 1995).

Reconceptualizing the value of usage in school

GP is merited by the formation of identity along with learning and knowing; GD is merited by the reformation of identity along with learning and knowing. Identity has to do with knowing and being. Sharritt (2008) and Gee (2008) emphasized that the cyclical learning process (doing-thinking-understanding) embedded in GP also provides an opportunity for identity formation. Hence, in GP, the making of knowledge and identity is done through the process of expanding ways of knowing and being through role-play. Based on the social constructivist view, Sharritt (2008) and Gee (2008) remarked that learning is a self-adapted meaning-making process when a student experiences various scenarios and roles. The meaning involves the making of both knowledge and identity (Brunar, 1985; Dewey, 1998; Vygotsky, 1978). Sharritt (2008) and Gee (2008) emphasized that learning and identity formation are interrelated and are developed back and forth in the process of role-playing in the game to interpret and apply knowledge across various contexts. In other words, learning is immersed in situated players' identities in investigating and manipulating the virtual world. Eventually, identity formation and learning acquisition are formed mutually in the process of multiple role-plays.

Conversely, for GD, learning is signified at the macro level through reinterpreting and creating, which in turn lead to societal reconceptualization by the reconstruction of values, knowledge, and meanings. In this way, identity is also reformatted through triangulating the perspectives of designers and players when creating the story line and designing the task. For example, Ong and Tzuo (2010) empowered girls to reconstruct the meaning of characters' roles and power relationships (such as gender, socioeconomic status, and race) to eliminate stereotyped differences between females and males and prospect for an innovative societal landscape. The study found that girls' identities are reformatted by discovering the possibilities of female's roles when developing the story line. Such a process is merited by the postmodernist view of pedagogy that positions youths as co-constructors of society rather than as reproducers only (Dahlberg et al., 2006).

Effectiveness in student learning

Unpacking game play-based learning (GP)

This reduces test anxiety. In scholarly work exploring how GP relates to students' socio-emotional needs, findings are consistently inconclusive that it reduces students' test anxiety and enhances students' motivation or promotion of self-esteem. Studies have consistently found that the stakes for failure and test anxiety during game play are significantly reduced (O'Neil et al., 2005). With regard to motivation, a number of studies (that is, Hidi and Renninger, 2006; Pivec et al., 2009) have found that students become more engaged and motivated to learn than with instruction-based teaching, whereas others have found that teachers' teaching strategies outplay the factor of game adoption in student motivation (Chang et al., 2010). In terms of self-esteem, whereas self-esteem is positioned to be enhanced by Scoresby and Shelton (2007), Miller and Robertson (2010) found that GP enhances confidence in coping with the changing global context but is not significant for other aspects.

Unpacking game play-based learning (GP)

Here, areas of subject learning are enhanced. Various empirical studies (as indicated later in this paragraph) have explored the interplay between digital gaming and students' subject learning by means of comparison either between the contexts of game learning and non–game learning or the contexts of game and other-IT-assisted learning such as computer-facilitated e-learning. Within the game context, the studies have also compared between the behaviors of game watching and game

playing. Across the various studies, its effectiveness with regard to subject learning can be synthesized as follows:

1. There is effectiveness in the language arts by acting as a tutorial superseding teachers' instruction with drills and practice, including improved acquisition of vocabulary and enhanced quality of writing (Warren and Dondlinger, 2008; Yip and Kwan, 2006); Moreover, Gee (2008) explained that video games can provide ideal learner-centered contexts for school literacy and language learning. He remarked that learners are given ad hoc information where required or when demanded for use, instead of being overloaded with information.
2. There is assistance in spatial presentation to promote students' comprehension of geometry (Sedig, 2008).
3. There is promotion of students' (here fourth graders') computation speed and accuracy in game-simulated learning (Miller and Robertson, 2010).
4. There is assistance in social studies (such as history) through students overcoming the hindrance of fragmented learning with the affordance of immersive stories aligning events, space, and characters (Akkerman et al., 2009).
5. There is assistance in science education through the setting up of explicit contexts in which to deal with real-world problems that require students' application of scientific knowledge and thinking such as in SimCity 4 (Nilson and Anders, 2011).

On the other hand, in terms of the amount of content-based information, GP cannot reap the large amount of information that students can obtain with Web learning. Second, deHann et al. (2010) have indicated that watching video clips, versus game playing, is more effective for grasping new vocabulary and for test recall after a short while playing or watching.

Unpacking game design-based learning (GD)

This involves eliminating senses of failure. The objective of game-design projects (that is, Robertson and Good, 2005; Robertson and Howells, 2008; Scaife and Rogers, 1998) is to acknowledge youth-designers' varying potential and creativity. Even though GP (game play) can function as entertainment to reduce students' test-taking anxiety, it is still competition natured, with losses and wins. In contrast, game design (GD) can act with more equality by acknowledging each design. In other words, in game design within a context of equality, the sense of failure can be eliminated in the celebration of each student's uniqueness.

Unpacking game design-based learning (GD)

This enhances areas of subject learning. GD has been found to be useful in assisting teachers:

1. In the language arts, to enhance 21st-century literacy skills in terms of meaning production, meaning interpretation, and meaning practices when reading and writing (Myers, 2008).
2. In critical sociocultural studies (such as history or civil education), to promote the ability to analyze and interpret a present or past event using a holistic view that takes account of background and context (Mathews, 2010).
3. To enhance the understanding of the rationales and values of particular subjects, even though academic performance does not show much difference, as in the study of physics by Li (2010).
4. To motivate students from historically disadvantaged or underrepresented groups to develop new identities and become more motivated for school subject learning (Kafai, 2006; Li, 2010). For example, in Kafai's (1995) project, girls built their games against traditional stereotypes (such as that females are damsels and preferred to play fantasizing games only), crucial for critical literacy.

To sum up, GD is significant to the subjects of literacy and critical sociocultural studies by promoting students' critical thinking and analytical ability in light of equality and diversity in education. It also motivates under-represented groups and minorities. It is believed that all these qualities fall into not only constructionist learning theories that promote learning by producing (Perkins, 1992; Prensky, 2008) but also postmodernist social constructionist views that position youths as co-constructors in transforming society (Dahlberg et al., 2006).

Reconceptualizing the alignment with school curricula

GP is used to align with the transitional and transactional curriculum; GD is used to align with the transformative curriculum. Although, both GP and GD provide opportunities for subject learning, based on the preceding review, GP can be conceptualized as being implemented in the context of transitional and transactional curricula and GD in the context of transformative curricula. According to Miller (2007), there are three types of curricula: transitional, transactional, and transformative. The transitional curriculum is oriented toward passing knowledge directly to students; the transactional curriculum emphasizes the process of experiencing and thinking in designing activity; and the transformative curriculum is aimed at transforming society through students' created ideas and artifacts. As the preceding review indicates, GP is beneficial for knowledge acquisition in the areas of reading and geometry; for enhancement of skills in writing and calculating; and for promotion of comprehensive thinking skills in social

studies. Hence it fits into the school context, which is oriented toward either transitional or transactional curricula.

Conversely, GD inspires youth-designers from consumers to producers to personalize their own games and thereby produce their own worldviews and values. The diversity of youth-designers' backgrounds and interests was expressed through their game narratives and tasks (Kafai, 1995). This is perfectly aligned with the goals of transformative curricula to transform society through students' representations of knowledge and creation of ideas and artifacts.

Summary

As suggested earlier, GP and GD have different pedagogical characteristics. Hence, they are strong in their various functions of assisting teachers' teaching and the conduct of learning activities. GP provides a vehicle for cyclical learning, with its easy access to content knowledge, whereas GD provides opportunities to apply previously gained knowledge, think critically, and construct new meanings and ways of application.

In consequence, the pedagogical usability of GP and GD can be reconceptualized differently. GP is best used for tutorial training in specific content knowledge or skills. GD is best used for critical pedagogy and critical literacy by acknowledging diversity and empowering students to reconstruct meanings and motivate minorities. Even though both GP and GD can enhance the learning of subject knowledge, language arts, and development of identity, purposes in using the two differ. Thereby the different functions and usages of GP and GD in school context also become salient, as presented in Table 2 below.

PEDAGOGICAL IMPLEMENTATION: TEACHERS' ROLES

Teacher-student interactions are also crucial to the pedagogical implementation of GP and GD. However, the mainstream focus of the current research stays focused on human-computer interaction (HCI), namely, student-computer interaction. There is scant work on teacher-student interaction to guide teachers in whether they should provide scaffolding to students when students interact with computers in the context of game play and game design. If they should, in turn, it is not clear what kind of guidance they have to provide. As Hanghoj (2010, para. 1) indicated, "There still exist relatively few studies of teachers' pedagogical approaches to games, and how games require new or re-defined teacher roles that is, as a guide, playmaker or explorer." Our review here is based on a context in which teachers are nonplayers but only observe and scaffold. We use a synthesis of a few related works to gain insight into teachers' possible implementations.

Observation

In both GP and GD, agreement can be reached that teachers have to observe children's engagement and immersed learning to ensure quality learning. Pivec et al. (2009) found that once a good situated game learning environment is set, game players and designers are spurred to exert "effort" on a task for the purposes of both entertainment and learning (O'Neil et al., 2005, p. 465). Throughout the process, players experience solving a problem to progress to an advanced level (for game play) or brainstorm ideas first to develop scenes and then to process the details of characters (for game design). However, current studies are unable to direct teachers, except by highlighting that teachers have to act as researchers to observe how students engage with GP and GD and how learning becomes immersed (that is, Tuzun, 2007; Yip and Kwan, 2006).

Regardless, two models are drawn on to directly or indirectly shed light on ways to observe students' engagement and immersive learning in GP. To observe student engagement, Hidi and Renninger's (2006) four-phase model of interest development" is fitting. The players first undergo affectively inspired experiences comprising triggered situational interest (a short-term spark) and maintained situated interest. Next, players' curiosity in the game develops through emerging individual interest and lastly, a well-developed individual interest. Learning is immersed when students develop emerging individual interest in learning and acquire more related knowledge in the real world rather than remaining in the phase of situated interest in the virtual gaming world only. In view of students' immersive learning, Kirkpatrick's learning framework (four levels) has been suggested (O'Neil et al., 2005) to chart the immersive paths of learning, as follows:

1. Reaction (learner satisfaction).
2. Learning (extent of newly acquired skills and knowledge).
3. Behavior (transfer of skills and knowledge to new applications).
4. Results (learning benefits). Hence, to ensure quality GP and GD, we suggest that teachers use observation to appraise students' engagement in learning based on Hidi and Renninger's (2006) four-phase model of interest development and evaluate students' learning performance by using Kirkpatrick's learning framework.

Scaffolding

Teachers' scaffolding, or lack thereof, in GP and GD is still under debate. For GP, Gee (2008) believed that games cue feedback and explanation, which can support the game player's learning without teachers. However, others believe that the situated game context alone cannot suffice and that some form of guidance is

Table 2. Pedagogical Usability of GBL.

	Unpacking pedagogical functions	Reconceptualizing pedagogical usability
GP	*Purpose of learning:* To gain skills and knowledge by situated learning	*Objective of adoption*: Tutors to help in learning desired knowledge/skills
	Ways to facilitate learning: -Cyclical learning process of redoing with changed levels of challenges -Problem-based learning: revolves around the given task -A self-oriented meaning of identity transformation	*Value of adoption:* GP is merited by formation of identity along with learning and knowing
	Effectiveness in learning: -Reduce test anxiety in schools - Language learning - Geometric illustration -Speed and accuracy of computation -History: remove the hindrance of a fragmented study -Science education: assistance in dealing with real-world problems	*Alignment with school currciulum:* Transitional and transactional curriculum
GD	*Purpose of learning:* To create new knowledge and thinking	*Objective of adoption*: Promotes an integrated view of a specific content knowledge
	Ways to facilitate learning: -To create new knowledge and thinking -Problem-based learning: revolves around views of teachers, students, and planners -A socially bounded meaning to equalize autonomy among teachers, students, and game programmers	*Value of adoption:* GD is merited by reformation identity along with learning and knowing
	Effectiveness in learning: -Eliminate senses of failure -Critical literacy -Critical sociocultural studies -Equality: to motivate underrepresented groups -Comprehensive views of the rationale of the subject under study	*Alignment with school curriculum:* Transformative curriculum

necessary. For example, a number of scholars (that is, De Freitas and Oliver, 2006; Gros, 2007; O'Neil et al., 2005; Pivec et al., 2009) have stressed the need for educators to consciously embed the game amidst other instructional activities. They argue for the need to explicitly lead learners to reflect on the experiences of GP and its connections to their learning in other curriculum activities (such as project work or cooperative learning). Likewise, Yip and Kwan (2006) defined the teacher's role in general as facilitator (like for other curriculum activities) and researcher (to investigate types of games to adopt).

In addition, teachers' roles are analyzed both in the game-play process and in the transition between game play and other nongaming activities. When student play the game, teachers are "consultants" (whereas students are managers) in attending to students' needs (Pivec et al., 2009, p. 6). While transitioning to nongaming activities, teachers "provide metacognitive aids" to assist students in connecting contexts of learning between computer games and other school learning activities (Walker and Shelton, 2008 p. 669).

Similarly, for GD, teachers' roles are not sidelined, regardless of the support from the research team in assisting students' designs of games. The design of the games requires students' independent coordination in navigating to a certain area, collecting information, and designing tasks, documentation, and presentation. According to Tuzun (2007), being an independent task performer in the unbounded context (less bounded than GP) is a challenge for some students, requiring teachers'

facilitation. Teachers have to float around to assist students one-on-one according to students' individual needs.

For GD, although teachers' scaffolding is important, there is a scarcity of research elaborating how teachers can facilitate students' learning during GD. Therefore, the study of Masters and Yelland (2002), with a similar teaching context, is drawn on to illuminate some ideas for GD. Similarly to the learning task of GD and the use of computers, students in Masters and Yelland's study were requested to create a story with other multimedia programs embedded in a computer such as PowerPoint and drawing. To ensure quality learning, the researchers investigated teachers' scaffolding strategies and found out that there are two aspects of scaffolding for two purposes. One regards the aspect of cognition in assisting the students with concept development in the process of creating stories. The other regards the aspect of group management to ensure better group dynamics in the processes of brainstorming, discussion, and problem solving. For concept development, teachers' scaffolding strategies include the enforcement of tasks, prompting for ideas, reviewing the current stage, and prospecting the next movement with the students and narrowing the choices of ideas if students cannot decide on one in the process of brainstorming. For group management, teachers' scaffolding strategies include defining the roles among each student and guiding students' time management. We believe that purposes and strategies for teachers' scaffolding that Masters and Yelland uncovered can also be transferred to the context of GD due to its similar learning tasks involving students' use of computers.

The reflexive relationships of teachers' roles in game play-based learning (GP) and game design-based learning (GD) and non-GP/GD

Various studies suggest that not only is teachers' scaffolding crucial and apparent in GP and GD but it must also reflect scaffolding in nongaming activities. In other words, teachers' scaffolding has to be consistent in both GP/GD and non-GP/GD contexts. Chang et al. (2010) indicated that the effectiveness of GP/GD in promoting student motivation, peer interactions, and content-oriented learning is dependent on teachers' continual application of teaching strategies as in nongaming domains of learning. In their study, Chang et al. (2010) found that teachers who scaffold students to align game experiences with other subject learning can successfully motivate students to become learning oriented. Similarly, Whitemore and Laurich (2010) have indicated that teachers must also transfer the successful elements of GP to the classroom setting (such as literacy activities) to sustain the effectiveness of GP. In their study, the authors found that learning principles revealed in video game arcades, including peer collaboration and empowerment of students, have to be carried over to other aspects of literacy learning. For teacher-student interactions, it has also been found that students who used to depend more on teachers' guidance in nongaming learning require teachers' continual scaffoldding in GP (Barendregt and Bekker, 2011).

CONCLUSIONS

The significance of this article is in its manifestations of GP and GD for teachers' pedagogical usage in terms of pedagogical functions and means of implementation, which have been sidelined in game-based learning literature addressing the design of game rules and narrative motivating play (playability) and learning (learnability; Aarseth, 2003). Even though Ang et al. (2008) has started to elaborate the usability of computer games by linking them to pedagogical theories, their efforts are still much more grounded in the analysis of games and in the context of HCI.

Our article has taken a new look at game-based learning by making the following two contributions. First, the scope of game-based learning has encompassed not only constructivist but also constructionist (Papert, 1991) views on learning by multiplying students' roles as both players and designers to create their narratives and tasks, instead of embedding learning in a prewritten game context created by programmers only. Rather than debating which is better, our literature review, analysis, and practical suggestions provide teachers a way to evaluate and find optimal applications. Second, we have touched on the issues of teachers' roles in GP/GD and ways to observe and scaffold, and on their reflexivity with other non-GP/GD activities.

Future research should delve further with cross-disciplinary collaborative research among learning science researchers; curriculum developers and enactors, including teachers and students; and game design and curriculum development. Likewise, the design of computer games can be fortified for better usability in catering to different contexts and various stakeholders.

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