Transforming K-12 Classrooms with Digital Technology

Zongkai Yang
Central China Normal University, P. R. China

Harrison Hao Yang
State University of New York at Oswego, USA & Central China Normal University, P. R. China

Di Wu
Central China Normal University, P. R. China

Sanya Liu
Central China Normal University, P. R. China

A volume in the Advances in Early Childhood and K-12 Education (AECKE) Book Series

Information Science REFERENCE
An Imprint of IGI Global

Managing Director: Lindsay Johnston
Production Manager: Jennifer Yoder
Publishing Systems Analyst: Adrienne Freeland
Development Editor: Erin O'Dea
Acquisitions Editor: Kayla Wolfe
Typesetter: John Crodian
Cover Design: Jason Mull

Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

Library of Congress Cataloging-in-Publication Data

Transforming K-12 classrooms with digital technology / Zongkai Yang, Harrison Hao Yang, Di Wu, and Sanya Liu, editors.
pages cm
Includes bibliographical references and index.
ISBN 978-1-4666-4538-7 (hardcover) -- ISBN 978-1-4666-4539-4 (ebook) -- ISBN 978-1-4666-4540-0 (print & perpetual access) 1. Educational technology--United States. 2. Computer-assisted instruction--United States. 3. Educational innovations--United States. I. Yang, Zongkai.
LB1028.3.T717 2014
371.33--dc23

2013029766

This book is published in the IGI Global book series Advances in Early Childhood and K-12 Education (AECKE) (ISSN: 2329-5929; eISSN: 2329-5937)

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Chapter 5
Finding and Evaluating Great Educational Games

Elisa Gopin
Lifelong Learner, Israel

ABSTRACT

Digital games are increasingly being used as educational tools. They are intrinsically motivating for many students and offer a natural learning environment. However, not all games are equally effective in the classroom and there is thus a need for frameworks to guide teachers so that learning goals are aligned with a game's goals and to determine whether or not the game design supports effective learning. This chapter offers an analysis framework that can be used by classroom teachers to understand the different ways that games can support learning and to critique specific games to determine whether or not they meet the learning requirements. The chapter includes a checklist for teachers, as well as a feedback form for students who playtest games for use in the classroom.

GAMES AND LEARNING

Digital games are increasingly being used as educational tools (Habgood & Ainsworth, 2011). As technology becomes more sophisticated, the potential for integrating games and learning dramatically increases (Paras & Bizzocchi, 2005). However, the challenge for educational game designers is to make sure that learning dynamics are properly integrated with gameplay dynamics to create an intrinsic learning environment (Prensky, 2000). By creating intrinsically motivating experiences educators can maximize the impact of games in the classroom (Kiili, 2005).

Despite the fact that there have been many books written about game design in general, there has been much less written about designing and evaluating educational games (Habgood & Ainsworth, 2011). Few frameworks are available to

DOI: 10.4018/978-1-4666-4538-7.ch005

guide an educator who wants to use games in the classroom (Hong et al., 2009; Kiili, 2005). Only a limited amount of research can be found on the value of specific games in the K-12 environment (deFreitas, 2006). Because different types of games align with different types of learning goals, not all educational games will be equally effective for every situation (Fisch, 2005). With all these factors to consider it can be hard for a teacher interested in using games in the classroom to know where to begin.

Unfortunately, even when games are used in the classroom there are few reliable ways for educators to assess their effectiveness. A study of the use of Quest Atlantis in a science class resulted in mixed conclusions (Lim, Nonis, & Hedberg, 2006). While students seem more engaged with the game environment than the standard classroom, there was no increase in overall learning. Additionally, Schrader (2010) found that although the game Spore is designed around the concept of evolution it is more likely to reinforce misconceptions than to correct them. Therefore it is very hard for educators to properly evaluate existing games for use in the classroom, without further guidelines from researchers.

The purpose of this chapter is to outline a game analysis framework to provide important questions that teachers can ask themselves in order to evaluate both the appropriateness and the potential effectiveness of a specific game. The framework combines instructional design principles and general game design principles, and will start with an overview of the elements of the framework followed by an in-depth look at each section with support from the literature. The appendix includes a checklist that teachers can use to apply the analysis framework to a specific game, as well as a feedback form for students that is also based on the analysis framework.

Those studying educational game design can also use the information in this chapter to learn more about design by analyzing existing games. This chapter focuses on digital games, which includes games played on a computer, a dedicated game console, or a hand-held device, and refers to players, students, and learners interchangeably.

OVERVIEW OF FRAMEWORK

The analysis framework proposed in this chapter is built on three parts: Setting learning goals, identifying strategies that support motivation and make games fun, and identifying strategies that support learning.

1. Define Instructional Goals

As with any learning task, learning outcomes can vary widely depending on the game designer's goals (Warren & Najmi, 2013). Also, teachers can use games in different ways in order to achieve distinct learning goals. For example, *Angry Birds* can be used to analyze trajectories in a Physics class, or to analyze hit-to-miss ratios in a Math class. The first step should always be to identify the desired learning goals for a specific game - what skills or knowledge should players gain by playing the game? A good way to think about this is in terms of *Bloom's Revised Taxonomy*, which presents a hierarchy of skills that correlate to different levels of learning. This hierarchy consists of 6 levels:

- Remembering
- Understanding
- Applying
- Analyzing
- Evaluating
- Creating

Different games will address different levels of the taxonomy - identify which level is being targeted with the gameplay.

2. Strategies that Support Motivation in Games

- **Cognitive Curiosity ("Fun"):** The game should make the player curious to play the game and explore the game world.
- **Continual Challenge ("Balance"):** The game should increase in difficulty as a player's skills increase to maintain a steady challenge.
- **Player Control:** The game should provide feedback so the player has a sense of control over the game environment. This is done through:
  - **Rules and Procedures:** There are specific ways players can interact with the game.
  - **Goals:** The game must present clear goals and subgoals, so players don't get confused or frustrated about what is expected of them.
  - **Rewards:** Players are rewarded when they do something right, and see negative consequences when they don't. This way they see that their actions have an effect on the game world.
  - **Fantasy Context:** The game fantasy should reinforce the learning goals and stimulate the interest of the learner.

3. Strategies that Support Learning in Games

- *Active Learning:*
  - **Adaptive Play:** The game should adjust challenges in response to learner performance, and should provide leveled challenges that take into account differences in prior knowledge and experience.
  - **Intrinsic Learning:** The game should be based on the learning content as opposed to adding learning content onto an existing game. Also, a player should not be able to complete the game without mastering the learning content (i.e. by guessing).
- *Critical Thinking/Problem Solving:*
  - **Strategizing:** Players should be able to solve game challenges by attempting a solution, receiving corrective feedback from the game, and reassessing the solution. This is an iterative cycle repeated throughout the game.
  - **Experimentation:** Players can learn from mistakes through do-overs and are free to try different solutions until they get it right.
  - **Brainstorming:** Games often do not give explicit instructions for beating game challenges. Players have to look around at their in-game resources and come up with relevant ideas to move them forward through the gameplay.
- *Scaffolding:*
  - **Feedback:** The game should offer hints and support when players need help ("just in time"), and these should be available during gameplay when the player needs them ("on demand") - not presented as a big block of text at the beginning of the game.
  - **Authentic Learning:** Realistic characters with which players can relate, or a familiar game setting, to provide learners with the chance to develop skills they can apply outside the game ("transfer").
  - **Connection to Formal Education:** Game goals and content should be aligned with instructional needs, whether they were originally designed that way as in most educational games, or whether they happen to line up with stated learning goals as in many COTS games.

Ideally games should also provide opportunity for the following:

- **Access to External Support/Resources:** Players should be encouraged to extend their learning by accessing resources outside of the game, such as websites, mentors, fellow students, articles, or to visit real world locations.
- **Teacher Interaction:** There should be opportunities for the teacher to guide student learning and assess student skills. Sometimes a teacher can take on a role within the game and interact with students in-game, but even without that integration they can still monitor gameplay, which improves learning.
- **Reflective Activities:** Learners should be presented with opportunities to reflect on and absorb what they are learning. When they make a mistake they should have enough information to hypothesize about why it was a mistake, and how to fix it. These meta-cognitive activities help strengthen the learning.

ANALYSIS OF FRAMEWORK

Let us take a closer look at each element of the framework and see how it is supported in the literature.

1. Define Instructional Goals

In order to create an educational gaming experience that takes advantage of the learning that happens naturally in games, it is important to make sure the educational experience is integrated with the gaming experience (Fisch, 2005). Both the educational goals and the entertainment goals need to be balanced in order for one to reinforce the other (Kiili, 2005; Foley & Yildirim, 2011; Prensky, 2000). A teacher should therefore define the learning goals before attempting to choose a relevant game.

Games are ideal learning environments. They guide the player from a state of complete unfamiliarity with the game to a state of mastery. If a game is designed with specific learning goals and integrates content appropriately, than succeeding in the game means mastering the learning goals in the game (Fisch, 2005). However, the game should be focused on the learning goals - the knowledge may be integrated well into gameplay at certain points, but if the player only rarely encounters it in the game they won't learn much (Egenfeldt-Nielsen, 2011). For example, the *Assassin's Creed* series exposes players to elements of several historical societies but doesn't necessarily require them to master knowledge of those societies, merely to exist in them.

Similarly, many games are designed with educational content placed next to entertainment - get ten answers correct, and see a cute animation. This can be somewhat more motivating to learners in the short term than filling out worksheets; however research shows that engagement with the learning environment does not guarantee engagement with the learning content (Lim, Nonis, & Hedberg, 2006). In fact, learners are more like to remember the appealing elements (i.e. cute animation) and not the learning content. Additionally, in the long term this can turn learners off even more since they come to see the learning as something they have to suffer through in order to get to the fun stuff (Fisch, 2005). The challenge is to create an experience that utilizes the motivating aspects of games without distracting the learner. The best way to do that is to choose games that are built around the learning content itself (Habgood & Ainsworth, 2011).

2. Strategies that Support Motivation in Games

Games provide a motivating experience for learners. Dickey (2006) notes that a game's narrative

context and feedback loop promote intrinsic motivation to start playing. Also, three different levels of goals - *short term* (immediate, i.e. time the jump correctly so you don't fall into the pit), *medium term* (can last a few minutes, i.e. collect enough coins to gain an extra life), and *long term* (must complete the game to complete these goals, i.e. find all the pages of the diary to uncover the story) - motivate learners to keep playing (Dondlinger, 2007). Motivated learners generally learn more and learn better (Paras & Bizzocchi, 2005).

Lepper and Malone (1987) suggested that a game that provides an integrated relationship between the fantasy context and the learning content - "intrinsic fantasy"- will be more appealing to players. Questions in a Jeopardy game can be created from any content; the game is less appealing than an intrinsic fantasy game because there is no relationship between the game actions and what is being learned. On the other hand, learning chemical formulas while working in a virtual lab creates more intrinsically motivated gameplay. The authors identified four attributes that enhance motivation: continual challenge, cognitive curiosity, player control, and a fantasy context. While traditional instructional design focuses on motivation as a precursor to learning, maintaining intrinsic motivation throughout the learning process increases the learner's enjoyment of and curiosity towards the learning (Paras & Bizzocchi, 2005).

Games motivate learning to some degree because they're fun to play, especially for teenagers (Hong et al., 2009). However, this is not a magic bullet for education. New technologies in the classroom are generally motivating for students because they're new and exciting and students are used to having entertainment gadgets all around them (Prensky, 2000), but the "fun" factor wears off pretty quickly as soon as students realize they're still working hard. Ke (2008) studied gaming in a math class and concluded that the games where the learning was not intrinsic to the gameplay did not hold learners' interest for more than a few minutes. Students described these games as boring, and tried to get through them as fast as possible by guessing rather than figuring out the problems.

Yes, games can be "fun" but more importantly they're engaging for players. Despite being frustrating at times, players keep playing and try to overcome the challenges they face. "Fun" doesn't mean avoiding challenges, in fact, in games it usually means meeting them head on (Prensky, 2000). This is often the opposite of the behavior that is seen in classrooms, which could be important places where games can help students become more engaged with the learning content.

Flow Theory and Motivation

The motivation and engagement that games provide does not come from the novelty of using games in the classroom, rather they stem from a phenomenon called "flow" where a person is completely involved in an activity and simply enjoying the activity for its own sake (Paras & Bizzocchi, 2005). When a person is immersed in the flow state they lose a sense of passing time, have a strong feeling of control over the situation, and are intensely focused on the activity (Csikszentmihalyi, 2008). Flow in games leads to learners who become so engrossed in the learning activity that they are not aware of the challenges inherent in mastering new knowledge and skills, and are completely motivated to push their skills to the limit (Paras & Bizzocchi, 2005).

The elements that Csikszentmihalyi identifies that help induce flow line up nicely with Keller's ARCS model of motivational design (Paras & Bizzocchi, 2005). Keller identifies four components for creating motivation: gaining learners' attention (A), showing relevance of learning (R), giving learners' confidence that they can be successful (C), and reinforcing achievements to provide learner satisfaction (S) (Keller, 1987).

Similarly, implementation of the flow theory in learning focuses on providing learners with

control of the environment, which engages attention; setting concrete goals, which emphasize the relevance of the learning content; providing appropriate challenges to keep learners balanced between boredom (too easy) and frustration (too hard), which increases learner confidence; and giving clear feedback, which reinforces achievements (Paras & Bizzocchi, 2005). Research has shown that achieving the flow state during gameplay leads to an increase in learning (Kiili, 2005). Flow can be found in any activity but games are particularly structured in a way to encourage this state (Rogers, 2010).

Another factor that affects how well a game can induce flow is the game's usability - how easy it is for the player to learn to use (Kiili, 2005). Usability does not refer to how well the educational factors are integrated with the gameplay, but rather to elements of game control (i.e. the buttons, mouse clicks, etc. that allows a player to interact with the game), the layout of the game screens, how quickly a player can get to help screens, and other game design features that can either help or hinder a player's progress in the game regardless of skill level. A poorly designed interface means the player has to focus attention on learning how to play the game, rather than on the learning content itself, and this distraction reduces task flow (Krug, 2005).

3. Strategies that Support Learning in Games

Learning is integral to the gaming experience (Habgood & Ainsworth, 2011). A good game has to teach a player how to play the game, or the player will give up very quickly. A well-designed game will slowly introduce players to challenges, so they learn how to play the game by simply playing the game (Rogers, 2010). Challenges can gradually increase as players master easier challenges so players never feel they are working hard to learn, although they may in fact be working very hard (Prensky, 2000; Paras & Bizzocchi, 2005).

Games support learning in the following 3 main ways:

Active Learning: Learning is a process that is developed by the learner through active engagement with the content and with the context in which it is found (Warren & Najmi, 2013). Games are active experiences that provide a safe space for players to explore and experiment without serious consequences (Dickey, 2006; Paras & Bizzocchi, 2005). Through gameplay learners are actively engaged in the subject matter, situated in a specific context that reflects how it can be used in real life. This increases learning transfer as well (Warren & Najmi, 2013), which is one of the main goals of education.

Unlike other forms of media, games are highly interactive and allow the learner to feel that they are directly experiencing the game environment and working directly on the task at hand (Paras & Bizzocchi, 2005). The narrative of an adventure game creates an environment in which players gain practical skills, which can then be applied to the real world (Dickey, 2006). Games are also adaptive - they can increase challenges as players improve their skills or provide extra practice if a player is struggling. Games are based on the principle of mastery learning, which means learners have to master lower level skills before being allowed to progress to harder challenges (Gee, 2005).

Critical Thinking/Problem Solving: Games are natural problem solving environments (Gee, 2005; Dickey, 2006; Garris, Ahlers, & Driskell, 2002). Players must synthesize the information they gather through gameplay and analyze strategies for beating the game. Narrative structure is often used in daily problem solving, and narrative in adventure games provides a cognitive framework to encourage problem solving (Dickey, 2006). Ideally, games present engaging environments where solutions to game challenges require integration of skills and strategies as well as complex negotiations of relationships between real and simulated characters (Amory, 2007).

Games encourage problem solving through an iterative cycle of attempting a task, receiving feedback from the game, reflection on the outcome and reassessment of the strategy, and another attempt at the task which triggers another cycle of feedback-reflection-gameplay (Garris, Ahlers, & Driskell, 2002). Although a game may begin with trial and error, through in-game feedback - such as dying, losing coins, gaining a new life, or passing a level - a player develops an understanding of the system dynamics involved in the game and is able to create strategies that lead to success.

Games can provide a rich learning environment that encourages higher level thinking through ambiguous situations (Wu et al., 2012). Games are a form of problem based learning - players confront a question ("Can you figure out the dragon's movement pattern and raise the drawbridge safely?"), make a hypothesis ("If I jump after the third time he spins around, I can get past him"), and then prove the hypothesis by testing it ("I made it!") (Hong et al., 2009). If the hypothesis is not proven and players fail the task, they have to review the data and come up with a new hypothesis. Games provide a safe space for experimentation, and allow players to learn from their mistakes through unlimited do-overs (Prensky, 2000).

Studies indicate that games can promote real-time brainstorming and enhance the ability to develop new ideas (Hong et al., 2009). Success in many games requires the player to use critical thinking for decision-making and to analyze the consequences of their actions in the game to inform decisions later in the game. The repetition of challenges and problems in the game, along with variation in gameplay, encourages players to experiment and discover new ideas (Coyne, 2003).

Scaffolding: Instructional scaffolding is the process of managing task elements that are beyond a learner's capabilities to help them master those tasks. This concept is based on Vygotsky's Zone of Proximal Development - the idea that learning happens in the zone just above a learner's current skills. Vygotsky believed that with guidance and support, a learner would be able to master those skills that were previously out of their reach (Schunk, 1999). Games do this by providing hints, feedback via NPC dialogue, and visual clues. Additionally, they provide this information "just in time," i.e. when the player needs it; and "on demand," i.e. when the player wants it (Gee, 2007). When information is presented in context a player is more likely to remember it the next time they need it (Nelson, 1989).

Fisch (2005) suggests that the most effective way to provide feedback in a game is to let the learner know why an answer is wrong, so they are better able to figure out the right answer. For example, if a player is trying to find a certain barrel that holds a clue and looks in the wrong one, an NPC can say something like "Are you sure that's what you're looking for? The note said the clue you need is hidden inside a closed barrel. That one is open." If a player continues to have trouble with a task, the game should provide extra prompts and information until the player is successful.

A game that provides appropriate scaffolding and is well designed from a usability perspective can significantly reduce a player's cognitive load, which makes learning easier (Kiili, 2005). Working memory has a limited capacity, so when someone is presented with too much information at once - such as being attacked by 3 new enemies at the same time, as opposed to being introduced to them one a time and learning each one's weakness - they are bound to fail (Baddeley, 1999). Game designers can optimize cognitive load by reducing the amount of information that working memory has to process at once. This helps players to process problems more deeply and increases learning (Kiili, 2005).

MAXIMIZING THE LEARNING POTENTIAL OF GAMES IN THE CLASSROOM

In addition to choosing games that appropriately support the defined learning goals, teachers can do several things to further enhance the game based learning experience.

Encourage transfer: Transfer refers to the idea that someone can generalize knowledge they learn in one context and apply it to a different context; for example, someone who has played baseball might have an easier time learning to bat in cricket. While there is some indication that practicing with games could lead students to solve problems by using knowledge learned in one context and applying them somewhere else (Hong et al., 2009), research on transfer in game based learning is not conclusive. Even outside of games children very often have trouble applying mathematical knowledge to a different context than the one in which it was originally learned, even when the principles are the same (Habgood & Ainsworth, 2011).

To facilitate transfer, teachers can encourage players to interact in some way with real-world resources, such as peers, teachers or parents, online research, or print material. For example, some players refer to textbooks when playing *Civilization* (Fisch, 2005) and players of older text adventure games like *Zork* used to create and share maps of the game world for reference. *Where in the world is Carmen Sandiego* even came with reference material to help players make sense of clues in the game. Players also benefit from being debriefed by teachers either during or after gameplay. This helps strengthen the link between game activities and experiences in the real world (Garris, Ahlers, & Driskell, 2002).

Create opportunity for reflection: One challenge of utilizing flow in learning is that instruction requires a certain amount of reflection by the learner to reinforce the learning and lead to transfer. However, a player who is immersed in the flow state is generally not consciously reflecting on the learning that is taking place. While in the state of flow a player is willing to push their skills to the limit to achieve the in-game goals, but without active reflection on the strategies used to achieve those goals the long term learning will be limited (Paras & Bizzocchi, 2005).

Ideally, gameplay will integrate reflection into the normal play so the player is not removed from the flow state. An endogenous implementation of reflection will use reflection as one of the goals that drive gameplay, and will therefore feel very natural to the player without distracting from immersion in the game (Paras & Bizzocchi, 2005). This maintains the intrinsic motivation in the game and reinforces the learning that is taking place.

Improve usability: 3D learning environments should be easy to learn and navigate, so students do not waste mental energy learning the system rather than the content. It can be worthwhile to give students a few lessons in navigating the learning environment and provide scaffolding so they do not suffer cognitive overload and disengage with the learning (Lim, Nonis, & Hedberg, 2006). The most important design rule for any digital interface is not to make the user think too much about how to do what they want to do - it should just be obvious (Krug, 2005).

Playtest: Once you identify a game that fits your instructional needs for class make sure to play the game all the way through by yourself to make sure there is nothing inappropriate for your students. It is also important to try it out with a few students from your target audience to make sure they understand the game without too much trouble, and don't find it boring. Also, make sure the connection to the learning content is as strong as you think it is. You may find that a game is harder or easier than you thought, or that it would be better with an explicit introduction before gameplay. Playing the game through once with your target audience will give you ideas about how to improve the lesson plan.

Check effectiveness: Ideally you should have some way to evaluate whether the game is helping you accomplish your learning goals. When you identify your goals at the beginning of the game selection process, you have something to test against after students complete the play session or sessions. Whether you decide to test verbally, with a written test, or a subjective assessment, you should have some way to assess how students are progressing with the knowledge or skills you are targeting. These results can then be used as a formative assessment for the next time you use this particular game, and suggest changes that can make the play session more effective.

WHAT KINDS OF GAMES ARE EDUCATIONAL?

Educational games run the gamut from behaviorist influenced "drill and kill" games that are basically automated tutorials, to sophisticated commercial off-the-shelf (COTS) games that can be used in the classroom. There are games that are very educational without being much fun, and there are plenty of games that can provide hours of entertainment without touching on anything that would be relevant in a classroom. The challenge is to find games that fall somewhere in the middle and combine elements of both fun and learning where one supports the other. This challenge is only made greater by the fact that most instructional designers aren't trained in game design, and game designers usually know little about instructional design (Wu et al., 2012).

There is no one objective system for classifying games, but there are a few basic genres that games fall into. Many games are not easily classified and fall into more than one category, but knowing that a game is an action-adventure game as opposed to a sports-strategy game is still very helpful and therefore most games can be described using this basic list.

- **Action games:** Fast paced games, for example many classic arcade games such as *Donkey Kong* and *Super Mario Bros* are action games. A common subgenre of action games is platform games, which involve jumping to different heights to avoid enemies and traps and reach the end goal of each level
- **Adventure games:** Slower paced games that require players to solve various challenges, such as *Logical Journey of the Zoombinis* and *Oregon Trail*.
- **Puzzle games:** These games require problem solving, and can be based on words, math, logic, or even pictures (as in "spot the difference" challenges). Popular puzzle games are *Tetris* and match 3 games like *Bejeweled*.
- **Role playing games, or RPGs**: As in the tabletop game *Dungeons & Dragons*, players assume the role of an in game character and play as if they are that person or creature. Examples of this genre include the *Final Fantasy* series, *The Elder Scrolls*, and online massively multi-player games like *World of Warcraft.*
- **Simulations:** The game simulates a realistic environment, such as a plane cockpit or car. Microsoft's *Flight Simulator* is perhaps the best example of this.
- **Sports games:** These are based on sports games that people play in real life.
- **Strategy games:** Players have to come up with strategies to achieve their goal, such as winning a battle or building a city. Strategies usually involve managing limited resources and games can either be real time or turn based. Strategy games include *Civilization, Rise of Nations*, *Age of Empires*, and *Roller Coaster Tycoon*.

Casual games are also worth mentioning here, although they can belong to any genre. They are characterized by offering a shorter overall play-

time that is broken up into short levels that can be completed in one sitting. Most Facebook games are casual games, and online game sites like miniclip.com and friv.com offer casual games. These types of games are often useful in educational settings since they are easier to fit into typical class periods than longer games (Whitton, 2010).

CONCLUSION

While there are many factors involved in making a game an efficient educational tool, the most important aspect is how well the game tasks and goals line up with learning goals. Ideally, an educational game will provide an intrinsic learning experience that is both motivating and cognitively efficient for the learner. Additionally, a teacher should try to provide resources outside the game that can extend the learning and increase transfer, such as reflective activities, collaboration with other students, electronic or print resources, or adult mentors. The appendix provides a checklist that a teacher can use to evaluate a specific game for use in the classroom, as well as an evaluation that can be filled out by students who are playtesting a game.

REFERENCES

Amory, A. (2007). Game object model version II: A theoretical framework for educational game development. *Educational Technology Research and Development*, *55*(1), 51–77. doi:10.1007/s11423-006-9001-x.

Baddeley, A. (1999). *Essentials of human memory*. New York: Taylor & Francis.

Coyne, R. (2003). Mindless repetition: Learning from computer games. *Design Studies*, *24*(3), 199. doi:10.1016/S0142-694X(02)00052-2.

Csikszentmihalyi, M. (2008). *Flow: The psychology of optimal experience*. New York: Harper Perennial Modern Classics.

deFreitas, S. (2006). *Learning in immersive worlds*. Bristol, UK: Joint Information Systems Committee.

Dickey, M. (2006). Game design narrative for learning: Appropriating adventure game design narrative devices and techniques for the design of interactive learning environments. *Educational Technology Research and Development*, *54*(3), 245–263. doi:10.1007/s11423-006-8806-y.

Dondlinger, M. J. (2007). Educational video game design: A review of the literature. *Journal of Applied Educational Technology*, *4*(1), 21–31.

Egenfeldt-Nielsen, S. (2011). *eLearn Magazine: What makes a good learning game?* Retrieved May 22, 2012, from http://elearnmag.acm.org/featured.cfm?aid=1943210

Fisch, S. (2005). Making educational computer games educational. In *Proceedings of the 2005 Conference on Interaction Design and Children* (pp. 56–61). New York, NY: ACM. doi:10.1145/1109540.1109548

Foley, A., & Yildirim, N. (2011). The relationship between game design and instructional design. *Academic Exchange Quarterly*, *15*(2), 14–20.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, *33*(4), 441–467. doi:10.1177/1046878102238607.

Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-learning*, *2*(1), 5–16. doi:10.2304/elea.2005.2.1.5.

Gee, J. P. (2007). Learning and games. In D. Buckingham (Ed.), *The John D., & Catherine T. MacArthur Foundation Series on Digital Media and Learning* (pp. 21–40). Cambridge, MA: The MIT Press.

Habgood, M. P. J., & Ainsworth, S. E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. *Journal of the Learning Sciences*, *20*(2), 169–206. doi:10.1080/10508406.2010.508029.

Hong, J.-C., Cheng, C.-L., Hwang, M.-Y., Lee, C.-K., & Chang, H.-Y. (2009). Assessing the educational values of digital games. *Journal of Computer Assisted Learning*, *25*(5), 423–437. doi:10.1111/j.1365-2729.2009.00319.x.

Ke, F. (2008). A case study of computer gaming for math: Engaged learning from gameplay? *Computers & Education*, *51*(4), 1609. doi:10.1016/j.compedu.2008.03.003.

Keller, J. M. (1987). Strategies for stimulating the motivation to learn. *Performance and Instruction*, *26*(8), 1–7. doi:10.1002/pfi.4160260802.

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and Higher Education*, *8*(1), 13–24. doi:10.1016/j.iheduc.2004.12.001.

Krug, S. (2005). *Don't make me think: A common sense approach to web usability* (2nd ed.). New Riders.

Lepper, M. R., & Malone, T. W. (1987). Intrinsic motivation and instructional effectiveness in computer-based education. In R. Snow & M. Farr (Eds.), Aptitude, learning, and instruction: Vol. 3: Cognitive and affective process analysis (pp. 255-286). Hillsdale NJ: Erlbaum.

Lim, C. P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multiuser virtual environment: Engaging students in science lessons. *British Journal of Educational Technology*, *37*(2), 211–231. doi:10.1111/j.1467-8535.2006.00531.x.

Nelson, O. (1989). Storytelling: Language experience for meaning making. *The Reading Teacher*, *42*(6), 386–390.

Paras, B., & Bizzocchi, J. (2005). *Game, motivation, and effective learning: An integrated model for educational game design.* Paper presented at the DiGRA 2005 Conference: Changing Views - Worlds in Play. Retrieved from http://summit.sfu.ca/item/281

Prensky, M. (2000). *Digital game-based learning*. New York: McGraw-Hill Companies.

Rogers, S. (2010). *Level up! The guide to great video game design*. New York: Wiley.

Schrader, P. G. (2010). Video games in education opportunities for learning beyond research claims and advertising hype. In P. Zemliansky, & D. Wilcox (Eds.), *Design and implementation of educational games: Theoretical and practical perspectives*. Hershey, PA: IGI Global. doi:10.4018/978-1-61520-781-7.ch020.

Schunk, D. H. (1999). *Learning theories: An educational perspective* (3rd ed.). New York: Prentice Hall.

Warren, S., & Najmi, A. (2013). Learning and teaching as communicative actions: Broken window as a model of transmedia game learning. In Y. Baek, & N. Whitton (Eds.), *Cases on Digital Game-Based Learning: Methods, Models, and Strategies*. Hershey, PA: IGI Global.

Whitton, N. (2010). *Learning with digital games: A practical guide to engaging students in higher education*. New York: Routledge.

Wu, W. H., Hsiao, H. C., Wu, P. L., Lin, C. H., & Huang, S. H. (2012). Investigating the learning- Theory foundations of game-based learning: A meta-analysis. *Journal of Computer Assisted Learning*, *28*(3), 265–279. doi:10.1111/j.1365-2729.2011.00437.x.

KEY TERMS AND DEFINITIONS

Adaptive Play: Gameplay that adjusts itself to accommodate the skill level of the player

Fantasy Context: The setting and story in which a game is packaged; for example a racetrack where several drivers are competing, or astronauts exploring a new planet

Feedback Loop: Interaction between a player and a game described by the rewards and consequences in the game that happen in response to a player's actions

Flow Theory: A theory that describes engagement in an activity that is so complete a person can easily forget about anything outside of what they are doing

Game Mechanics: The rules and procedures that control how a player interacts with a game

Intrinsic Integration: Game design that requires game activities to be inherently tied to the learning content and based on learning activities

Intrinsic Motivation: An urge to do something for its own sake, rather than for any external reward that may be received

APPENDIX A

Teacher Analysis Checklist

Define the learning goals of the game.

What new skills and/or knowledge should players have when they complete the game? _____

_____

_____

_____

What level(s) of Bloom's Revised Taxonomy are met by activities in this game?

- Remembering
- Understanding
- Applying
- Analyzing
- Evaluating
- Creating

Strategies that support motivation in games

Analyze the motivational aspects.

- **Fun:**
  - Is the game fun to play?
  - Is the core mechanic satisfying?
  - Does the game make the learning content fun?
  - Does the game provide interesting, meaningful choices to the player?
  - Does the game have the potential to induce the flow experience?
- **Balance:**
  - Are game challenges balanced?
  - Does the game increase challenges as players master each level/stage?
- **Control:**
  - Are there specific rules and procedures to guide the player's experience?
  - Does the game provide clear goals?
  - Does the game provide numerous sub-goals?
  - Does the game offer short, medium, and long term goals?
  - Are players rewarded when they do something right?
  - Is there feedback when players make a mistake?
- **Fantasy:**
  - Does the game fantasy reinforce the learning goals?
  - Will the game fantasy stimulate the interest of the learner?

Strategies that Support Learning in Games

Analyze the learning strategies.

- **Active Learning:**
  - Does the game provide leveled challenges that take into account differences in prior knowledge and experience?
  - Does the game reflect how newfound skills and knowledge can be used in real life?
  - Does the game require players to master lower level skills before progressing to harder challenges?
- **Critical Thinking/Problem Solving:**
  - Does the game promote critical thinking?
  - Does the game promote problem solving?
  - Is gameplay fast (to build fluency of a skill)?
  - Is gameplay slow (to allow the player to make sense of the learning content)?
- **Scaffolding:**
  - Is the learning intrinsic to the gameplay?
  - Is the core mechanic inherently connected to the learning content, or can the player succeed at the game without learning anything new?
  - Does the game assume prior knowledge that players may not have?
  - Does the game provide help "on demand?"
  - Does the game provide help "just in time?"
- **Maximizing the learning potential of games in the classroom:**
  - Does the game include reflective activities?
  - Does the game encourage players to consult external resources such as teachers, other students, or print material?
  - Does the game encourage "transfer" of new knowledge and skills to the real world?
  - Will players need an introduction to the game before they play on their own to familiarize themselves with the interface and/or gameworld (especially if 3D)?
  - Have you playtested the game yourself before using with students?
  - Have you playtested the game with a small group of students before using in class?
  - How will you evaluate whether or not the game was a successful learning experience?

APPENDIX B

Table 1A. Student playtest checklist (please indicate how you felt about each item while playing the game)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I enjoyed playing the game					
I found the game frustrating					
The game was too easy					
The game was too hard					
I got bored before I finished the game					
It was very clear what I was supposed to do in the game					
I felt absorbed in the game activities					
It was clear what I could learn from the game					
I found the game very satisfying to play					
It was easy to get help in the game when I needed it					
Time passed quickly while playing					
The game objectives were clear					
The game story and characters were interesting					
Gameplay required skills I do not have (and did not learn by playing the game)					