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• CHAPTER TEN •

Digital Game Analysis: Using the Technological Pedagogical Content Knowledge Framework to Determine the Affordances of a Game for Learning

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Introduction

In recent years, game-based learning has proliferated like a conflagration and is viewed as a lightning rod in academia (Williams, 2003). Many researchers have argued about the positive potentials (Gee, 2003, 2007; Shaffer, 2006; Foreman, 2004; Jenkins & Squire, 2005) and perils (Gentile & Walsh, 2002; Carnagey & Anderson, 2004) of games for learning. The arguments from proponents and opponents of games for learning are usually based on the claimed affordances for games and learning (Foster & Mishra, 2009; Mishra & Foster, 2007). Proponents claim that games have the best pedagogy in them and can prepare learners for 21st century jobs, while detractors say that games cause aggressive and dangerous behaviors. Despite their disagreement, both sides agree that learning is possible from games.

Based on a survey that documented the claimed affordances of games for learning, Mishra and Foster (2007) argue that digital games afford learning and development by shaping attitudes, affecting behavior, influencing understanding, and affecting spatial and motor abilities. Of course, such a survey reveals only potential learning affordances, and researchers still must conduct empirical studies to examine the extent to which these affordances are realized in particular games. Not all digital games afford the same benefits because genres and content within games are varied (Foster & Mishra, 2009).

To understand the affordances of a specific game (for specific outcomes), we advocate that researchers first conduct a game analysis to examine the technological, pedagogical, and content knowledge affordances of the game for learning. In this chapter, we discuss a game analysis conducted on *RollerCoaster Tycoon 3: Platinum (RCT3)*. The goal of this analysis was to determine if this simulation strategy game appropriately afforded learning foundational economics principles, such as opportunity cost, and whether this game could be appropriately used with upper elementary and middle school children ages 10 to 12 years old.

In this chapter, we first discuss the affordances of games for learning. Second, we examine how the Technological Pedagogical Content Knowledge framework and the Playing Research Methodology approach can inform game analyses. Third, we exemplify the type of game analysis we advocate through the illustrative example of the analysis of *RollerCoaster Tycoon 3*. We conclude with results of the analysis and some larger implications of game analysis for teachers and researchers.

Affordances of Games for Learning

The potential of games for learning are generally couched in terms of their ability to situate learning in environments and experiences that are anchored, generative, and embodied (Aarseth, 1997; Barab et al., 2007; Calleja, 2007; Malone & Lepper, 1987). For instance, it is argued that games present a fundamentally different pedagogical stance from traditional direct or guided instructional practices, and that well-designed games have the best pedagogy embedded in them for learning (Federation of American Scientists, 2006; Foreman, 2004). Other researchers argue that games demand things from players in ways that other texts do not (Krzywinska, 2006; Oblinger, 2004). Some of these attributes include the ability for contextualizing, individualizing and collaborating, feedback and assessment, experiential and social learning, active learning, intrinsic and extrinsic motivation, transfer, and scaffolding (Asgari, 2005; Gee, 2003; Oblinger, 2004; Prensky, 2001). The claimed affordances of games for learning and motivation shape games as an embodied semiotic domain much like a curriculum.

Historical trends about the affordances of games for learning and motivation focused on aspects such as intrinsic and extrinsic motivation, spatial abilities, and other skills (Ball, 1978; Greenfield & Subrahmanyan, 1994). De Aguilera and Mendiz (2003), in their meta-analysis of studies on games from the 1970s to the 1990s, concluded that adolescents with medium- or long-term experience playing video games show greater visual capacity, motor activity, and spatial abilities/reflexes and responses. By 1994, researchers such as Greenfield (1984) argued that games were good for helping children with basic skills. De Aguilera and Mendiz (2003) concluded that many video games are conducive to the development of specific skills: attention, spatial concentration, problem solving, decision making, collaborative work, creativity, and information and technology skills.

Relatively absent in this thinking about the affordances of games has been a differentiation based upon game genres. For example, a real-time strategy game such as *SimCity* offers a different physiological and psychological learning experience than the more puzzle-like game *Physicus*. Likewise, *World of Warcraft* offers different affordances for learning than *Civilization IV*. Many arguments about learning from games lead people to assume that the pedagogical value of one game is the same as that of another. This misrepresents the varied potential that different genres of games can offer. Foster and Mishra (2009) argue that it is important to look carefully at game genre because the design stance (including the design of a game, the kinds of choices regarding gameplay, structure, the nature of progress through a game, nature of representation and so on) is the result of conscious (and possibly subconscious) decisions made by game designers. From an educational perspective, this stance can be seen as an implicit pedagogical approach with implicit theories of learning, behavior, and epistemology. It is reasonable that consideration of game genres would lead to "more nuanced, meaningful, and critical vocabulary for discussing video games" (Apperley, 2006).

Also relatively less frequent in an analysis of the affordances of games for learning is attention to roles of pedagogy and content. Jenkins and Squire (2005) are among the researchers who have called for research that focuses on content in order to build theory. Clearly, game content ranges widely and few studies focus on subject matter content or pedagogy (Foster & Mishra, 2009). A game for learning about chemistry content would be different from one about economics or one about ethical and social relationships. A well-designed game for learning chemistry content may involve information at both the microscopic and macroscopic levels illustrating appropriate pedagogic and con-

tent approach, as is typical in games such as Science Papa. A well-designed game for economics may involve a more macroscopic approach to the design and for managing resources, as is typical in games such as *RollerCoaster Tycoon 3* or *Civilization IV*.

Using the Technological Pedagogical Content Knowledge Framework

One way to think about learning from games is to pay attention to the interaction of three key aspects. First is an understanding of the content or subject matter in the game. Second is the learning approach, genre, or pedagogy embedded in the game, whether it be simulation, strategy, role-playing, or a whole range of other genres. The third aspect is an attention to the technology being used—in this case, games. Learning from games is inherently different than learning from lectures or web pages. Considering these three aspects is one formulation of the Technological Pedagogical Content Knowledge (TPACK) framework, originally designed to be used to describe teacher knowledge for the integration of technology (Mishra & Koehler, 2006). The framework focuses on how knowledge of content (C), pedagogy (P), and technology (T) interact to produce effective teaching (see Figure 10.1).

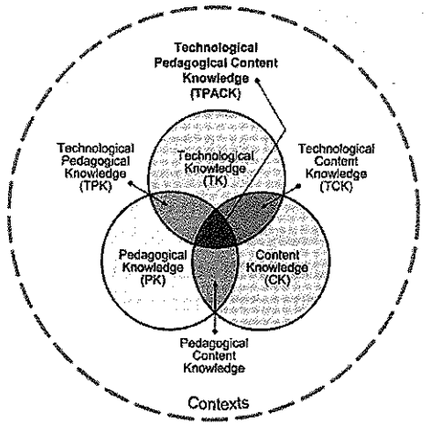

Figure 10.1. Technological Pedagogical Content Knowledge framework.

Learning from games, or teaching with games, can be thought of as what Mishra and Koehler describe as Technological Pedagogical Knowledge (TPK). TPK represents knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings. For

TPK, Mishra and Koehler argue that teaching and learning change depending on particular technologies. This requires knowing the affordances and constraints of those technologies as well as the disciplines or content areas of usage. Within the context of game-based learning and game design research, TPACK is being co-opted to help identify critical aspects of what is needed for learning in games as well as what is learned when players play a game. From the perspective of game-based learning, TPK is useful because of the strong resemblances to game genres.

For conducting a game analysis, the TPACK framework provides for a focused analysis of how technology integrates with content and pedagogy. TPACK is used as a lens for focusing on the content and the genre in the game. By exploring what content a game offers, the game analysis also facilitates researcher or teacher knowledge construction for what to focus on for assessment of learning in a study or for teaching in a classroom. It aids in preventing the conflation of the game genre variable by highlighting the process of learning through the interactivity allowed by the dominant pedagogy of the genre. The pedagogy is one factor that helps to determine how players navigate as well as what is learned in terms of content. When viewed through the lens of interactivity, game genres are another way of describing how a particular game integrates technology and pedagogy. Thus, the game has T and P via game genre, while C is designed into it. Foster and Mishra (2009) argue that a well-designed educational game would seamlessly integrate all three aspects of TPACK, namely T, P, and C.

The inclusion of TPACK provides a framework for focusing and analyzing the content of *RCT3* and how it integrates with the simulation strategy genre. It allows the researcher to highlight the game genre, thereby reducing the conflation of that variable in learning, and it provides insight on the focus for learning and how learning could occur and be assessed. Genre plays a crucial role in game-based learning assessment because of its implicit role as a form of pedagogy.

While the TPACK framework provides a lens for what to focus on in the digital game analysis, Aarseth (2003) provides a methodological path for analyzing a game. Aarseth did not name this methodological approach, but for the sake of identification purposes it is being called the Playing Research Methodology, after his article "Playing research: Methodological approaches to game analysis."

Aarseth's Game Analysis Approach: The Playing Research Methodology

Aarseth (2003) promotes and outlines a methodology for the aesthetic study of games. For this Playing Research Methodology (PRM), Aarseth argues that any theoretical approach to game aesthetics implies a methodology of play, implying that part of studying games for learning or for purely aesthetic reasons must involve play at some level. Implicit in this argument is that the study of the structural characteristics of games, including a game analysis focused on the affordances for pedagogical, technological, and content characteristics of a game, should include the researchers engaging in play to acquire knowledge of the game characteristics under focus.

According to Aarseth, there are three ways to acquire knowledge about what is in a game or what it affords: (1) by studying the mechanics and design of the game, (2) by observing others playing the game, and (3) by playing the game yourself. Aarseth argues that the third way is the best, especially when combined with one or both of the other ways. In addition, Aarseth contends that player interviews are necessary in game analysis because they provide us with an understanding that we could not get otherwise about the game.

Hence, a central tenet in the game analysis discussed in this chapter is the combination of Aarseth's third charge of addressing the affordances for learning provided by a game with the TPACK framework. TPACK provides a framework for focusing on technology, pedagogy, and content, while PRM provides an approach for conducting game analysis by way of gameplay. The game analysis was conducted by the researcher to aid in the decision to use *RollerCoaster Tycoon 3: Platinum* (*RCT3*) by determining its affordances for learning disciplinary knowledge (economics and social studies) and skills (information and technology knowledge).

The Game: *RollerCoaster Tycoon 3: Platinum*

The computer game *RollerCoaster Tycoon 3: Platinum (RCT3)* is the latest economic simulation strategy game in the RollerCoaster Tycoon series of games, which were first designed and developed by Chris Sawyer in 1999 (Sawyer, 1999). *RollerCoaster Tycoon* has seen three major games in the series due to its popularity as indicated by sales units (Entertainment Software Association, 2007). These titles include *RollerCoaster Tycoon (RCT)* (Sawyer, 1999), RollerCoasterTycoon 2 (Sawyer, 2002), and *RollerCoaster Tycoon 3* (Frontier Developments, 2004). Each major title spawned expansion packs that were sold as individual games. Overall, there are 13 titles in the series, with the most recent being *RollerCoaster Tycoon 3: Platinum*, which was released on November 21, 2006 (Frontier Developments, 2006). It includes a combination of *RCT3*, which has all the elements of previous *RCT* games, including new 3-D views of the games, as well as everything from the expansion packs of *Soaked!* (a water-park building game) and *Wild!* (a safari-type theme-park building game). *RCT3: Platinum* gameplay combines everything from *RCT3*, *Soaked!*, and *Wild!*

The aim of the game is to complete objectives and scenarios by redesigning or building the best amusement park and generating as much profit as possible while managing other resources such as time, money, workers, and land space. The design and building of the theme park is directly related to game knowledge, including technology literacy and information literacy skills. Learning how to play the game, understanding the content, and applying the content are related to knowledge of profit, cost-benefit, opportunity cost, scarcity, supply and demand, and pricing. Learning by doing (Schank et al., 1999) in managing the resources and redesigning or building in *RCT3* requires balancing constraints and affordances in the game while working within a particular scenario.

The game, like others in the simulation strategy genre, allows players to control whole systems and make decisions about how to manage the system (the virtual world). In *RCT3*, players control the theme park by managing resources, training and disciplining workers, building rides, and trying to maintain a beautiful and clean park by adding amenities while also entertaining visitors and VIPs. Players can design their own theme park with roller coasters and other rides or they can modify existing parks and purchase existing rides developed from research. Players must also meet the needs of guests visiting their park by building facilities such as food stalls, drink stands, ATMs, information booths, bathrooms, benches, and other amenities.

Central to the game is that players must manage their resources (time, land space, money, and workers) and balance their budgets in terms of expenses and income. Players must also consider the affordances of their designs of rides with respect to the in-game (virtual ecological) needs as dictated by terrain, space, and available money. In addition, they must meet their own personal needs in how they design the park as well as satisfying guests' needs for a certain level of excitement, park type, food, ride intensity, and so on. Players may allocate money for research to develop rides, attractions, and other amenities. They may also do advertising or run marketing campaigns to publicize the park and rides.

RCT3 Game Analysis

The researcher used Aarseth's PRM approach combined with Mishra and Koehler's TPACK framework. The researcher played the game for about six months, read and made notes about basic microeconomic and foundational economic principles, and read information about *RCT3* relating to its genre, content, and popularity. In addition, the researcher consulted an economics professor who was knowledgeable about the Tycoon series of games, with the following general questions in mind: What level of economics and skills are possible to be learned in the game? What type of questions could be asked to assess knowledge of what students learn about economics and social studies in the game?

During gameplay, the researcher focused on aspects of the technology in the game and analyzed its content and pedagogy within the limits of the game technology to determine the affordances for learning disciplinary knowledge and skills, including social studies, economics, information literacy, and technology literacy. Using the TPACK framework as a lens to focus on technology in *RCT3*, the researcher examined the affordances of the game technology within the genre and how it allows access to the content to be learned. Thus, while the categories of technology, pedagogy, and content are presented in the game analysis, they do not exist as mutually exclusive units, and there is an interrelationship a

Technology: *RCT3* Game

The technology being analyzed is the game. *RCT3* is a computer-based economics simulation strategy game for building amusement parks. There are 18 scenarios in *RCT3*, and each has three levels—Apprentice, Entrepreneur, and Tycoon. Only the first six scenarios were analyzed. The six scenarios analyzed include Vanilla Hills, Goldrush, Checkered Flag, Box Office, Fright Night, and Go With The Flow (see Tables 10.1, 10.2, and 10.3). In all of the scenarios, players start in a theme park with a certain amount of money, which they must use in the park to generate more money by adding rides and satisfying the needs of guests in various ways, such as keeping the park clean, providing enough food, meeting their ride wants, and setting reasonable prices. The aim is always to build the best park in terms of value—park ratings, park profit, number of people in the park, beauty of the park, ride reliability, efficient workers, and prizes or achievements, depending on the requirements of a particular scenario.

RCT3 has a steep learning curve requiring players to negotiate the game objectives (see Tables 10.1, 10.2, and 10.3) while trying to understand the gameplay tools, which have many visual elements. These include navigating with the use of a computer mouse and keyboard, and focusing on a computer screen that has many icons and symbols, with each revealing more icons when clicked (see Figure 10.4). Each icon represents either a tool or a gateway to many more tools for building rides or accessing information about the theme park under construction. This requires players to quickly grasp the game content in order to be successful as they move from Apprentice to Tycoon level. The gameplay changes from scenario to scenario because of different game objectives with specific visual information (see Tables 10.1, 10.2, and 10.3), but navigation remains the same for how to interact with the game.

Table 10.1. Analysis of Vanilla Hills and Goldrush Scenarios and Level Requirements

Vanilla Hills	**Goldrush**
The Vanilla Hills are the starting point on your meteoric—or not—rise to RollerCoaster Tycoon status. Can you turn this plot into the peeps talk of the town? Your rating as Apprentice, Entrepreneur, or Tycoon depends on it.	Now's your chance to hit pay dirt by using this unstable, abandoned mining area to showcase low-rise coasters. Over time, your coasters must start to make up in adrenaline what they lack in height to keep your claimed stake with the visitors.
1. Apprentice a. Guests in park: 400 Condition can be achieved at any time. b. Minimum park value: $20,000 Condition can be achieved at any time.	**1. Apprentice** a. Minimum excitement: 3 i. Two coasters b. Minimum length: 1000.66 ft i. Two coasters c. Total monthly ride income: $300 Condition can be achieved at any time.
2. Entrepreneur a. Guests in park: 500 Condition can be achieved at any time. b. Minimum park value: $60,000 Condition can be achieved at any time.	**2. Entrepreneur** a. Repay loan Condition can be achieved at any time. b. Total monthly ride income: $500 Condition can be achieved at any time.
3. Tycoon a. Guests in park: 600 Condition can be achieved at any time. b. Minimum park value: $100,000 Condition can be achieved at any time.	**3. Tycoon** a. Minimum excitement: 4 i. Three coasters b. Minimum length: 1213.91 ft i. Three coasters c. Total monthly ride income: $700 Condition can be achieved at any time.

Table 10.2. Analysis of Checkered Flag and Box Office Scenarios and Level Requirements

Checkered Flag	**Box Office**
Formula RCT has made a pit stop in town! It's not going to be easy taking this crowd for a joyride, but put the pedal to the metal and go for a spin anyhow. Don't forget to buckle up!	Look out, unamusing amusement parks! A movie studio has cast you in the role of superhero. Not for a movie, but for the daunting task of updating its aging back-lot park without ruining its pedigreed heritage. You're the producer, the director, and the star of the show. Can you deliver the blockbuster the studio wants?
1. Apprentice a. VIP (Clint Bushton) i. Arrives May 16 ii. Wants to visit one roller coaster with excitement rating of at least 4 b. Total monthly shop profit: $100 Condition can be achieved at any time.	**1. Apprentice** a. Park rating: 300 i. Sustained for at least 1 month b. VIP (Cami O) i. Arrives: May 7 ii. Litter tolerance: Low
2. Entrepreneur a. VIP (Clint Bushton) i. Arrives July 25 ii. Wants to visit one roller coaster with excitement rating of at least 5 b. Total monthly shop profit: $150 Condition can be achieved at any time.	**2. Entrepreneur** a. VIP (Cami O) i. Arrives July 19 ii. Breakdown tolerance: medium b. Park rating: 500 i. Sustained for at least 2 months c. Total monthly shop profit: $100 Condition can be achieved at any time.
3. Tycoon a. VIP (Clint Bushton) i. Arrives May 13 ii. Wants to visit one roller coaster with excitement rating of at least 6 b. Total monthly shop profit: $200 Condition can be achieved at any time.	**3. Tycoon** a. VIP (Cami O) i. Arrives October 8 ii. Wants to visit one roller coaster with excitement rating of at least 7 b. Park rating: 700 i. Sustained for at least 3 months

Table 10.3. Analysis of Fright Night and Go With The Flow Scenarios and Level Requirements

Fright Night	**Go With The Flow**
Forget about haunted houses and costumed characters, because cheap thrills just don't scare the teens in this town. You'll need to give them something they can really scream about—like roller coasters that would scare the hair off a werewolf.	Get ready to cool off. Put your park-building skills to work in this watery wonderland to create a park worthy of this spectacular setting—and one that can soak up as much cash from your guests as possible. It's sink or swim!
1. Apprentice a. Minimum excitement: 5 i. Two coasters b. Minimum length: 524.93 ft i. Two coasters c. Total monthly ride income: $200 Condition can be achieved at any time.	**1. Apprentice** a. Minimum park value: $15,000 i. Sustained for at least 1 month b. Total monthly ride income: $100 Condition can be achieved at any time.
2. Entrepreneur a. Minimum excitement: 6 i. Two coasters b. Minimum length: 1017.06 ft i. Two coasters c. Repay loan Condition can be achieved at any time	**2. Entrepreneur** a. Minimum park value: $30,000 i. Sustained for at least 2 months b. Total monthly ride income: $200 Condition can be achieved at any time.
3. Tycoon a. Minimum excitement: 7 i. Two coasters b. Minimum length: 1509.19 ft i. Two coasters c. Total monthly ride income: $600 Condition can be achieved at any time	**3. Tycoon** a. Minimum park value: $45,000 i. Sustained for at least 3 months b. Total monthly ride income: $300 Condition can be achieved at any time.

While visual information and/or objectives may change, the game solicits the same type of psychological or physiological skills over and over, but with increasing complexity within each scenario as one advances (See Table 10.5). For instance, it requires continual tinkering to determine how to use the terrain tools, build waterfalls, or to satisfy the needs of guests and yourself while meeting game objectives. These processes afford critical thinking, problem solving, design, and creativity skills. The technology, including navigation capabilities and visual tools, facilitates continual technological and informational literacy skill development in every level and scenario of *RCT3* with the various objectives. This facilitates what Gee (2003, 2007) calls cycles of expertise, a necessary precursor to enhancing or developing creativity and other skills.

Pedagogy

Pedagogy, the principles and methods of teaching, in a video game is connected to the genre of the game. The video game genre dictates the interactivity, which is the way the game is experienced (Apperley, 2006). Researchers contend that the classification of video game genres by interactivity is a good method because video games have very specific objectives (learning goals) that a player tries to complete, and thus also have specific interactions, which the player carries out (Apperley, 2006; Wolf, 2001). The intentions of the player are often clear and can be analyzed as part of the game.

RCT3 combines simulation and strategy genre features. In addition, it is often described as an economics game. This describes the nature of the content of the game; however, simulation strategy describes the nature of the interactivity, part of the way the game is experienced. Being an economic simulation strategy game, *RCT3* also falls under the broader genre of strategy games, which consists of turn-based strategy (TBS) games such as the Civilization series (Briggs & Johnson, 2001; Johnson, 2005; Meier, 1991; Reynolds et al., 1996) and real-time strategy (RTS) games such as The Sims. In addition, it has some simulation characteristics.

Pure simulations try to create real-world representations (Gredler, 1996). They are based on a system of expertise development, as in many games such as *RCT3*; however, pure simulations do not contain the same type of rules that guide exploration in games. Like games, pure simulations allow players to make safe mistakes, but usually do not provide immediate feedback about the mistake at the point it is made, rather the mistake is revealed at the point a player moves to the next scenario or level. The simulation then indicates (visually or aurally) that the desired results are not achievable because somewhere in the progress of play an error was made. Where the error was made in the pure simulation is often not clear and must be discovered by the user.

RCT3 does not always provide immediate feedback on all decisions; rather, it allows players to progress whether or not the player is making choices that will allow him/her to progress to a new level and scenario. RCT3, however, does give feedback on mistakes in that if an objective is not fulfilled, a player cannot advance to a new level. Players get this feedback clearly in the game by not advancing or through warnings in game play that some activities for maintaining the theme park need attention.

It is also clear to players what goals they should meet to achieve objectives and pass levels (Apprentice, Entrepreneur, and Tycoon, see Tables 10.1, 10.2, and 10.3); however, it is not clear what processes are involved in achieving these objectives. Therefore, players must learn about the game, the content, and how best to solve problems ("objectives" in *RCT3*) during gaming. This is similar to arguments

in the research community about the pedagogy of games facilitating learning by doing and that content learning and gameplay are inextricably intertwined because gameplay is dictated by the genre or pedagogy (Barab et al., 2001; Gee, 2003).

Caldwell (2004) asserted that RTS games and TBS games are similar and belong in the same genre because they share a lot of the same characteristics, including similar aesthetics, a general god's-eye or bird's-eye view, and a tendency toward photorealistic depictions. Apperley (2006) asserts that gameplay in strategy games is associated with expert play. He contends that expert players contextualize relationships between certain values within the game world to get the best outcomes, while beginner players are engaged with the play of the game on the level of response. That is, beginners do not strategize much; they proceed by responding to actions in the game. In *RCT3*, this is responding at the basic observation of an action from the general god's-eye view position and then intervening in the game world to take action. This could be called the observation and intervention pedagogical approach of simulation strategy games.

The genre is also activity based around the observation and intervention pedagogy. That is, simulation strategy games are characterized by visual cues that draw attention to their visual aesthetics (see Figure 10.2). Rather than facing a constant barrage of information, as in first-person shooter games, players monitor a situation waiting for something that will require their intervention while all the time contextualizing relationships and developing expertise in the game. The level of interactivity in simulation strategy games and their visual aesthetics are the two main elements that characterize the genre and promote gameplay and pedagogy.

The observation and intervention pedagogical affordance facilitates a slow pace of play. This genre effect may be utilized differently for different players through the management of time and money resources through action-planning ahead or not. The pedagogy influences the way learning occurs as players may plan ahead as a game-playing strategy by looking at the requirements for all the levels and then building and satisfying Tycoon-level requirements. This may allow players to progress faster through the game since satisfying Tycoon requirements usually means you will also have satisfied Apprentice and Entrepreneur requirements. For instance, to satisfy Tycoon requirements in Goldrush (see Figure 10.3) a player must build extra roller coasters that are bigger, longer, and with higher excitement levels. Thus, by planning ahead, a strategizing player may satisfy both Apprentice and Tycoon requirements. Players seeking to quickly beat the game may plan ahead rather than only playing by observation and intervention methods.

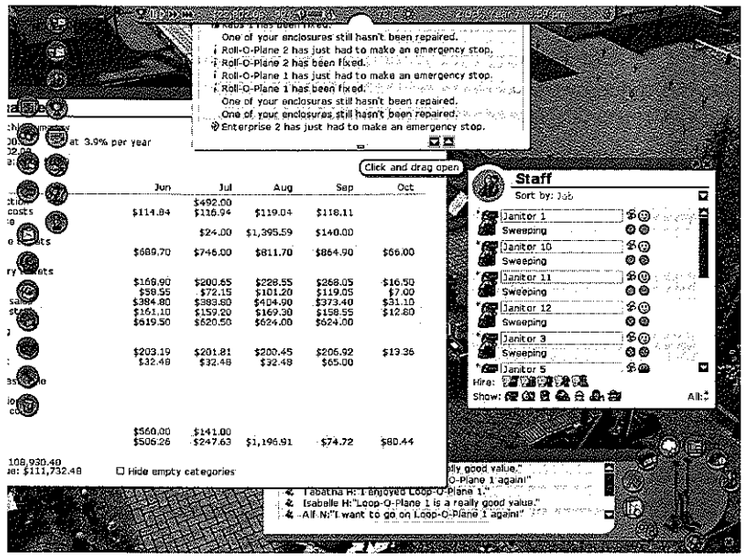

Figure 10.2. Some visual cues that draw players' attention while observing.

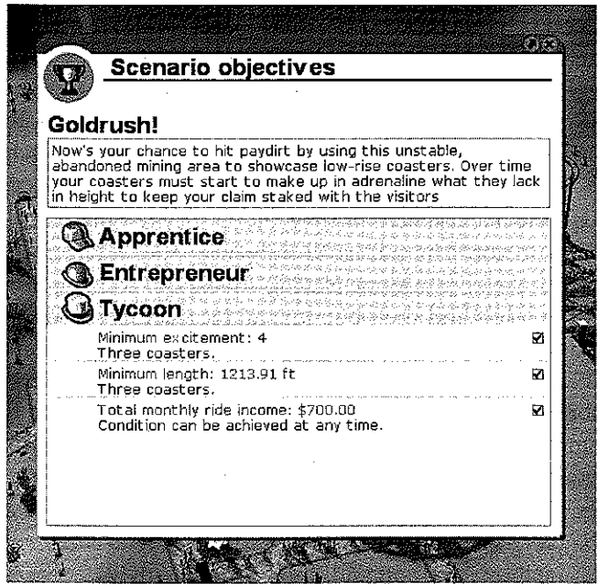

Figure 10.3. Scenario objectives for Goldrush, the second *RCT3* scenario.

On the other hand, a player may choose not to plan ahead to meet the game objectives. Players who want to beat the game or play quickly may plan ahead, while players seeking satisfaction through exploration, designing, and building may choose a slower pace of play by addressing the game requirements through only the game feedback window while focusing on exploration and building. Thus, adopted play styles in gameplay have implications for what is learned and how.

Observation and intervention have an impact on the resource of time. Time as it relates to pace of play is a resource that is important in some scenarios of *RCT3*. In terms of speed of building the roller coasters, time is important in Goldrush, Checkered Flag, and Fright Night because players are given a lot of money at the beginning of these scenarios, but the money is quickly used up on other needs by the in-game artificial intelligence that helps manage the park. Thus, when it comes to decision making (building a ride versus buying a ride or planning ahead versus deep exploration), opportunity cost plays an important role in what players are giving up and what is experienced.

The pedagogy in the game arises through the natural pace of gameplay, a kind of interactivity needed for the observation and then intervention approach, the trial and error approach, or the explorative approach in *RCT3*. This occurs in the game through an immediate or delayed feedback system that supports players in achieving game objectives. The game teaches players in subtle ways, such as when a VIP visits a player's park in Checkered Flag (see Table 10.2). If the player does not adapt to the pace and fulfill the objectives set out to satisfy the VIP, *RCT3* provides delayed feedback to say that "you failed to satisfy the VIP," and the player will be given another opportunity in a year (April to November in the game) or the next month. In doing this, a player gets an opportunity to adapt to the pace of play in that particular scenario, usually tending to the VIP needs and itinerary faster.

In cases where players are building rides and doing landscaping, the game provides faster and immediate feedback with visual cues that indicate if the ride is completed and in an operable condition or if the land has been deformed by creating small hills, valleys, or other undulating surfaces that disconnect walking paths. In both cases of building rides and landscaping, instructional feedback is given in actions that adversely affect the value of a park and the speed of play in the game. This gives the player an opportunity to adapt to the type of dominant pedagogy—observe and intervene, trial and error, and less exploration. For instance, if a ride is not completed properly, the game tells you it cannot be opened for riders. Three-color coded circular visual icons provide feedback on ride readiness: red indicates completed, but not ready to be open; yellow indicates you are getting there but some essential part of the ride is still missing; and

green indicates the ride is ready to be open (see Figure 10.4). Players must adapt to the pedagogical style of the game in order to be successful, whether it requires an explorative approach through observing and intervening for one objective or quick actions after errors to try new methods of management in order to get the park operating efficiently to increase its value.

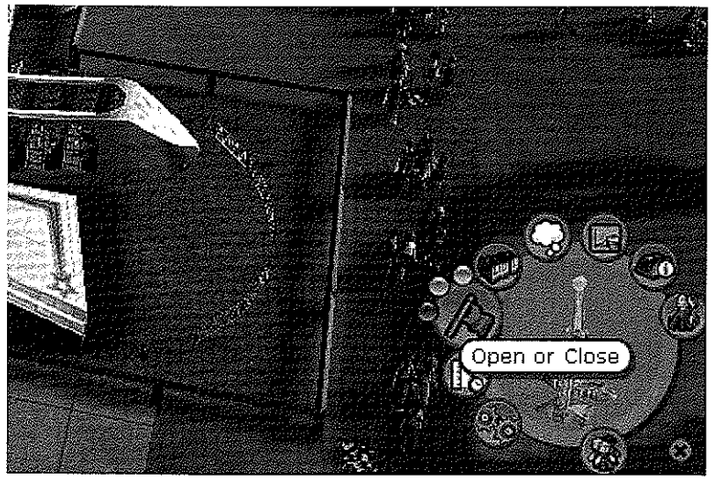

Figure 10.4. Three-color coded circular visual icon for opening and closing rides.

In other cases, such as when a player is supposed to generate a certain amount of total sales per month from shops and stalls—let's say $200—if the player cannot find the best way to provide the conditions to get that amount in sales each month, the game does not provide feedback. Instead, the player must engage in problem solving through an interactive exploration and/or trial and error approach until the problem is resolved. For instance, the player must use land space wisely to build shops in optimal locations in the park (front vs. rear of park) and ensure that there are a lot of people in the park to purchase goods and services. In order to have a lot of people in the park, the player must have a significant number of rides and amenities to support a large number of people in a park. Thus, the player must progress through several stages of play in order to meet the objective of $200 in shop sales. The play process afforded by the interactivity of the simulation strategy pedagogy for each objective and level in *RCT3* requires problem solving, critical thinking, and systemic thinking to meet even small objectives. It is in these moments of solving problems that players may be able to learn opportunity cost, scarcity, and other economics content as well as content that only becomes salient through the play process, such as the role of the resources time and money. It is through playing the game from the design stance of its creators that this becomes possible, thereby highlighting the interplay of technology, pedagogy, and content in the game.

Another set of crucial pedagogical tools in *RCT3* is the icons or visual aesthetics. Digital games are semiotic domains. Semiotic domains are multimodal and embodied spaces. An important part of semiotic domains is their internal aspects, which facilitate the content of the domain. Icons and the visual aesthetics play an important part of the internal aspects of the semiotic domain. Icons play a crucial role as part of video games technology due to their symbolic and interactive nature. They are symbolic because they represent some action or give meaning to an action. It is in giving meaning to an action that icons help support the content or internal aspects of a semiotic domain. For instance, in *RCT3*, on the left of the screen is a long list of icons that represent different doorways to tools or information for use in the game, such as a Ferris wheel icon that symbolizes or means "rides" (see Figure 10.5). The Ferris wheel icon also gives meaning to the action of building rides in the context of *RCT3*.

The interactive nature is based on a feedback loop. In this regard, icons are not only symbolic, but they support or scaffold information via feedback. For instance, the interactive drop-down window has icons to the left of the textual information that give hints about what needs attention in the theme park (see Figure 10.5). When clicked, the icon takes you to the location of the park that needs attention or requires fixing. The icon also shows up in the bottom-right corner with available tools that give access to the park feature to be fixed (see Figure 10.4). The textual information tells the player the nature of the problem such as "Studio Tour just had to make an emergency stop" (see Figure 10.5). The combination of the technology with pedagogy (textual hints, trial and error, exploration, observation and intervention combining with icons that when clicked take the player to area of need) helps to promote a better understanding of the gameplay and content. This may influence players' development of knowledge while playing the game and their speed of progress in the game. Speed of progress should be important because it gives players a chance to have more exposure to different game content and the possibility of learning in multiple contexts; however this does not mean a player exploring only one scenario versus one who plays six scenarios will learn less. This is because a player playing one scenario may choose to explore and learn more subtle details about the game such as in ride construction and creativity while the player playing fast by meeting the game objectives may beat the game but miss opportunities to build rides and creativity skills related to it. Thus the player who beats the game may learn less about the explorative and nuance details about the game.

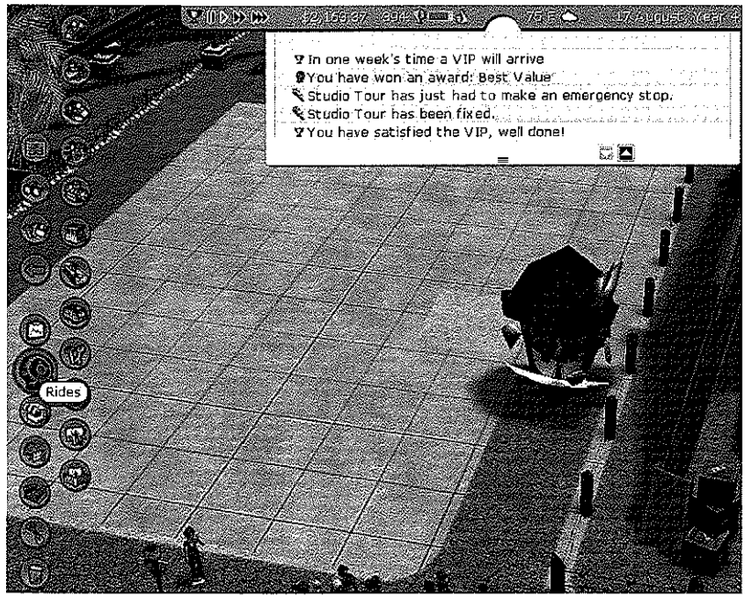

Figure 10.5. Icons on left of screen and drop-down menu provide information to guide players.

Interactivity and visual aesthetics individually aid in teaching players about the game, but when combined they provide a very crucial genre characteristic that influences the pedagogy of the game. Gee (2003) describes the pedagogy of the game as being embedded in the design of the game. Observation and intervention are a major pedagogical approach that is a result of the genre of the game that dictates the pace of the game, and visual aesthetic enhances the play. The pace and visual aesthetics drive the interactive nature—observe and then intervene or strategize in planning ahead before a problem occurs or to anticipate future needs of guests or satisfy some design need of the player.

What has been discussed shows the crucial role of the game genre/pedagogy. Tables 10.4 and 10.5 illustrate an example of the analysis for how the game is analyzed according to levels and what economics/social studies principles can be learned. In this game the economics principles could be learned in all levels of a scenario in some variation, but gameplay increases in complexity across the levels (see Table 10.5). This is important for both teachers and researchers when considering the game pedagogy/genre because it facilitates what can be learned and it dictates that learning objectives or goals should be closely aligned with the game genre and content, not by simply replacing the game content with external content or pedagogy.

Table 10.4. Example of Analysis of Scenarios

Apprentice: Increase number of rides and company cash, which will increase park value and guests in the park. Requires managing the given $10,000, which includes a $5,000 loan at 3.9% per year, by making decisions that will affect the number of patrons in the park and park value. Decisions such as the types of ride: several smaller ones or one big expensive and exciting ride? Managing workers, their training and wages. Research, ride ticketing, food and drink sales and stock, loan interest. Patron attitude, park cleanliness, number of workers, loan interest and ride reliability may be overlooked because reaching the goals here is easy, with the main focus on increasing number of rides and placing food and drink stands.	**Apprentice:** No paid workers. Under $12,000 with $1,000 loan at 10.9% per year. Given three rides including one roller coaster. Given just under $12,000, the level can be achieved by building or buying a roller coaster from the available ones in the library that are over 1,000 ft long and have an excitement level of at least 3. More research increases the number of available rides and park tools. By increasing ticket prices for rides, monthly ride ticket sales will go up. Workers will have to be employed and paid. This affects ride reliability, and park cleanliness and value. Food and drinks will have to be provided. What happens if they are not provided, since they are not required to fulfill achievement?
Entrepreneur: Same as Apprentice—reiteration of skills but with increased complexity. Taking into consideration ride value, food value, park cleanliness, ride reliability, patrons' attitudes, and ride reliability. More patrons mean more trash in the park—increase budget for park maintenance and amenities, more janitors. More rides means more mechanics, more payment for salary, need for more food and sanitary conditions (bathrooms, bins), better looking park means more patrons and receiving good awards. Bad looking park means a chance to receive negative rewards. Manage workers' attitude. React to patrons' views about the rides. Your decisions enhance the park value.	**Entrepreneur:** Repaying the loan can be achieved easily, but this decreases available cash. How does repaying a loan affect what you can do in your park? How does it affect available cash? Increasing the number of rides and the ticket prices will increase monthly ticket sales and money. Good rides.
Tycoon: Same as Entrepreneur—reiteration of skills but with increased complexity.	**Tycoon:** Same as Apprentice—reiteration of skills but with increased complexity.

Table 10.5. Example of Possible Economics and Social Studies Concepts to Be Learned Within a Scenario

Scenario	Vanilla Hills	Complexity
Apprentice level:	Opportunity cost, scarcity (cash), cost-benefits, competition (rides), trade-offs	Low
Entrepreneur level:	Opportunity cost, scarcity (cash), cost-benefits, competition (rides), trade-offs	Medium
Tycoon level:	Opportunity cost, scarcity (cash), cost-benefits, competition (rides), trade-offs	High

Content and Skills

Content in *RCT3* spans a wide range. It includes information about roller coasters, business, economics, social studies, mathematics, physics, technological literacy, social relationships, ethics, information literacy, and capitalist ideals of buying and selling. While the game covers a lot of different content areas, they overlap, and in this interaction four of these areas emerged as having more depth than the others. The four content areas that emerged after playing the game and exploring what could be learned in more depth, based on the interaction with technology and pedagogy, are economics, social studies, and information and technology literacy skills. Economics, social studies, information literacy, and technology literacy emerged as designed content made possible by the designers of the game. The focus on building and managing theme parks, the genre choice that influences the pedagogy, and the technology all play roles in the emergence of what can be learned in a significant manner in the game, including supply and demand, the importance of a good location, scarcity, opportunity cost, pricing, and systemic management of resources such as money, time, and space.

Much of how and what is possible to be learned was discussed under the preceding topic (Pedagogy). Content and skills are learned when applying strategies to navigate and play the game. Much of the economics that can be learned in *RCT3* are microeconomics principles, such as supply and demand or scarcity. Social studies encompass knowledge of economics, including production, managing resources, and helping young people making informed decisions. *RCT3* is a production-economics focus game based on managing resources such as money, time, workers, and space.

Information literacy encompasses being able to evaluate information critically, creatively, efficiently, effectively, and competently. Technology literacy encompasses knowledge about creativity and innovation; communication and collaboration; research and information fluency; critical thinking, problem solving, and decision making; digital citizenship; and technology operations and concepts. Thus, both types of literacy overlap and can be learned as a part of gameplay and developing game knowledge.

Conclusions and Implications

There are several key implications from this game analysis. First, using the combination of the Playing Research Methodology and Technological Pedagogical Content Knowledge framework offers a focus and coherent approach for conducting a game analysis. It provides a platform from which a researcher may choose a game for a game-based learning study or for which a teacher may choose a game to be used in a classroom to learn particular content objectives. In this game analysis conducted as precursor to a game-based learning study, playing the game and focusing on the content, pedagogy, and the technology facilitated knowing the affordances for each of those areas in a multifaceted and interconnected manner.

Second, the analysis of *RollerCoaster Tycoon 3: Platinum*, though conducted and presented in separate units (technology, pedagogy, and content), clearly showed the interrelatedness of each unit and the effect of the TPACK framework for focusing on the analysis. Digital games are holistic environments, and the technology, pedagogy, and content are inextricably intertwined in the environment. The technology of the game was influenced by the genre and this in turn had an effect on the content that emerged. The content that the game was designed around may only be fully understood and learned through playing or close observation of gameplay to fully comprehend how it emerges.

Third, researchers should play the games they study. The level of interactivity in simulation strategy games and their visual aesthetics are the two main elements that characterize the genre and promote gameplay and pedagogy. This is important because the combination of the technology with pedagogy (textual hints, trial and error, exploration, observation and intervention) helps to promote a better understanding of the gameplay and content. In *RCT3*, part of the content emerged through playing the game. Thus, playing the game as researcher provides a better understanding of what to assess for in a study of the game for learning. It also gives a better understanding of how the structural characteristics of games influence the process of learning. Likewise, teachers should play the games they plan to use in their courses in order to know what to focus on and how to focus on a particular learning goal.

Finally, from using the TPACK framework, it was revealed that *RCT3* is representative of the other games within the simulation strategy genre, such as *Civilization IV*, in that it has a dominant embedded pedagogical approach of observation and intervention at the level of interactivity to proceed in gameplay. The game combines disciplinary knowledge of economics and social studies, and skills including information literacy and technology literacy, with gameplay in order to achieve its objectives and eventual goal of building and operating a theme park business. Basic physics principles and mathematics may also be learned while playing the game. It does all this without saying explicitly to children that they will be learning economics, social studies, information literacy, and technology literacy. This is important because children tend to disengage from games that are explicit in their objectives to teach about some educational content (Laurel, 2003).

A game analysis should look beyond TPACK and the PRM approach when analyzing a game as a precursor for a study and for appropriateness with a targeted population. Popularity and appeal to both genders are important. Thus, in the end, what the game analysis provides is a way to examine technology, pedagogy, content, representativeness, popularity of the game, and whether the game caters to both genders of the age-appropriate target group. A game analysis reveals that whether for teaching or for researching games, game genre is important because it facilitates what can be learned. This in turn requires when teaching with games that the learning objectives or goals should be closely aligned with the game genre and content. It also means that one cannot simply replace the game content with external content or pedagogy and expect seamless integration of the game, pedagogy, and the content.

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