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Evaluating Educational Videogames: A Magic Bullet

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Abstract

This paper outlines a simple and effective model used to evaluate and design educational digital games. It facilitates the formulation of strategies for using existing games in learning contexts. An overview of the model is provided and then the model is used to analyze several games. The implications that this model has for the design and use of games as instructional technologies are described.

Introduction

The medium of the videogame is set apart from other media by its highly interactive nature - people proceed in games by doing things, and this experiential quality lies at the very core of game design. It isn't a game if there is no interaction – in other words the environment **must** change as a result of player actions. Videogames are popular precisely because they provide an experience - and games designed for learning can do no less. Thus, any epistemology of games must begin with the experience (Squire, 2006). With few exceptions most videogames also involve learning: a player finishes with a videogame when there is nothing more to be learned from it.

This paper outlines a simple yet effective model that can be used to help in the evaluation and design of digital games for educational purposes. Further, this model can help educators formulate strategies for using existing games within a learning context. The first part of the paper provides an overview of the model and the second part will use the model to analyze several popular commercial and educational digital games. Implications for game-based learning in formal settings are discussed at the conclusion.

All Games Teach

The path to the end of a videogame always requires the player to learn something: new facts, new skills, new strategies, and so on. This is true of all games, at least the first time they are played. There are some games that are what the author refers to as "Sorting & Organizing" games (such as *Tetris* and *Bejeweled*) where replayability does not rely on learning something new, but instead taps into our natural propensity to classify as a means of making sense of the world. For the purposes of this discussion, *learning* includes all possible learning that can occur (useful/useless, valuable/worthless, etc.) and is the superset of *education*, which includes only that which a society deems valuable. Thus it can be said that all games require learning, even if that learning has no use or value outside the game environment. It follows then that all games teach, since most single-player games are typically designed to be self-contained in that they are intended to be playable by a person who is alone and without help. This has implications for understanding games in a learning context.

Analyzing Games

When designing a new game or evaluating an existing game for its potential in a classroom or other formal educational situation it is critical that we understand what the game is intended to teach and how the game facilitates that learning. In fact, one of the things that makes a good game good is that it supports the learning players must do to win in effective ways. Many videogames already embody sound learning design principles (Becker, 2008) but there are still very few formal ways to assess and evaluate games. The one described here allows us to analyze how the various learning elements in the game are balanced, which in turn has implications for how

engaging a game will be and how it might be used in the classroom. The model is a simple one as simple models have the advantage of being easy to remember and implement. It can be used to evaluate the design of a game not yet built but is also helpful in evaluating existing commercial games to uncover what kind of learning that game can facilitate. Evaluating a game using this approach can help educators create a better fit between identified learning objectives and the ways in which a game can be used to help achieve those objectives.

The Magic Bullet Model

The author originally developed this model while analyzing several videogames using a different methodology known as instructional ethology (Becker, 2007b). In the process of producing extensive gameplay logs it became apparent that all learning in and around a game can be classified into four broad categories. It is known that not all learning in a game is necessary to win and also that sometimes learning occurs that was never intended by the designers. Concomitant learning in games can be classified as (non-exclusive) members of at least one of these sets. Several visualizations of the interrelationships of these four sets were created, and the final picture ended up being somewhat bullet-shaped (see Figures 1-4 below). Thus, it earned the moniker "Magic Bullet".

The four categories of learning are as follows:

1. **Things we CAN learn** - as deliberately designed by those who created the game. This can include learning from all domains (cognitive, psychomotor, and affective) and all categories (remembering, understanding, applying, analyzing, evaluating, creating (Anderson, Krathwohl, & Bloom, 2001)). Learning in this category need not be related to any of the game's goals. For example, it is possible to learn how to create new items and levels in *Scribblenauts*, but the game can be won without ever doing that.

2. **Things we MUST learn** - this will almost always be a subset of the first category, and includes only those items that are *necessary* in order to win or get to the end. Since there is often more than one way to win a game these item must sometimes be qualified in the form of an *if-then* statement, such as "If we wish to pay off our mortgage in *Animal Crossing* then we MUST learn how to earn 'bells'." By contrast, planting fruit trees and selling the fruit is one way to accomplish this in the game, but it is not necessary as there are also other ways to earn 'bells' so it falls under the CAN-Learn category for this goal. However, if the goal is to collect all possible forms of fruit, then 'planting fruit trees' falls under the MUST Learn category.

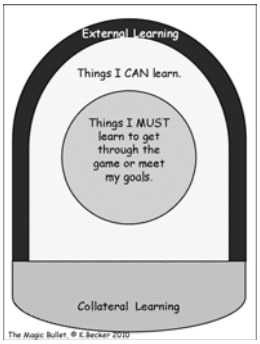
3. **Collateral Learning** - other things we can learn. These are not necessarily designed into the game, although sometimes designers may hope that players choose to take these up. For example, *Tekken* is a martial arts fighting game featuring a form of fighting called capoeira. As a direct result of playing this game, players may research and learn about capoeira, which is a Brazilian form started by slaves that combines dance, aerobics and music with kicking.

4. **External Learning** – This category includes learning that happens outside of the game: in fan sites, and other social venues. This category also includes 'cheats'. One could argue whether or not this should be seen as a category distinct from Things-We-CAN-Learn. Cheats were originally designed into the game for testing purposes, and are often left in the game once it ships. Thus, they are deliberate design elements on the part of the designers, but are not really considered part of the normal gameplay. Note that some game designers may consciously put the cheats into play by assuming people will use them and designing accordingly but they are rarely, if ever, *required* to win, so they are almost never part of what we MUST learn. For many people, a game like the original *Myst* can not be won without turning to game guides that include spoilers.

Variations on a Theme

This model is highly flexible and is intended to provide a visual representation of the relative proportions of the four categories of learning in a game. The four variations below are each explained and accompanied by an example of a game that fits the image shown. While it would be counter productive to use too fine a granularity when mapping out the learning balance of a game, there are still many other variations that can be used to inform game design.

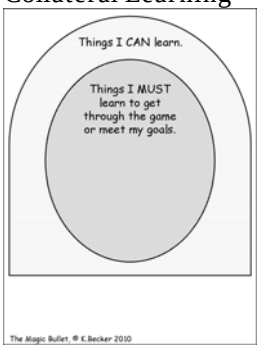
Figure 1: The Magic Bullet © K.Becker



This is the original conception of a well balanced game. What a player MUST learn is less than half of what can be learned, but is still a reasonable amount. There exist opportunities both for collateral and external learning. Examples of popular games in this category would include: *Black and White*, The *Nancy Drew* series, *Half-Life*, and the *Zelda* series.

It should be noted that deciding on the exact proportions depicted for any given game is a subjective process and always open for discussion. This feature is in fact one of the aspects of this model that makes it both useful and unique: variations in the proportions as seen by several analyzers can inspire useful conversations about what is in the game and how that fits in with the goals of those who will be using the game.

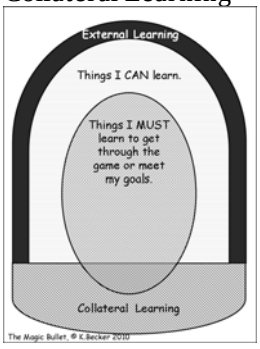
Figure 2: No Collateral Learning



In this configuration there is no collateral or external learning at all, which would imply that this game offers little connection to any real-world activities, situations, or experiences. The lack of collateral learning opportunities in a design like this implies either a single-purpose game (which could still be a good game if it is a mini-game), or an impoverished one. Very few, if any popular games could be described with this version of the Magic Bullet. A game such as *The New Super Mario Bros.* might fall into this category, but only if one disregards cheats and the learning that is transferable to other platform games.

Some games of this sort can still be entertaining, and therefore this design can also make for a worthwhile educational game, but the design must be very carefully considered and aspects the contribute to a compelling entertainment game can't always be co-opted for use in an educational game. Many 'classic' arcade games such as *Space Invaders*, or *Pac Man* would qualify for this category.

Figure 3: MUST Learn includes Collateral Learning

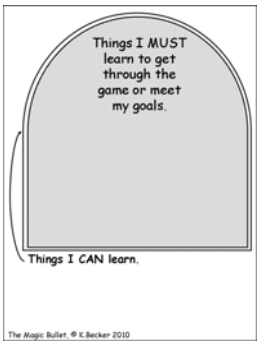


Though not originally designed as an educational game, *Where in the World is Carmen Sandiego?* has come to be grouped with games for learning, and it can be described very nicely using this version of the Magic Bullet. At the height of the game's popularity in the mid-80's, players would often complain that they didn't know enough geography to get good at the game.

This kind of scenario is a highly desirable one for educators but such a game will only work if appropriate opportunities to gather the requisite collateral learning are provided and appropriate teacher support for using the game is easily accessible. This is also a design that works best for a game intended to be used over numerous sessions - perhaps throughout an entire unit or even over several years.

Figure 4: MUST Learn = CAN Learn

Games in this category are ones where there is really nothing to learn that isn't part of the goal. They are often classified as 'bad' games by players.



Sadly, many 'edutainment' games fall into this category. One of the games that many teachers recognize and perceive as a 'good' game is in fact one of these games, namely, *MathBlaster*. The author performed a detailed comparison of *Mathblaster* and *The New Super Mario Brothers* and though both games are side-scrolling platformers where the challenges have little to do with the story, one is part of one of the most popular series of all time, and the other is the game that many game industry professional 'love to hate' (Becker, 2007a).

This is a more extreme variant of the distribution shown in Figure 2, and would ONLY work as a good game if the game is a short-form game that is either not intended to be replayed (such as *September 12*), or includes a considerable random component (such as *Tetris*).

Summary

In spite of countless attempts, we have still not succeeded in finding a model, method, theory, or other prescription that can guarantee 'good', or successful novels, films, games, instruction, or any other creative design effort. This model does not change that. The author makes no claims that this model can guarantee success either in the design of a game or in the design of an intervention that uses a game. It does however provide an easy to use, flexible framework through which to view games, and thereby provides a structure that allows games and designs to be compared against each other. It allows for a more deliberate design and analysis that can help to ensure that the learning in a game is in fact related to the educational objectives of the intervention where it is used.

Biography

Katrin has taught Computer Science for over 30 years. She also teaches game design and technical writing. Her PhD in Educational Technology focuses on instructional game design. She's been teaching about digital games since 1998 and taught one of the first Digital Game Based Learning courses for an Education faculty.

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