A Magic Bullet for Assessing Games for Learning

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Abstract: This paper outlines a simple and effective model that can be used to evaluate and design digital games for learning. This model can also help in the formulation of strategies for using existing games in learning contexts. An overview of the general model is provided, followed by a new variant designed specifically for the analysis of educational games. Several familiar games are then examined using this model as the lens. The implications that this model has for the design and use of games as instructional technologies are described.

Introduction

Making use of media to augment and enhance learning is nothing new: we've been doing it as long as anyone knows. Ancient people used to gather around the campfire and tell stories, complete with pantomime and sound effects. The skillful use of the teller's voice, sound effects, body movements, and even props and firelight – all of these are forms of communication media.

Ever since we started to examine learning in a more formal way we have struggled to find effective ways to assess the value and efficacy of the technologies we use to deliver instruction. Some methodologies look at the learner (Dick, Carey, & Carey, 2001; Pirnay-Dummer, Ifenthaler, & Spector, 2010; Sims, 2006), and this is very important, but as the design of instructional solutions relies more and more heavily on the integration of technology, it also becomes important to be able to evaluate the object itself. It is useful to be able to assess an instructional object while it is still in the design stages. Also, as the number of ready-made objects grows, it also becomes important to have a methodology that can be used to help choose among them. Although there is no shortage of resources on how to design and build digital educational applications, approaches to evaluation of the same are far less plentiful (Schleyer & Johnson, 2003). This is especially true of interactive objects.

Videogames are among the most highly interactive digital media currently known, and while they share qualities with many other media forms, their interactivity sets them apart (Egenfeldt-Nielsen 2004). A key aspect of games is that people proceed in games by doing things, and this experiential quality lies at the very core of game design. A game is not 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 of this experience. Games designed for learning should do no less. Thus, any epistemology of games for learning must begin with the experience (Squire, 2006).

Formative and summative evaluation of instructional materials are essential elements of the instructional design process, but when using digital games and simulations for learning it is essential that we be able to assess the software *before* it is used in a real situation. Evaluations and reviews of software do exist, but they often say little about what and how the students will learn (Kafai, Franke, & Battey, 2002). This paper outlines a simple yet effective model that can be used to evaluate existing games as well as evaluating the design of new digital games for educational purposes. Further, this model can help educators formulate strategies for using existing games within a learning context.

All (Video) Games Teach

Game design documents (GDD) are meant to describe a game in sufficient detail that a development team can build it (Fullerton, Swain, & Hoffman, 2008). These documents discuss the type of play, the look and feel, the narrative if one exists, and what players can DO in the game. As players progress through the game, there are skills that they must acquire and perfect, facts they must remember, and problems they must solve. These are also described in the GDD. Game designers are primarily concerned with the player's experience and thus the design documents describe this in considerable detail.

Another way to look at games that is normally not considered by designers draws on the notion that all games teach. To get to the end of the game, players must always LEARN something, and that is the perspective that is the focus of the Magic Bullet model. This model looks at various kinds of learning in a game from a perspective that helps visualize how those kinds of learning are balanced within the game. The nature of that balance reveals much about the game, also allows us to analyze the game from an educational perspective.

Learning and *education* are two related but distinct terms. R.S. Peters, in Criteria of Education (1966) states that it is impossible to consider education without implying some worthwhile and desirable change in the person being educated. Thus, *education* is value-laden and often culturally defined but *learning* happens all the time – it is what we humans *do*. While there is no clear and simple definition of learning, it usually includes some sort of change in behavior or in what is known. Given that, it can be said that all games require learning, even if it is only learning how to play the game. Most single-player games are designed to be self-contained, and if all games require learning, it also follows that all games must teach. In other words, there must be sufficient support within the game itself to help the player learn what they need to learn in order to progress through the game. The commercial success of the game often depends on it. This has implications for understanding games in a learning context. It especially has implications for approaches we might use to evaluate games.

In order to get to the end of a videogame the player must learn something: facts, skills, strategies, and so on. This is true of all games, even the simplest of games, at least the first time they are played. While there are other reasons as well, a game stops being fun to play when the player has learned all there is to learn in the game. The more there is to learn in a game, the more replayability it has. Players will sometimes go back and play through a game again even after they have already won. They do this because there are still more things to discover – more things to explore, different endings, and so on - in other words there are still more things to learn. At the other end of the spectrum, 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, but even these involve learning strategies.

The Magic Bullet Model

This model originally came about as a by-product of a more formal analysis of videogames using a different methodology that was also developed by the author known as instructional ethology (Becker, 2007b). In the course of producing extensive gameplay logs it became apparent that one could classify the learning that happened in all of the games into four broad categories. Some learning in a game is not required in order to win. It is also true that sometimes learning occurs during gameplay that was never intended by the designers. Ultimately, all learning in games can be classified as belonging to at least one of the following four sets:

1) things we CAN learn in the game,
2) things we MUST learn in order to get to the end,
3) things we learn as a result of playing the game but aren't part of the game itself (collateral learning),
4) things we learn outside the game that are helpful back in the game (external learning).

Several visualizations of the interrelationships of these four sets were created by the author, and the final picture ended up being somewhat bullet-shaped (see Figure 1). Thus, it earned the moniker "Magic Bullet". The four categories of learning can be described as follows:

1. **Things we CAN learn.** This first category of learning in games includes all the elements deliberately designed by those who created the game and includes anything and everything we can learn directly from the game. This category encompasses all of the learning that can happen IN the game.

2. **Things we MUST learn**. This set 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. Some games have a fairly clear set of requirements but there is often more than one way to win a game and in these cases the MUST-Learn item must sometimes be qualified in the form of an *if-then* statement. For example, it is not possible to win in *Tetris* without learning how to move and rotate blocks so both of these items fall in the MUST Learn

category. In a game like *Animal Crossing* however, planting fruit trees and selling the fruit is one way to accomplish the goal of earning bells in this game, but it is not strictly necessary as there are also other ways to earn bells so planting trees 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**. This category includes emergent behaviors and other things we can learn that are not part of the game and that *do not impact on our success in the game*. For example, *Tekken* is a martial arts fighting game featuring a form of martial art called capoeira. For example, one of the activities players can perform in *Animal Crossing* is fishing. The fish in the game are all fish that exist in real life, and when examined in the game’s inventory or viewed in the museum, players are presented with some facts about those species of fish, such as their size. Most of these facts have nothing to do with the game and so the facts would fall under the CAN Learn category but if we then Google those fish and learn more about them, it constitutes collateral learning.

4. **External Learning** – Distinct from the previous category, this last category includes learning that *can impact on our success in the game* but that happens entirely outside of the game in places like fan sites and other social venues. This category also includes game ‘cheats’. Cheats are elements included in the game by the developers for the purposes of testing the game during development. They allow players to do things like skip levels or become invincible. Cheats were originally designed into the game for testing purposes, and are often left in the game once it ships. Although they are deliberate design elements on the part of the designers, they were not intended to be part of the normal gameplay. Note that some game designers may consciously put the cheats into play when they assume people will use them and design their games accordingly but they are rarely, if ever, *required* to win, so they are almost never part of what we MUST learn.

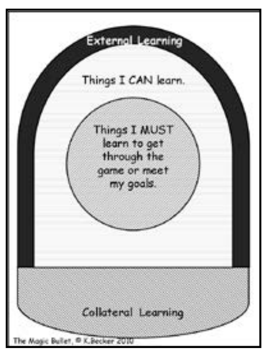

Figure 1: The Magic Bullet

Figure 1 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 when the whole of what CAN be learned is considered. There also exist opportunities both for collateral and external learning. This model depicts a game that allows for exploratory play both inside and outside of the game. The model implies a richness of experience that often translates into many hours of play.

These four elements create a visual representation where all of the learning in a game can be represented proportionally. Using this representation, it is possible to consider that learning in terms of the relative proportions depicted. These categories are broad and there is a temptation to try and define various sub-categories in order to better classify the myriad forms of learning that we formally know about, but that temptation should be resisted, with one exception to be explained in the next section. The problem with trying to create a fine grained model is that the greater the complexity, the harder the model will become to use as a tool. Merrill’s Component Display Theory (Merrill, 1999a) is a case in point. The basic idea is quite useful, namely that of designing instruction by following a set of prescriptions that effectively functions like a “Chinese Menu”. In other words instructional objects are sorted into columns and an intervention can be fashioned by ensuring that there are sufficient items from each column in the final solution. In practice, the idea was rather too complicated. In an effort to facilitate the automation of this theory, Merrill produced an even more complex solution called Instructional Transaction Theory (Merrill, 1999b). The author wishes to prevent a similar progression here by preserving the simplicity of the Magic Bullet model and allowing those who use it to add whatever embellishments they deem necessary. When we are considering games designed explicitly for learning, or games being repurposed to meet specific learning goals it becomes necessary to look at the model from several interrelated perspectives.

The Magic Bullet for Education

Games used for purposed other than pure entertainment are commonly known as *serious games* (Sawyer, 2003). Educational games fall into this category, although the term ‘serious games’ encompasses much more than that. In order to apply the magic bullet to games specifically intended for use in learning contexts it becomes necessary to further classify the learning into that which is *operational*, *elective*, and that which is identifiably *educational*. In an educational game the proportion of overall learning that is identifiably educational establishes its relative value in an educational setting. The first of these categories, namely operational learning is that which is needed in order to operate the game. This includes the use of the game controller in console games and learning the functions of the keys on the keyboard in computer games. Educational learning includes only that which meets the specific objectives of the current use. All other learning will fall into the third category, namely, elective learning. Just as in the more general model it is the balance that is important. Attempts to establish any specific proportion as being ‘right’ will only lead to designs that end up all looking the same. There are, however some important guidelines. The operational learning must make up a minority of the total learning. If one examines this notion from the perspective of time spent then the question becomes how much of the total time spent in the game should be attributable to learning how to operate the game? It would seem reasonable that the percentage of time spent learning the controls, navigation, etc. not take up much more than 10 or 15% of the total time spent. Put another way, suppose the game is one intended to be played in a 50 minute class at school. 10-15% implies that players should not need to spend more than 5-7 minutes learning how to play the game. That leaves approximately 45 minutes of gameplay, or at least, of time in the game to spend on other things. Here too while it may not be advisable to prescribe a specific number, it would seem reasonable to say that at least half the remaining time should be spent on activities that are directly related to the learning objectives. Looked at in this way it becomes easier to justify a longer time commitment for operational “must learn” items when the game is intended to be played over longer periods of time, such as is the case in Kurt Squire’s work using *Civilization* in high school classes (Squire, 2003).

One of the challenges of this model is in finding ways to measure the relative sizes of the categories for a specific game. It is unlikely that it will be possible to create an exhaustive or definitive list of all things that can be learned in a game unless it is an exceedingly simplistic game. Further, this model cannot yield a fully objective result. However, it will still be possible to use this approach as a way to get a sense for what’s in the game. Further, it serves as a well-structured framework around which discussions regarding learning content can be focused.

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 visual representation offers an easy to comprehend conception of how the learning in a given game is distributed and in that way offers a model that can be compared against other games and discussed. The magic bullet is primarily intended as a tool to help developers make more informed decisions about their game designs and to help educators evaluate games and game designs for use in learning. Different proportions of these categories will result in very different experiences in terms of gameplay, which in turn result in different learning experiences. To illustrate this, several variations of the model are described below and each is accompanied by an example of one or more games that fit the image shown.

In its ’original’ form, the model can result in many variations that can be used to inform game design, both generally and specifically for learning. The author does not recommend attempting to delineate all of the learning that can happen in a given game – it is not clear that is even possible in many games. Producing a partial list is a useful exercise however, and items should be categorized as they are listed when this is done. Some games have games within games (mini-games) and these should be listed as single items where-ever possible. If necessary, separate lists can be generated for the mini-games. Once this is done, it is possible to create a Magic Bullet image of the game. The combination of list and image are then used to analyze the game’s design and determine if this game will serve our intended purpose.

Deciding on the proportions of each category 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 different analyzers can lead to highly productive conversations about what is in the game and how that fits in with the goals of those who will be using the game.

One configuration has no collateral or external learning at all (in which case they would not be part of the image), which could imply that this game offers little connection to any real-world activities, situations, or experiences. The lack of collateral learning opportunities in a design implies that the game is either a single-purpose game, or an impoverished one. If this is a description of a learning game, then it would likely be important that the MUST learn category is made up mostly of educational content.

This configuration could also portray a short form game (i.e. one that takes 15 minutes or less to play through). Some games of this sort can be quite engaging, and therefore this design can still make for a worthwhile educational game, but the design must be very carefully considered and aspects that contribute to a compelling entertainment game can't always be co-opted effectively for use in an educational game.

Originally released in the 1980s, *Where in the World is Carmen Sandiego?* can be described very nicely using a version of the Magic Bullet where the MUST learn portion actually overlaps the collateral learning area. That implies that this game actually requires learning outside of the game in order to win. When a game is designed that requires collateral learning in order to win, it must be clear that the target audience has the ability to acquire that learning. *Carmen Sandiego* had that. At the height of the game's popularity, players would often complain that they didn't know enough geography to get good at the game. In this case, a significant portion of the collateral learning is educational as opposed to elective.

The kind of game where key educational learning can be incorporated as collateral learning is highly desirable in education 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. On the other hand a simulation like *Real Lives* has been designed with much of that same sort of content included as part of the game itself. Although the overall configuration of *Real Lives* would look much the same as that for *Carmen Sandiego*, the mix changes if we separate out the operational, educational, and elective learning. *Real Lives* requires very little operational learning (meaning it is easy to learn how to play the game) and the bulk of both the MUST learn and CAN learn categories consist of educational learning.

Another variation would have the MUST learn and CAN learn areas occupy almost the exact same space. This describes a game where there is really nothing to learn that isn't part of the goal. These games are often classified as 'bad' games by players. Sadly, many typical 'edutainment' games fall into this category. For example, a game that many teachers describe 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 a member 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). One of numerous differences is that *MathBlaster* really offers no opportunity for exploration (CAN learn), and there is typically only one way to achieve the desired result.

If we take a game where the MUST learn and CAN learn regions are almost identical, and which is also lacking in both collateral and external learning, it would ONLY work as a good game if the game is a short-form game that is: a) not really intended to be replayed (such as *September 12*), or b) that includes a considerable random component (such as *Tetris*).

Summary

In spite of countless attempts, we have still not succeeded in finding a single 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 and analyze games, and thereby provides a structure that allows games and designs to be compared against each other. It facilitates 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. It can be used to assess candidate digital games to see if they're even worthy of further analysis. The model can be used to generate learning profiles of proposed designs, and evaluate the potential of non-educational commercial games. It can be used to facilitate a first cut analysis when a choice must be made among numerous options. The learning profile generated as a result of the analysis provides a simple high-level view of how the things we can learn from the game are balanced, and with that we can decide how best to support learners when they use it.

The process of generating the list of 'things learned' and classifying them into Can-Learn, Must-Learn, Collateral Learning, and External Learning is simple enough to be highly flexible yet structured enough to result in a robust analysis that provides a new way to think about games in education. The idea of using games as learning objects is very attractive to many but without a thorough analysis of the tool we cannot take full advantage of the medium.

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