The Key to Adventure Game Design: Insight and Sense-making

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Abstract

This paper aims at understanding how adventure games can support educational goals by understanding the foundations of their design, and what how inherent properties lend themselves to specific types of learning. The potential of adventure games as educational tools has been repeatedly discussed from the standpoint of education (Carroll, 1982; Cavallari, Hedberg & Harper, 1992; Ju & Wagner, 1997; Amory, Naicker Vincent & Adams, 1999; Moser, 2002; Dickey, 2006), usually focusing on the narrative framing that adventure games provide (Dickey, 2006), but not on their specific design conventions. Understanding adventure games entails understanding how their design helps the player learn.

There are two key aspects of adventure games that are discussed here, derived from the puzzle-driven nature of adventure games: domain knowledge and insight. The domain specifies the knowledge that the player must have in order to solve the puzzles in the game, whereas insight takes place when the player figures out the solution to the puzzle. This paper analyzes how game design can set up the domain, what are the aspects of the game that facilitate insight and, more importantly, how these design properties of adventure games can be harnessed to develop educational games.

The Key to Adventure Game Design: Insight and Sense-making

In recent years, Gee (2003) has persuasively argued that meaningful learning occurs in videogame play, and Koster (2004) has suggested that learning is at the core of all fun (engagement) in game play. Yet for all we know about the pleasures of learning through game play, we seem to be stuck at square one when it comes to applying that understanding to the kind of domain-specific learning in math, science, history, or language arts we hope to stimulate in students.

Learning takes place in all kinds of videogames, from understanding the rules of the game to the names of the different characters, or the geography of a specific world. One of the missing pieces in the literature of educational games is the examination of the design of successful commercial games and how they encourage certain types of learning, as a way to produce certain guiding principles for the development of educational games. Most works on educational games are written from the standpoint of education, with a superficial knowledge of game design and development. The contribution of this paper is informed by our own experience as game developers, both for education and entertainment purposes.

The first assumption that must be challenged in this process is that all games are the same. Every game genre teaches differently, and certain types of games are better than others at teaching certain areas. This paper focuses on adventure games, which have been repeatedly studied in the literature because of their potential as an educational tool (Amory, Naicker Vincent & Adams, 1999; Carroll, 1982; Cavallari, Hedberg & Harper, 1992; Dickey, 2006; Ju & Wagner, 1997; Moser, 2002).

Another myth that must be dispelled is that games are best for learning certain generalizable cognitive skills such as problem-solving, but that “academic learning” in any given

domain is too specific and too mired in trivia to be of interest to a general audience of players. This argument seems to take for granted that there is only a specific set of topics that are relevant in an academic setting, and that if the students are not naturally attracted to these topics, there is no way to motivate their interest and they will just have to plod along. In such an educational set up, whatever impact games might have on students' thinking or learning will be limited to academic areas where those students already apply themselves and/or excel.

In reality, the panorama is not so bleak—most of us have had experiences where we have been motivated to learn more about a subject in which we have no expertise. Many informal settings are able to provide that motivation: visiting a planetarium, zoo, or civil war battlefield, looking at art, watching a film or reading a literary classic. It is possible to experience pleasure in a domain in which we do not consider ourselves expert. If the activity is undertaken entirely voluntarily and for no larger purpose than entertainment, then it can be considered play. If we believe that the goal of education is to help learners connect disparate fields of learning, and to help foster life-long curiosity and interest, videogames are one of the ways to make the broad array of academic disciplines interesting and accessible to the largest possible number of learners.

Videogames provide an informal setting, which can be used as an initial motivation for players to learn; they can also deal with a wide variety of domains. Adventure games are perhaps one of the videogame genres allowing the widest variety of domain knowledge that can be integrated in the design; what is more, they can accommodate topics that other videogame genres may not be so good at setting up, such as history, literature, or languages. If games generally hold the potential to produce these benefits, we argue that adventure games are particularly well

suited to the task. They set up domains that, although separate from everyday life, present players with challenges that they must tackle with a variety of strategies.

One of the recurring arguments for using adventure games as a model for educational purposes is that they provide a narrative framework for problem-solving (Dickey, 2006; Ju & Wagner, 1997). We take this assertion one step beyond: learning in games takes place because they provide insight when the player solves a puzzle. Insight is supported and encouraged by the design of the game; not only is it the moment when the player learns, insight is also pleasurable and a way to keep players motivated. Rather than taking a high-level approach to game design, which has been previously been proposed (Dickey, 2006; Moser, 2002), this paper focuses specific game design issues, and how particular design choices facilitate certain types of learning.

Design Analysis as First Necessary Step

The value of adventure games as an educational tool has been repeatedly invoked for almost 30 years. Carroll (1982) was first in proposing a series of recommendations to make it easier to learn how to use a text editor, based on lessons learned from the text adventure game *Adventure* (1975-7). Ju & Wagner (1997) evaluated the types of learning that took place in a commercial adventure game; although their results were not conclusive, they observed that adventure games promoted problem-solving skills by better understanding the game environment. Amory, Naicker, Vincent & Adams (1999) identified that adventure games were the most appropriate genre to use as an educational tool, by evaluating the reactions to a set of different game genres. Moser (2002) proposed design methods for educational games, without discussing examples from actual games, but theories of game design instead. We inquire into the features of adventure games as game designers and theorists, so our first task has been to analyze

the design of commercial adventure games, which are successful as games, explore how learning takes place within them, and suggest how academic learning might be adapted to this form, based on our own experience working at the Singapore-MIT GAMBIT Game Lab and The Education Arcade.

Defining Adventure Games

The label "adventure game" can be applied to a wide range of games following a quest-like structure. Previous definitions of adventure games in educational settings (Cavallari, et al., 1992; Ju & Wagner, 1997) have been too broad. For example, Cavallari, et al. (1992) define adventure games as "a software program which presents an artificial environment with which the user must interact in order to solve the problems presented in the game." This definition can be applied to a wide range of games, from first-person shooters to role-playing games. Defining a game genre entails referring both to more specific game design elements as well types interaction in the game.

For our purposes, "adventure games" refers to a particular set of games that have their origins in the text game *Adventure*. This does not mean that adventure games are text-only: the earliest games inspired by *Adventure* were text adventures (*Zork: The Great Underground Empire* (1980), *The Hitchhiker's Guide to the Galaxy* (1984); the uses of the graphical capabilities of computers gave way to graphic adventure games (*King's Quest* (1984), *The Secret of Monkey Island* (1990)). With the generalization of the mouse as an input device, point-and-click became the standard interface of adventure games, such as *Myst* (1993) or *Machinarium* (2009) more recently. These games share five features (Fernandez Vara, 2009), which set them apart from other games: they are story-driven, the player controls a player character, puzzle-solving constitutes their basic core mechanic, the interaction with the world is mainly object

manipulation, and the game motivates the player to explore the space of the game and the possible actions within it. Let us describe these characteristics in more detail:

Story-driven

Adventure games have a story, which unfolds as the player advances in the game. In some cases, the story may be simple, as the treasure raiding of *Adventure* or *Zork: The Great Underground Empire* (1980); other times the player may have to reconstruct what happened in the world, as in the case of *Myst* (1993). The story is inextricable from gameplay, since the objects and characters of the story are also agents and items in the game.

Player Character

The player participates in the game world by controlling a player character, who carries out the commands of the player in the world. The player character may be a blank slate, as in first-person point of view games like *Myst* (1993) or most early text adventure games; graphic adventure games feature a player character that the player can see on the screen. The player also becomes the center of the action, because she is controlling the protagonist of the story. Unlike computer role-playing games, the player character of adventure games does not have any stats or health points that improve as the player acquires more experience through the game.

Puzzle-solving

Through the game, the player must solve a series of problems in the game world. Each problem is a puzzle that is integrated in the environment, and solving it constitutes an event in the story of the game. The puzzles in the game are interrelated, so that solving one may open up a new one, or facilitate solving another. Puzzles are the focus of this paper, therefore we will expand on the nature of their design in the sections below.

Object Manipulation

The player interacts with the game world by inputting commands for the player character. These commands are predominantly picking up objects, examining and manipulating them to solve puzzles (e.g. combining them, giving them to characters). Some of the basic commands available to the player are *look*, *open*, *close*, *pull*, or *push*. Interacting with characters is an anthropomorphic way of manipulating objects, since the player obtains information about the world in general and the character in particular through dialogue or by observing the character.

Exploration of space and action

Manipulating objects and interacting with other characters encourages the player to explore the world to learn how it works. The player thus has to experiment in the world in order to solve the puzzles, see what works and what does not. Rather than explaining to the player what to do, the player has to seek information by talking to characters, and trying different actions with every object. This takes place within the game world, a simulated world the player navigates in search of information and challenges.

These five features are not unique of this genre, but their co-existence characterizes every adventure game. By these standards, *The Legend of Zelda: A Link to the Past* (1992) is not an adventure game, since its core mechanic is not puzzle-solving but combat, the puzzles are not interconnected, and the player character has stats, in the form of health containers which increase through the game. In contrast, games as diverse as *Zork* (1980), *Phoenix Wright: Ace Attorney* (2005) *Machinarium* (2009), and *Heavy Rain* (2009) do share these features and can be considered adventure games.

These features make adventure games particularly apt to motivate learning. Their story-driven nature provides a narrative in which the problems are integrated, thus encouraging

situated learning through problem-solving (Dickey, 2006). The player must learn about the game world through a continuous enquiry: exploring the space, talking to characters, examining all the objects and manipulating them. Exploration helps the player know more about the story of the game, the workings of the game world and its limits. What is more, this exploration also models a stance toward the world that characterizes the work of scientists, mathematicians, historians and philosophers. As such, adventure games represent an ideal platform for spurring reflection on what it means to engage the world with curiosity and inventiveness. In the following sections, we will unpack how learning takes place in adventure games, how design can encourage it, and what commercial games do not do that educational adventure games should aim at.

Basic Features of Puzzles

Puzzles are not exclusive to adventure games: they are as old as the Sphinx riddle, and as common as jigsaws, crosswords, or mazes. A puzzle is a problem in need of a solution, as Danesi (2002) states; the solution is usually unique, although there may be more than one way to achieve it. Think of a 1000-piece jigsaw: even though many players will start by assembling the edge of the image, not everyone will follow the same strategy to complete the puzzle. Some people will fill from the edge in, others will assemble pieces of the same color; it is highly unlikely that two players will place the pieces in the same order, and yet the final result will always be the same image.

Puzzles thrive in an essential ambiguity, since they conceal their answer at the same time they demand it (Hovanec, 1978). Designing a puzzle of any kind therefore establishes a basic contract between the designer and the player, where the designer will provide a challenge that is fair to the player (the game is not too easy nor too difficult), and the information needed must be

available to the player, either from what they already know or what is provided in the puzzle. The designer of an educational game must set up the same contract: the difficulty of the game must be adequate to the learner; the designer must consider what the learner may already know; if it is something that the learner may not know, the information and concepts to be learned must be integrated and accessible in the game. The opportunity for the designer of educational games is that, if the puzzles are well designed, the process of solving them becomes the very process of building knowledge and skills, which is one of the end goals of education.

Along with solitaire card games, puzzles were the only single-player games before the advent of videogames. Whereas solitaire requires only rudimentary understanding, and is partly a game of chance (whether it is solvable or not depends on the order of the cards), puzzles are games in which players' success is dependent on skills or knowledge they bring to the game, or what they learn to master through the course of gameplay.

Puzzle books were a popular ladies' entertainment during the 19th century, and were also considered to improve women's intellect (Hovanec, 1978). Although puzzle books could be shared, their book form configured them as single-player experiences. Conversely, the computer screen has turned puzzles in adventure games into an experience that can be shared with other players. There can be communal puzzle-solving of an adventure game, which does not require any extra options or multiplayer design features. This implied characteristic is relevant to educational adventure games, because learners can learn from each other as well as from the game.

Furthermore, technology also makes it possible to support collaboration between players, expanding how adventure games naturally accommodate multiple people playing. The Education Arcade's mathematical puzzle adventure game *Lure of the Labyrinth* (2008) is

designed to be played by teams of players, with scoring that provides an incentive for players to help their teammates, and a built-in messaging system to encourage in-game communication. Players can therefore communicate puzzle-solving strategies to each other. By exchanging information online, players improve their reading, writing, and critical thinking.

Technology also makes it possible to create puzzles that are procedurally generated, where the solutions are different every time they are played. In such puzzles, the player is not learning the answer to a specific question, but rather learning puzzle-solving strategies. In *Zoombinis' Logical Journey* (1996) players must get past a troll that demands a pizza without specifying the preferred toppings. The player must keep offering up choices, and deduce the winning one based on his two possible replies, either "there's something on that I don't like," or "more toppings." Every time the player encounters the troll, his preferences have changed so remembering his preferences in meaningless. Only when players learn the procedure of controlling for variables—that is altering the offerings by only one topping at a time—can they routinely solve the puzzle. By learning to solve the puzzle, the player gains insight into a practice critical for analytical work in both hard science and social sciences.

Insigth as the Key to Learning

Providing the player with insight is a defiing feature of puzzles (Danesi, 2002), which is key to understanding how learning takes place in adventure games: there is an 'a-ha' moment, when the player understands a part of how the world works and what she has to do to solve the puzzle. The moment of insight is also a moment of learning.

Insight is pleasurable: learning something new is a discovery, it is rewarding. As Danesi (2002) indicates, the player solves a mystery, fills a gap thanks to that insight. Solving the mystery makes the player feel clever, which is one of the best motivations that can be provided

to a learner. In well-designed adventure games, where one puzzle leads to another, insight is recurrent, providing an incentive to keep playing. This is reinforced by giving the player something new as a reward: from obtaining an object, to opening up a new area, to watching a cut-scene that reveals what happens next in the story. Educational games can take advantage of the pleasure of insight as a way to incentivize learners, to keep them playing and to enjoy learning.

Mathematical word puzzles have tried to encourage insight for many years, by presenting a situation where the learner has to find a mathematical solution to a problem. The issue with word puzzles is that the context they provide is usually limited and contrived; the situations are artificial, and finding the solution does not seem particularly insightful. The solution is not meaningful to the learner, because the problem does not seem to have any further purpose than completing the homework itself.

In adventure games, the puzzles are contextualized in a meaningful way and interrelated, so that the solution to one problem may lead to another puzzle or another solution. There are also patterns that may recur with variations from puzzle to puzzle. *Myst* (1993), for example, is an excellent example of interrelated puzzles and patterns: by solving the puzzles in the main area of the game (Myst Island), the player gains access to other islands (called Ages), where there are new puzzles. Each age has puzzles that follow different patterns: in the Selenitic Age, most of the puzzles involve listening to sounds; in the Mechanical Age, the puzzles involve rotating devices in order to gain access to different parts of the island. The player can thus apply what she has learned from one puzzle to another.

To a lesser extent, insight can also take place even when the player is provided the solution, because it allows the player to learn something new. If the player sees where the

solution comes from, it will help her to understand the game world better and maybe to apply that knowledge in a later puzzle.

Some adventure games, however, are notorious for puzzles that do not seem to make sense, even after being given the solution or solving the puzzle by trying something at random. This prevents insight from taking place, even when players are given the solution, and it is due to designers ignoring a set of basic principles of how players make sense of games (see Wolpaw, 2000, for a detailed example of one such puzzle). The following section explains how insight takes place, the ways in which game design can encourage insight and therefore learning.

Domain Knowledge

Puzzles are situated within a domain, established by how the puzzle is posed. Arrangement puzzles such as tangrams, for example, are framed within the domain of geometry; algebraic puzzles are situated within the domain of mathematical operations. Riddles are situated first in the realm of the language in which they are formulated, which is also associated to a specific sociocultural background, which is another domain.

Defining the domain is essential to the design of adventure games. The player must know that domain, or have access to it, in order to solve the puzzles. If the domain is familiar to the designer and not the player, the puzzles will not be solved and the player will eventually give up. It has been often the case that adventure game designers try to outwit the player, without realizing that they are failing at keeping the player's interest by preventing insight from taking place. This is known as a "designer puzzle" (Bates, 2004), a practice decried by professional game designers because it breaches the contract between the player and the designer. It is not a matter of concealing the information completely, but providing enough information to entice the player, providing a challenge on a par with the player's abilities.

In adventure games, the domain can also be set by the fictional world of the game: from the world of pirates (*The Secret of Monkey Island* (1990); *Plundered Hearts* (1987)), fairy tales (*King's Quest* (1984) series), the Victorian England of Sherlock Holmes (*The Lost Files of Sherlock Holmes: The Case of the Serrated Scalpel* (1992); *Sherlock Holmes: Secret of the Silver Earring* (2004)). If the game is set in a fictional world, the game has to explain its rules to the player: e.g. it is not the same to have a game where the player can use magic to solve problems (*Loom* (1990), *Simon the Sorcerer* (1993)), or the means to solve puzzles involve science-fiction robotics (*Beneath a Steel Sky* (1994)).

Even when placed in fantastic settings, these games nevertheless point toward how the same structure might be applied to academic domains. In *Trace Memory* (2005) Ashley Robbins looks for her missing parents on a mysterious, and ghost-inhabited island. Though set in a science-fiction world, it provides a model that may be used in the study of history. Through the course of her investigation, the protagonist finds photos, letters and diary entries that gradually form a picture of the troubled family that once occupied the island. It is not a far stretch to propose a similar game introducing players to the kinds of reasoning historians use to piece together a specific event in history from fragmentary primary sources. In fact, a teacher could even use *Trace Memory* as an introduction to historiography.

Adventure games entice the player to learn more about the domain. In *Riven: The Sequel to Myst* (1996), some of the puzzles involve figuring out the symbols used in the island, which represent numbers. In *Lure of the Labyrinth* (2008) we used similar challenges to help players understand that numerals were merely symbol systems distinct from the numbers they represented, numbers which in fact can be represented through a variety of symbols. The puzzles prepared students to see numbers through alternative systems such as binary notation or

hexadecimal. This is another example of how to set up the domain for the player to learn about it in order to solve the puzzles; making the domain knowledge intriguing and stimulating is a basic strategy that educational games can take advantage of.

Insight Thinking

Since puzzles provide the player with insight, solving the puzzle requires insight thinking. Danesi (2002) points out to Sternberg's theories of intelligence (1985) to explain how players make sense of puzzles. Sternberg (1985) describes three different types of insight thinking: selective encoding, selective comparison and selective combination. Each one of these types not only represents different strategies a learner processes information, but also call for different game design strategies.

Selective Encoding

Selective encoding means making apparently irrelevant information relevant. This is a typical tactic in riddles or in puzzles where you have to find the hidden image, for example. The designer conceals the solution so that the insight takes place the moment the player understands the information or finds the right image.

In adventure games, the information can be encoded in the text of an adventure game, in the form of a clue. For example, in *Gabriel Knight: Sins of the Fathers* (1993), the eponymous character can read books, documents and newspapers. In some cases, the player learns about the events of the story; the daily newspaper provides updates on the murder case Gabriel is following. In others, the readings enclose information that is essential to solve later puzzles: from learning that constrictor snakes are sensitive to vibration to a few words in German. By remembering this, the player will know how to free a character from the grip of a constrictor, and will be able to translate a poem in German (a riddle whose solution is the clue to another puzzle).

This process of paying attention to observable detail is often the starting place for historical, literary, or scientific exploration. Giving players insight into the rewards of such attentive exploration is the basis to a powerful potential educational use.

Another type of puzzle using selective encoding is the "hunt the pixel" puzzle, which consists of hiding a small object in the environment, so that the player must sweep the screen with the mouse until she finds a hotspot. *Beneath a Steel Sky* contains several puzzles where player must find items that are just a couple of pixels on the screen, such as a nugget of putty or a very small metal plate (in a dark corner). These items are necessary to solve other puzzles, but finding them does not really provide insight, but rather requires patience in sweeping through the screen. Thus, while selective encoding of verbal information can be productive and encourage players to pay attention and decode all the clues in the game, "hunt-the-pixel" does not seem to have any educational value.

Selective Comparison

Selective comparison is the use of analogies and metaphors in order to draw a non-obvious relationship between two pieces of information. This is another tactic of many riddles, which are essentially metaphors or similes. In a metaphor or simile, an object or concept (the tenor) is presented in terms of another object or concept (the vehicle). The vehicle may have a relationship of proximity or similarity to the tenor, such as shape, color, in which case the metaphor is a metonymy (see Baldick, 2001). The relationship may be based on being part of the whole, or the whole representing one part, which is the case of synecdoche. The puzzle maker has to come up with the analogy, and the riddle usually consists of the vehicle—the player has to guess the tenor from it. *Loom* resorts to selective comparison in many puzzles: a spell learned from a waterspout twirls up objects, but it also unwinds them if performed backwards. The spell

can also be used to unwind a spiral staircase, so that it becomes a bridge between the tower that the stairs went around and a ledge.

This type of puzzle is also productive in educational games. *Lure of the Labyrinth* uses maps to lead players to puzzle rooms, but the maps are themselves puzzles, using alternate mathematical representations of the space the player must navigate. Successfully using the maps requires the player to develop sophisticated mental models of the game world. Such modeling and being able to find analogies is critical in all academic domains; adventure games have players learn the power and pleasure in thinking through models.

Selective Combination

Selective combination happens when different pieces of information are merged in order to form a novel one. It is the widest type of insight required in puzzles: from jigsaws where the player has to assemble the image, to mathematical puzzles such as magic squares (grids where a series of numbers have to be distributed according to a specific condition). Selective combination characterizes most puzzles in adventure games as well. Building machines, cooking, or using a key in a lock are all examples of selective combination puzzles.

One important affordance of the technology that favors selective combination is that the player can actually manipulate the elements of the puzzle. Whereas a mathematical word puzzle sits inertly on the page waiting for the player to think her way to insight, computer-based puzzles can encourage exploratory play as a way of thinking through a puzzle challenge. The puzzles in *The Incredible Machine* (1992) are an excellent example of how to invite constructive exploration to through manipulation, although it is not an adventure game—puzzles that teach mechanics, physics, engineering and design through the construction of Rube Goldberg contraptions. The player can experiment with the ways different sized balls bounce on

trampolines, or with what kinds of energy can be harnessed to light a lamp. Rather than simply wait for the 'a-ha' moment to happen, such puzzles invite the player to construct new knowledge through direct manipulation as a stepping stone towards insight.

Engineering-like puzzles are also possible in adventure games. *Riven: The Sequel to Myst* (1996) and *Machinarium* (2009) both integrate puzzles that involve fixing or completing machines. Although these puzzles are less complex, there is no reason why adventure games could not incorporate Rube Goldberg-like inventions, since object manipulation an exploration of actions are defining features of the genre.

There are other examples of selective combination in the domain of the humanities as well. In the language learning adventure game *Who is Oscar Lake?* (1995) players are plunged into a mystery that plays out entirely in a foreign language. Only by combining fragments of the language being learned with visual evidence from the game world can players solve the mystery, and in the process they learn a powerful decoding strategies necessary for the mastery of any foreign language.

By being aware of these different types of insight thinking, game designers can anticipate how to encourage specific types of thinking, and by extension of learning. After determining what the domain of the game is, the design can also build the relationships the player must establish in order to solve the puzzle, thus encouraging specific types of thinking.

Puzzle-Solving Strategies

So far we have dealt with puzzle design from the standpoint of the designer, but we must also account for how the player tackles the game. Since puzzles are a give and take between designer and player, it is necessary to describe how specific game designs will foster different problem-solving strategies in the game.

Adventure games do require a strategy to solve their puzzles, principally based on the exploration of space and objects. The player must make sense of the workings of the game in order to establish the domain knowledge. Almost every action in an adventure game should be based on a question that the player needs to find an answer for. For example, the brass lamp in *Zork: The Great Underground Empire* (1980) and its workings turns out to be the key for many puzzles. To begin with, if the player character ventures in the dark depths of the dungeon without a light source, he will be warned he can be eaten by a grue. If the player goes in anyways, the grue shows up and eats the player character. Once the player character has the lamp, it turns out that it has a battery that runs out after several turns. The player must find other light sources, and figure out by examining the lamp that it needs batteries; so the player must look for replacement batteries while navigating the space.

Adventure games also require the player to pay attention to the environment, to the consequences of one's actions, and to read descriptions closely. As the player explores, she is gathering information from the world. These strategies are somewhat different from other videogame genres, in that they require the player to perform a close inspection of the world. Most videogame players are not used to read text closely, expecting descriptions to be "flavor text" rather than useful information. It is a habit that designers of educational games will have to fight against, or at least be aware of.

The Importance of Feedback

Every action in the game needs feedback, to indicate the player whether that action may be productive or not. As Moser (2002) states, one of the lessons learned from Instructional Design that can be applied to the development of adventure games is that clear and rapid

feedback is key for educational design, to let the player know of the results of her actions in the game.

Feedback is essential as part of the game design, given that exploration of actions is one of the basic strategies of adventure games. The player needs clear indicators of whether a specific course of action is right or not. As we stated above, text can be an easy way to provide information, but it is also very likely that players will overlook it. Thus, feedback needs to be not only evident, but also redundant. For example, in many graphic adventure games, there may be a door that the player needs to open. If the player tries to open the door but that action is not relevant to gameplay, a piece of text will tell the player that she should not care about that door, such as "I don't think that will be of any help." If the door is relevant, but the player needs a key to open it, when the player tries to open the door, she will see an animation of the character moving his hand to the handle, and a sound will represent the jiggling of the door handle. But if the player does not have the key to open the door, the game will display a message, "The door is locked." Once the player obtains the key, the animation will show the character opening the door at the same time a sound of the door opening plays. The player character may even state "The door is open."

Thus feedback cues the player on what the right course of action may be, particularly as a way to prevent trial-and-error from turning into mindless clicking around. Unfortunately, bad puzzle design in adventure games is relatively frequent, either because of an abundance of "designer puzzles" or because proper feedback is missing, so that players cannot know whether an action will help find the solution or not; worse enough, the absence of proper feedback may even prevent the player from learning that there is a challenge.

Another aspect of feedback is how much room for error we are providing the player. In old school adventure games, if the player made a mistake, it was often fatal and brought the game to an abrupt end. At times the player would get a warning, as in the case of *Zork* and the grue. Other times, the player did not get any warning until it was too late—in the case of the limited batteries of the lamp, the player only realizes it's running out later in the game; by then the lamp does not have enough batteries to even complete the game, forcing the player to start over. The most infamous cases are those games where the player makes a mistake and gets the player immediately killed. Although a game over screen is clear feedback that the player did something wrong, it can also be very frustrating, particularly if it is not clear to the player what the mistake was, or when the player forgot to save her progress in the game.

That is why we advocate a type of adventure game where mistakes receive clear feedback but are not punished. Current adventure games, such as *Machinarium* or the new *Sam and Max* episodic games, follow the design school that lets the player make mistakes and continue playing. In our own experience, this design strategy encourages players to keep playing and experimenting; otherwise the game is penalizing the player for exploring, which is essential in adventure games and the foundation of learning.

Finally, feedback is most powerful when it gives players information they can use to reason about the puzzle. In the example of the *Zoombinis* pizza troll described above, the troll's responses are actually pieces of valuable evidence that lead to the correct solution. Meaningful feedback encourages the player to understand that short-term "failure" is not merely unavoidable, but actually useful on the path to ultimate success. In this context, the player can fail safely, because she is not punished for being wrong, but actually provided with helpful information. The notion of useful failure is essential to art, design, engineering, and science, and

educators can use players' intuitive understanding of that usefulness in games to encourage the same spirit of exploration in academics.

Conclusion

Understanding the design of adventure games is essential to develop educational adventure games. The tools and resources to produce them are relatively accessible and have large communities of development, which is an additional incentive to produce these games. Although we have not dealt with the development process itself, we would like to recommend developers of educational adventure games to follow an iterative process, where the design of the game is continuously evaluated through playtesting. Videogame design is not an exact science, and although we believe the concepts proposed will hopefully help designers and educators understand the nature of adventure games better, they are no substitute for the benefits obtained through playtesting and iteration (see Fullerton (2008) for a detailed account of best game design and development practices).

The method used in this paper can be extended to other videogame genres. By defining the types of games that will be developed first, it becomes easier to understand what types of learning happens in that genre and how. Definition and analysis later help identifying the features that educators and developers can make the most of in educational games. By focusing on best design practices first, we make sure that the games are good games first, and that the learning process is part of engaging and fun gameplay.

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