Teachers, Computers, Games, and Designers

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The Essential Problem

Different students learn in different ways and are motivated by different things, a truth that was well understood in classical times. The Roman rhetorician Marcus Fabius Quintilianus (fl. 1st century AD, and usually called Quintilian) is quoted as saying

> There are some boys who are slack, unless pressed on; others again are impatient of control: some are amenable to fear, while others are paralysed by it: in some cases the mind requires continued application to form it, in others this result is best obtained by rapid concentration. (Quintilian, 1922a)

Thus we have the conundrum of all schools from the most ancient times to the modern day: how to devise a uniform curriculum and teaching methodology that properly educates a diverse group of students? As class sizes grow, the problem becomes worse, a phenomenon that Quintilian himself recognized. (Quintilian, 1922b) He argues that schools have certain advantages over one-to-one learning with a tutor, in particular the benefits of social interaction with other pupils, but he does not provide an explicit solution to the problem.

Computerized education has been the subject of intense study for 40 years, from the PLATO system onwards. The computer appears to offer a solution to the problem by enabling a pupil to interact on a one-to-one basis with the machine, if it is possible to provide a computer, or terminal, for every student. This is seldom possible in developing world. The One Laptop Per Child project offers one approach, but its machine is still beyond the reach of most of the world's poorest people. Nevertheless, the idea of individualized, computerized instruction still merits investigation because it is increasingly feasible in the developed world, especially at institutions of higher education where students are routinely expected to provide their own computers.

Limitations of Computers as Teachers

Leaving aside the question of hardware availability, significant technological obstacles to individual computerized instruction remain. Philosopher Patrick Suppes conducted extensive empirical research into computer-based education in the 1970s and concluded

> The central task [of instruction] is one well described by Socrates long ago in Plato's dialogue *Phaedrus.* Toward the end of this dialogue, Socrates emphasizes that the written word is but a pale image of the spoken; the highest form of intellectual discourse is to be found neither in written works or prepared speeches but in the give and take of spoken arguments that are based on knowledge of the truth. Until we have been able to reach the standard set by Socrates, we will not have solved the deepest problems in the instructional use of computers. How far we shall be able to go in having computer programs and accompanying hardware that permit free and easy spoken interaction between the learner and the instructional program is not possible to forecast with any reasonable confidence, for we are too far from yet having solved simple problems of language recognition and understanding. (Suppes, 1970)

In a 2005 article inspired by Suppes' work, I wrote

> "Teaching machines," as they were once called, have mostly failed us. They're OK for typing, or for drill-and-practice lessons, only just tolerable for things like chemistry or history, and hopeless at debating the political philosophy of liberty. They generally teach in a linear, inflexible way. They cannot think up new analogies to help convey an idea to a student. A good teacher can adapt his approach to the strengths and weaknesses of his audience on the fly. It's like the difference between a computerized dungeon master and a human dungeon master in a role-playing game. The human can modify the quest to take into account the particular composition of the party of adventurers.
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> A lot of bad educational software was designed beginning with the assumption that human interaction is unnecessary, and teachers are superfluous. This is wrong. Good teaching still requires a teacher. A teacher's two greatest tools are **charisma** and **attention**, both things that computers cannot offer. A teacher uses his charisma to create interest and excitement in the student, and uses his attention to reward, punish, and compel attention back from the student. A student knows that when a computer program says "Well done!" it's just a programmed response, and if she does badly or ignores the computer, the computer doesn't really care. Computers don't pay attention; all they do is sit and wait for input. (Adams, 2005)

Given these points, we may reasonably conclude that computerized educational tools do not yet solve the essential riddle of mass education; the computer is still not a substitute for a teacher, much less the individualized instruction of a tutor. What, then, may we do with computers?

Computer games appeal strongly as educational tools for several reasons. Firstly, they are familiar to large numbers of children and increasing numbers of adults as well. Children will generally accept the idea of playing a computer game, and be excited by the prospect, when they might be hostile to other learning modalities. Secondly, computer games do offer a degree of one-to-one interaction even though they cannot achieve the levels of dialectic possible with a teacher. They can enable a child to proceed at his own pace and to experiment and test hypotheses in his own way. Thirdly, computers have the power to make abstract concepts, such as inverse square law, concrete and comprehensible at a visceral level. Finally, video game consoles, in particular, are both cheaper and rather more robust than conventional desktop computers, and many children already own them. Efforts to provide courseware through networked Microsoft Xbox consoles is already under way. (Bourke, 2007)

Commercial Off-the-Shelf Games

Over the years there has been considerable discussion of the potential offered by commercial off-the-shelf (COTS) computer games for education, with the *SimCity* and *Civilization* series frequently cited as examples. These products do, in fact, impart some factual knowledge and certain principles to their players, but they do so in a haphazard and disorganized fashion. Players learn to beat computer games by trial-and-error, a pedagogically inefficient process. While the games are enjoyable for the players, it may take hours for the players to recognize and learn a relatively simple principle.

Worse, conventional computer games do not clearly indicate which of the information they present is fictitious and which is factual, nor do they make clear what biases and preconceptions underlie their simulations. The algorithms of *SimCity,* for example, include two debatable premises: one, that raising taxes tends to drive business away; two, that spending tax money on public amenities improves the morale of the citizens. Each of these ideas has been criticized, the former by the political left, the latter, by the political right. Clearly, these issues deserve classroom discussion, yet neither is explicitly spelled out in the game's documentation. Players, and indeed instructors, have to discover them for themselves. *SimCity* is an entertainment product; it was never intended for pedagogy.

This is not to say that COTS games have no place in the classroom, only that their value lies not in direct teaching, but as adjuncts to other modalities. I have argued elsewhere (Adams, 2005) that COTS games do not teach principles, they illustrate them. A flight simulator, for example, does not explain such concepts as lift, gravity, thrust and drag, but it demonstrates these concepts in use and enables students to experiment with them and observe how they operate. A teacher is still needed to introduce the ideas in the first place.

COTS games can also be used to provide context and incentive to learn, even when the game itself does not address the particular skills to be taught. Meldrum Primary School in Aberdeenshire, Scotland has adopted the game *Guitar Hero* as the centerpiece of a number of educational activities for seventh-year primary students. Pupils exercise writing skills by creating biographies of fictitious rock stars in an imaginary band named Full Moon. They study design by creating fantasy guitars out of found materials; art by creating album covers, posters, and T-shirts for the band; geography by planning a European concert tour; drama by scripting a music video; and science by investigating the acoustic properties of guitar strings. The game serves to tie together what would otherwise be a collection of disparate subjects with no common theme. Students have a strong interest in the material and enjoy their work. (Roberts, 2007)

Such efforts require little in the way of institutional support or policy formation, apart from allocating the money required for the games themselves. Rather, they require that schools adopt a culture and style of teaching that encourages such imaginative approaches, and that does not fear computer games out of misunderstanding created by media alarmism.

In addition to using COTS games, however, there is great potential in applying the principles of game design to new computerized tools that support the pedagogical aims of educational institutions and systems. The remainder of this paper is devoted to discussing how these may be created.

Special-Purpose Educational Games

Early efforts to create game-like educational software, often dubbed "edutainment," tended to rely on an analogy between gameplay and learning. When playing games, players overcome obstacles in order to achieve victory, and they do so by learning whatever is required to overcome the obstacle – a solution to a puzzle, a weakness in an enemy, a particular set of hand-eye coordination skills. When studying in a class, students try to learn the information that will be required on the test. Therefore, victory in the game is seen as analogous to success on the test, and learning to overcome obstacles is seen as analogous to learning the material required by the curriculum. The early edutainment products treated the process of learning the subject matter as a process of overcoming obstacles.

These products had all the disadvantages of test-focused learning and few of the advantages of interactive entertainment. Both students and game players know that once they have achieved whatever goal is placed in front of them, it is safe to forget the material they have learned, if it is no longer useful or required of them. Rather than being enjoyable learning experiences, they were simply dull games; in effect, electronic flash cards with a poor retention rate. Many were failures in the marketplace. However, there are ways to avoid these errors.

Facts, Skills, and Principles

For the purposes of this article, let us divide the sorts of things that educators seek to teach into three categories: facts, skills, and principles. Computer games are capable of assisting in the educational process with all three, but different approaches are required.

Facts naturally refers to data or information that the student is expected to know, and to be able to demonstrate knowledge of by some assessment technique. "The Norman Conquest of England took place in AD 1066," or "Marcus Garvey was the first national hero of Jamaica" are examples of facts.

Skills refer to techniques that offer mastery over a task or problem. Long division and essay-writing are skills.

Principles are theories that have gained wide acceptance because they are demonstrably correct and useful, such as the principle of algebraic substitution, or because they help to explain a natural or social phenomenon, e.g. the principle of natural selection helps to explain the emergence of new species of life on earth.

Stealth Learning

Game designer Richard Bartle reports that he taught his children the names of all the European capitals by designing a game for them that involved travel among the capitals. The object of the game was not to learn the names of the capitals, but something else entirely; nevertheless, it was necessary to learn them in order to play. (Bartle, 2006) Similarly, West Nottinghamshire College in the UK has significantly improved the success rates in key skills through the use of a computer game that requires players to be able to perform arithmetic calculations as an integral part of the gameplay; yet the stated goal of the same – fulfilling an adventurous quest – has nothing to do with arithmetic. (BBC, 2007) The board game *Monopoly* teaches children how to make purchases with paper money. Again, handling money is not a stated goal, simply a natural part of the play. Such an approach has been dubbed "stealth learning." Stealth learning is a good way to teach facts and skills.

All games involve an element of artifice or pretending. (Adams, 2006) Even football players pretend that kicking the ball into the net, a purely artificial activity, is a valuable thing to achieve. Pretending encourages exploration and experimentation. When a student's marks are determined by the outcome of the game, playing the game ceases to be pretending and becomes serious; in fact, it ceases to be play and becomes work. The key to stealth learning, then, is to disconnect the object of the game from the instructor's assessment mechanism. The students will be less stressed, and more likely to enjoy the game, if they don't regard the victory condition as a test upon which their marks depend. Those who do learn the material will naturally tend to do well at the game, but victory is a by-product of learning rather than a explicit objective with all the psychological burdens that presents. A computer game that offers stealth learning can still perform *sub rosa* assessment for the benefit of the instructor by recording how often the students supply correct answers.

Simulations

Principles must be taught in a different way from facts and skills. It is often necessary to explain a principle by example or by analogy. Games do not teach principles well, but they can illustrate them well. They normally do this by means of simulations.

As remarked earlier, COTS games such as *Civilization* are often confusing, complicated simulations that present the player with so many different principles at once that it is difficult to understand what is happening. Furthermore, these games hide their assumptions, which makes it difficult to test them. In creating simulations for special-purpose educational software, we should instead adopt a policy of transparency. All the built-in assumptions should be revealed, at least to the instructor but preferably to the students as well.

Similarly, COTS games seldom allow the players to change critical simulation parameters (such as the force of gravity or the top speed of a vehicle); these parameters have been set by the designer in such a way as to maximize enjoyment, often at the expense of accuracy, and locked there. A simulation for educational purposes should permit the instructor, students, or both, to adjust its parameters in order to observe their effects.

Finally, a simulation works best when it does not impose a particular viewpoint upon the player. The political game *Peacemaker* challenges players to arrive at a successful two-state solution to the conflict in Palestine. In so doing, they may take the role of either the Prime Minister of Israel or the President of the Palestinian Authority. Likewise, the game *Balance of Power* allows the player to play either the Russian or the American side in a Cold-War era struggle for geopolitical prestige. Both games illustrate a number of important principles about diplomacy and geopolitics. Neither game would be as successful at doing so if they offered only one viewpoint. (Adams, 2007) Where possible, allow options for multiple viewpoints, especially in asymmetric competitive games.

Context and Incentives

Children will learn something from a game if there is an incentive to do so, in a context in which that knowledge belongs. The weakness of many of the "electronic flash card" style of games was that the incentive (e.g. "win the game and you'll get to see the fireworks display") had nothing to do with the challenges ("perform these subtraction problems"). In Bartle's game, knowing the names of the European capitals was an entirely natural requirement for a game about travel; the material learned was appropriate to the context of the game.

Designer Raph Koster observes

> Games work best at teaching when the challenges are organic to the experience, rather than out of left field… just strapping an incentive structure on rote practice doesn't work very well, compared to instead building a long-term goal structure, and then presenting challenges on the way…
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> The path for educational games is to start with something that users care about, and just take care to select a goal that naturally offers up the sorts of challenges that we want to teach. (Koster, 2007)

The traditional incentives for school-based learning have generally been either social, personal, or long-term benefits: teacher and parental approval, competitive success over one's classmates, an innate desire to achieve, or an awareness that the material may be useful in later life. (In earlier times, fear of corporal punishment was also an incentive, and fear of failure or ridicule regrettably remains one today.) These incentives to not appeal to all children equally, however. In some cases their parents do not care whether they learn or not; some children do not care what their teachers think of them; some are not innately competitive, or have low expectations of themselves. Many are unable to recognize the long-term value of the material they are being taught.

Computer games, however, can offer much more clear and immediate incentives. An enjoyable game is its own reward; it creates pleasure even as it offers up more challenges. Learning the material required by the gameplay permits the learner to do well at the game and to continue to play. Computer games can also provide visible and audible rewards: music, images and novel content, particularly storytelling content that engages a player's attention and makes her want to know how the story ends. Many COTS games include secret content that only players who do well are allowed to see, and educational software can also adopt this approach. In short, computer games entertain in so many different ways that they can provide a wide variety of incentives to a wide variety of students.

Working with Game Designers

I now propose to offer some suggestions about working with professional game designers to create game-like educational tools. Commercial game developers and educators come from very different worlds. Their professional training is not the same; many game developers are self-taught and have no formal training about educational methods. Few will have heard of Dewey or Piaget. Educators normally belong to the public sector, with all the bureaucracy and oversight that that usually entails; game developers come from a highly entrepreneurial branch of the private sector, and are unused to providing reports and other formal measures of their progress. When educators and game designers collaborate on a project, there is a significant risk of communication difficulties. The most obvious of these will arise because each side has its own professional vocabulary and design principles that are unfamiliar to the other, but an even greater danger occurs when each side has unstated assumptions and goals that they have considered axiomatic for so long that they never think to discuss them. For a successful collaboration it is imperative that each side spell out exactly what it hopes to achieve and how. Otherwise they may spend days or weeks working at cross-purposes.

Quality versus Quantity of Entertainment Content

Students who are using computer games for learning will naturally expect them to resemble the COTS games that they are familiar with. Few educational games can afford the vast amount of entertainment content that COTS games provide, but players will forgive this so long as the quality of the available content is high. Developers should endeavor to provide the highest quality entertainment content that they can within the budgetary constraints of the project, even if it means reducing the overall amount.

The main reason to adopt computer games as learning tools is that they provide strong incentives to the students; therefore they must, in fact, supply those incentives. Students in the developed world are usually experienced consumers of entertainment software. They will not forgive poor game design or a boring experience.

Harnessing Designer Skills

Professional game designers are skilled in the art of creating engaging, even compelling, entertainment experiences. Among their talents is modulating the level of difficulty and intensity in a game in the same way that composers modulate the volume and tempo of their music. Periods of high stress are followed by periods of relaxation. Risks are compensated for with rewards, and so on. Players are also familiar with these concepts and will tend to expect them.

Educators who work with game designers must recognize and value these skills and give the designers the freedom to exercise them. In general it is better to allow the designer to construct the experience in the ways that she, and the student audience, are familiar with, than it is to impose a particular theory of education upon the process – so long as the concrete educational goals of the project are met. The worst educational games tend to be those that are constructed according to an abstract theory of learning without regard for the player's experience or the nature of the material. Bloom's Taxonomy is a poor place to begin a game design. The game must impart the subject matter, but **how** it does so is less important than that it does so successfully and in a way that the student will retain.

What Game Designers Must Understand

Professional game designers have a natural tendency to privilege "fun" or entertainment above all other design goals. They consider it axiomatic that any product that isn't continuously enjoyable is flawed. Developer Tim Holt was recently quoted on a game developers' Web site as saying, "If you have to make a mistake in the fun versus educational balance, it's better to be a bit too fun and a bit less educational than the other way around." (Bogost, 2007) In fact, however, this is not the goal of educational products – whether they are called "games" or something else. Fun is important – otherwise there is no point in using entertainment techniques to teach – but if the goal of the project is to educate (i.e. that is what the funding agencies are paying for) then that is what the product must do. If a professional game designer is to work on an educational product, he must understand that the metrics of success will not be the same as the ones he is used to in the conventional video game industry.

Conclusion

Computer games have enormous potential to enliven learning, improve retention, and provide immediate concrete incentives to students. They also offer some opportunities to tailor the learning experience to the particular needs of individual students. More research is necessary to discover the best way to integrate education with entertainment, but we have at least discovered a few principles – stealth learning, transparent simulations, meaningful contexts – for doing so. The single biggest obstacle to making better use of games in education is not philosophical, methodological, or technological, but political. Above all we must encourage educators and policymakers to recognize its potential and be open-minded about the opportunities that computer games offer.

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