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# *Students as designers and creators of educational computer games: Who else?*

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**Abstract**

In the companion article, *Spirit of the Game: Empowering Students as Designers in Schools?*, author Cher Ping Lim puts forth strong arguments supporting the creation and use of curricular, educational games in our schools and education. His essay ends with the question 'Can students build such games?' This paper responses to this question and provides examples of how students can design and build games within the school curriculum to enhance engagement in the classrooms. Two approaches are suggested: Mini-game-based curriculum and complex game for entire course.

All games are educational ... Good games are hard to design. But designing a good game around specific subject matter is really difficult.

Will Wright

Can students design and build games for entertainment? Absolutely! Young people around the world are learning, in their pre-teen years, to use tools like *Game Maker, Click & Play, Stagecast Creator* and others to build simple games. As they move into their teens and twenties kids learn to master and use Flash, modding tools, and even sophisticated tools like C++, game engines and graphics tools to create the complex, sophisticated games they imagine and design. Many of these students go on to enroll in college and graduate school game design and construction courses and majors, creating, while in school, games at, or very close to, professional levels.

But can students design and build successful *educational* games? The answer appears to be yes, as well, especially under the right conditions. And that is very good news for our schools and our learners. Because the next generation of educational games—the

games that will truly engage and teach students—is likely to come from the minds of other students, rather than from their teachers. And it is likely that learners will relate to these games, and learn from them, in a way that is not happening today.

How do we know students can build educational games? The answer is because they have already done so. What have the results been so far? There are many excellent games that include: Hidden Agenda games *MeCHeM, Waste of Space,* and *Elemental* for middle school science (http://www.hagames.com), MIT-build game 'mod' *Revolution* for US History (http://www.educationarcade.org/revolution), Hong Kong Polytechnic-built game *Eyewitness* for Chinese history: (http://www.mic.polyu.edu.hk/nanjing/index.asp) and award-winning Carnegie-Mellon-built *PeaceMaker* game about the Israeli-Palestinian conflict (http://www.peacemaker.org).

Why are *students* building these games, to be used by their contemporaries or by other students further down the grades? Why are they not being built rather by teachers, or other adult professionals? Because, try as they might, the grownups don't fully understand the minds of today's students, and the games they produce reflect this. 'Quite often, educational games or games for education created by educators or textbook publishing houses smell too much like school,' says Cher Ping Lim (Lim, 2008). 'Although various gaming elements such as narratives, point system, and challenges and levels are integrated into the virtual environment, the environment is often a replication of the existing power relations in the school where teachers and textbooks are the fountain of knowledge and students are empty vessels to be filled with knowledge. Students are not empowered to make decisions and take actions in these games about the political, cultural and social fabric in such environment.'

A student puts it much more simply: 'Don't try to use our technology,' she says, 'you'll only look stupid.'

An entire generation of educational software—the stuff known as 'edutainment'—was either (literally) dumped into holes in the ground, or sold off at a tiny fraction of its original cost. Why? Because the students had no input into its creation, and the stuff came out cute to the adults, but boring to the kids.

**Why and what kinds?**

So, it is clear that students *can* build games for learning. But why would they want to? And what kinds of games would they want to, or should they, build?

The answer to 'why would they want to' has to be 'because we give them an incentive.' Students will create the games we want when there is something in it for them. Although that incentive can be pure cash, doesn't necessarily have to be. Often just being allowed to do something that is not a usual part of school learning, and/or being recognized for creating something clever, or beating your peers, if rewarded properly and in public, will often suffice. Of course, additionally offering students pay, prizes, or other monetary incentives will help motivate the student creators, just as it does most people.

For the reasons outlined above, it would be enormously interesting and beneficial for educators to create a series of curricular games totally (or mostly) designed and made by students. Should educators decide to do this, there are at least two major approaches they can consider, based on a fundamental distinction among kinds of games.

## Mini versus complex games

When talking about educational games, it is extremely important to distinguish—no matter what the subject matter or genre—between two broad categories: the 'mini-game' and the 'complex' game (although few who write about educational games make this key distinction) (Prensky, 2005).

'Mini-games' (also known as 'casual games') are games that typically take less than an hour to play. They are generally about a single, narrow subject. They may have multiple levels, but the levels are usually just more difficult examples of the same basic game mechanic. If you look carefully at most of the educational games found today, especially on the Internet, you will find that they are mini-games.

'Complex games' on the other hand, are the games found in game stores today. Complex games are a totally different species, one that didn't exist when today's older educators were growing up. These games are expected to take 20–60 hours (or even more) to complete. Whatever their genre—action, adventure, role-playing, simulation—complex games, typically have multiple levels of complex goals, challenges and/or quests to achieve. Multiple skills need to be learned to achieve the goals, and often teams must be built and managed in order to do so.

The reason the distinction between mini and complex games is so important for educational games is that, both educationally and physically, the creation and use of the two types of games is very different.

Mini games can often be created by small teams of, typically, two (one programmer, one artist) or three students, doing their own research with a single advisor. The design of mini-games is relatively simple, and is often easily borrowed from other mini-games. Game construction takes a couple of months at most, and testing is relatively easy. Which is why, as noted, most of the educational games found today, especially on the Internet, are mini-games.

## One approach: a mini-game-based curriculum

Mini-games are not 'bad' for learning, but they are limited in their scope. You might learn a single skill or idea from one of them, but no mini-game, by itself, will give you an education, or even teach you about a broad piece of subject matter.

However mini-games can work in concert. Many larger, more complex games are, in fact, a collection of related mini-games.

One excellent approach, conceived by a high school teacher in Arizona, is to isolate each small unit of the curriculum, and have students build a game to teach it (Prensky, 2005). Using this approach, one could break down the entire curriculum—in every subject—into the individual skills, information and competencies students are required to learn, and design a separate mini-game to help students master each competency.

Suppose we did this? How many mini-games would it require? Several hundred, no doubt, for each subject, perhaps even several thousand in all. If that seems like a lot, think, on the other hand, of how many students would volunteer to work on such games. No doubt several million. So a collection of standards-based mini-games could be one viable approach to curricular game-based learning.

Were one to select this approach, an appropriate first step would be to post all the individual curricular units, or goals, on the Web (this already exists, by state, in many cases), and then find out whether there are mini-games that already exist for some of them, which is highly likely. Existing mini-games wouldn't have to come from any one school, district or even country—most of the curricular units are the same or very similar around the world, and lots of mini-games currently exist to teach them.

A second step would be to identify the most critically needed mini-games that do not yet exist—games for those for concepts or subject matter areas that the students find either the most boring or the most difficult to grasp. Building this next set of mini-games could be the subject of contests or prize money.

The final step would be to slowly 'fill in the pegboard' with mini-games around all the other curricular points. This, too, can be incentivized.

**Managing the games**

If such a system of curricular mini-games were built—a system that could be accessed via the web by all teachers and students—who would, could and should manage it? One good potential candidate is our Schools of Education and teacher training (with some changes, of course, to their current curriculum), working in concert with those institutions' IT departments. Were our education schools in charge of learning software, then our teachers being trained would be more likely to become familiar with it, and would, hopefully, use it in their practice once they began teaching.

**Iteration**

A key feature of such a curricular mini-game collection is that it does not remain static, but rather be in a state of constant update and iteration. Any existing mini-games considered only mediocre—say via a student and teacher rating system built into the site—would be candidates to be replaced. On the other hand, if there were more than one excellent game for the same content, both might be maintained.

**Advantages**

The 'series of mini-games' approach has several points to recommend it. Mini-games typically can be played to completion within a single class period, and so might get used more by teachers in class than any longer, more complex games. Mini-games are easy to put on the Internet, and therefore are easy to assign as homework. Mini-games can be created relatively easily and inexpensively (compared to complex games) by people around the world. So that the technology doesn't go stale, and the best games rise to the top, they can be upgraded and/or replaced on a regular basis by the schools that maintain them. Any motivated student, teacher, or group could submit a mini-game for inclusion in the set of curricular mini-games.

**Issues**

Issues that would need to be addressed and resolved for the 'series of mini-games' approach to work include quality control, maintenance, scoring and record-keeping. For example, if more than one game is created for a particular topic, who will decide which is to be retained? (As discussed, votes of teachers and students can help here, as can the students in the education schools.) If these games are to be accessed online by large numbers of students, both the code and the servers must be robust. Who will pay to build and/or maintain this? Should this system be organized on a local or national (or even international) scale? If teachers want records to be kept, a separate learning management system will be needed. Who will create and maintain it?

All of these issues are potentially solvable, and the 'series of mini-game' approach is one worth considering. Because each of its units is small and doable relatively easily in a limited time, it is perhaps the approach best suited for student creation.

**Approach II: a complex game for entire course**

A very different approach to creating curricular-based games for education, however, would be to emulate the commercial marketplace, and build the kind of games that today engage students for long hours—large 'complex' games for entire courses.

That complex games are capable of covering an entire course's material is without question. At least one such game, *Econ 201* from the University of North Carolina, already exists (http://web.uncg.edu/dcl/econ201/). Several more are under construction, such as *DimenXion* (http://www.dimensionm.com/) and *The Algebots* for Algebra I (http://www.games2train.com/games/algebots/thealgebots.html). In addition, many of the complex games currently in the marketplace, such as *Civilization IV or America's Army*, have a range of content as wide as any academic course.

Having the alternative of using complex games that cover entire subjects or courses would be a welcome option for many students now turned off by traditional teaching.

**Not easy**

But creating a good complex game for education is a large, difficult undertaking. As Will Wright, designer of *Sim City, The Sims*, and *Spore*, says, 'Creating a good game is hard enough; creating one based on educational content is even harder.'

Good complex games take years to create, test and iterate, cost a good deal of money, and typically involve large, specialized teams. The creators of *Econ 201* found that even enthusiastic graduate students took a long time to train and integrate into the game creation team. And students, of course, only remain so for a limited time. All of these things argue against a student-only creation approach for complex curricular games, except possibly by students already in university game-creation programs. If, however, a program were organized specifically to make the creation of complex curricular games happen, there would no doubt be a way to involve students at all levels in the process.

A possibility long hoped-for by many is for professional games companies to get involved in building complex curricular educational games. The reason they haven't is that, in the words of Bing Gordon of Electronic Arts, no good model for monetizing these games has yet arisen. Currently, however, several smaller games companies, such as Tabula Digita, Breakaway Games and Muzzy Lane (among others) have been trying to see if they can make a living selling games that are more or less curricular. There may yet emerge a model for making and distributing complex curricular game that involves some combinations of both students and professional game companies.

Still, even when such entire-course curricular games come into existence, there will remain much work to do around the maintenance, school systems integration and teacher adoption of such games. Of course, some of the same solutions described above for mini-games, such as basing and maintaining them in education schools, could be applied to complex learning games as well. But one of the disadvantages of the complex game in today's learning environment (ie the classroom) is that classrooms (even wired or wireless ones) and 45 minute periods do not always lend themselves to learning via complex games. Additional issues arise around exactly how to integrate complex games into the educational process (eg in class, outside of class or a combination), the teacher's role in the process, and whether the results from entire courses completed via complex games will be accepted for academic credit.

**Contests for student game creation**

Whether one chooses to build mini-game or complex games for education, one potentially effective way to create them is through contests. The idea of holding a prize-awarding contest to encourage the creation of educational games is now firmly established. It has a great deal of merit, and can be replicated and adapted in different situations to achieve various desired results.

One example of a successful educational curricular game creation contest is the Hidden Agenda contest for middle school games, which has been sponsored by the Liemandt

Foundation of Austin Texas for the past four years. The contest offers a US $25 000 prize to the winning team each year.

In the Hidden Agenda contest the creative teams (typically 2–5 people) are college or graduate students. The games to be submitted are mini-games for particular topics in middle school math and science.

The Hidden Agenda judges, consisting of a famous game designer, a writer on games and learning, several teachers, and several students, meet annually in June to select a winner from five finalist games. So far three finalist games and three runners up have been selected. The results can be seen and played at http://www.hagames.com.

The Hidden Agenda submissions by the participating teams (who work for six months on the game while they are attending school) are essentially working prototypes. The competition's organizers then pay professional developers to re-write the games as robust applications that can stand up to the pounding of thousands of middle-schoolers.

Other contests enable teams that develop educational games independently to submit them for prizes. The game *PeaceMaker,* for example, won a contest sponsored by USC's Annenburg School of Communication.

**Alternatives for student game creation and contest organization**

Here are several possible ways the student game design process could be organized and incentivized:

1. Students could be encouraged (and motivated with recognition and prizes) to create games for material they had just recently covered in class. This could happen at any level from elementary to college. The games would be mini-games. Teams of 2–4 students would work on them with a faculty content supervisor, and, hopefully a game supervisor (common to all teams) who knows about gaming and can help kids create good games.
   Guidelines for the structure and design of these games published (broad enough to allow for a great deal of creativity) could be developed, and examples offered.
2. Students could be encouraged (again, motivated with recognition and prizes) to create games for one or two school levels below them (ie high-schoolers would create games for elementary students, college students would create games for middle-schoolers and graduate students would create games for high-schoolers). This is based on the theory that each group of players needs the sophistication of creators who are above their level, yet not too far removed from their own experience.
3. A design-only contest might be held to collect and compare alternative student approaches to design of a complex game for learning Science, Math, Language or History skills at a particular level (or at several levels that would take a student though several years of learning.) Certain parameters of the design would be determined in advance, (say the subject matter and level) with the student designers

encouraged to think about goals, decisions, emotional involvement, cooperation and competition, adaptivity, iteration and fun as well as story and character. The winning team could then be funded to work with professional game developers to build the game.

4. A contest could be held to develop a complex game (or game prototype) for a specific subject, on a specific platform (eg the XBox 360). Targeting the same learning material for all of the entries would highlight alternative approaches, while letting entrants choose their material might provide a greater number of entries. Schools with game design or creation programs could be urged to compete. The competition period should be relatively long (eg 9 months—one year) with milestones, such as design document, playable prototype, etc. along the way.
   The incentive could be handled in one of two ways. A prize could be handed out for the best of the lot, or, like the X-Prize, a barrier could be set, such as a full curricular game about something, and a much larger prize awarded to the first team that achieves it.

**But will these games work?**

Computers games, mini or complex, offer many opportunities for engaged learning. But before one were to go about putting in large amounts of time and effort for building educational games, it is important to ask and answer the question Will they work? And more specifically, will they work in a school setting?

What has generally been found to be the case so far is that in classrooms games have mostly failed as educational tools (although games often work well as learning tools in the more flexible settings of 'after school' where kids are playing in guided after-school settings, or on their own.) 'Educators who are hoping that these games will be a "silver bullet" for the lack of learning engagement in schools will be disappointed. When computer games are being brought into schools, several issues arise. Issues include technical (ie lack of technical support, lack of time), structural (ie inflexible time-table, lack of professional learning opportunities), and cultural (ie teachers' perceptions of teaching and technologies.' (Lim, 2008)

**Practical concerns**

Because our schools generally have highly structured, discipline-specific curricula, little 'optional' time, and an inflexible schedule, a complex computer game may get short shrift. 'It may be introduced for an hour on Monday, students may be allowed to explore the features of the game for an hour on Wednesday, they may get to play the game for an hour on Friday, and then they are expected to reflect and discuss about the game the following Monday. Such practices are not the most pedagogically sound or desirable for either getting the most out of the games, or for learning.' (Lim, 2008) But few schools are willing to change their period or weekly structure to accommodate the needs of a complex learning game.

**Cultural issues**

However, in large part, the true issues of using games in a school are really not the practical ones (which, if desired, can be accommodated relatively easily), but rather cultural ones, which are far more difficult to overcome.

Lim (2008) and others quoted in his paper suggest, rather starkly, that, culturally, our schools are organized around social control rather than around learning. Whether this is true or not, games certainly help replace the prevailing 'control' paradigm of teaching ('teachers explaining to the class') with a new, student-originated-and-preferred paradigm of 'students learning on their own, with guidance.'

Like most digital technology in the classroom, computer games, do not mix well with the old 'teacher lecturing' paradigm. Whether or not it is because of the power relations Lim (2008) and others quoted in his paper see in this form of teaching, or because the students are already used to other, more interactive forms of learning in their life outside of school, today's kids hate being lectured to. 'I'm bored all the time in class, because the teachers just talk and talk and talk' is a typical student comment from almost anywhere in the developed world today (when they are asked, which is rarely or never.)

Computer games, along with other digital technologies, says Lim (2008), 'challenge the prevailing culture of schools, where externally determined knowledge is packed clearly for teachers to dispense to their students. If bringing games into schools merely reproduces these power relations or knowledge transmission, it is unlikely going to be any significant increase in learning engagement among students.'

Computer games (and other digital technologies) work best in the more student-centered world of 'after school,' where students teach themselves with adult guidance. For our schools to take maximum advantage of games and other technologies they will have to change significantly. In Lim's (2008) words 'schools need to transform their culture and practices by:

- Re-designing the curriculum around driving questions that are meaningful to students;
- Creating greater opportunities for students with different needs;
- Re-organising the highly segmented school day to be more flexible, allowing longer blocks of time when needed;
- Leveraging the outside-classroom experiences and expertise of students; and
- Shifting assessments away from evaluative structures that function to support social reproduction, towards opportunities to support learning.'

**Why student design matters**

Although it is often difficult to fathom for old-style educators (who believe all learning flows from the teacher), many of today's students are perfectly capable of designing learning experiences, especially for students in lower grades than themselves. This is

because, having learned the material the old-fashioned way, these students are capable of translating the teaching into forms that are more contemporary and engaging, such as games.

Says Lim (2008): 'If educators design learning experiences based solely on their own vision, goals and circumstances, they may be merely imposing their set of values upon their students; engaged learning is unlikely to happen in such an environment. It is only when students are empowered to take charge of their own learning by co-designing their learning experiences with teachers and other students that they are more likely to engage in their learning process. One way of doing so is to allow students to be the designers of their own computer games based on their own interpretations of the school curriculum.'

**Students as designers of curricular computer games**

Let us look at several scenarios for how educational computer games might be designed and built by students.

There are essentially two audiences ('markets') for educational games: 'School' and 'After School.' Games built for use in school need to take into account a great many constraints, including the current technology in the schools, the time constraints of the schools' organization, and the connections to the required curriculum (not to mention the teacher training involved, if any.) Games built for 'after-school,' on the other hand, have none of these constraints, which is why many of those who are building educational games prefer the after-school market and advise others to 'avoid the schools at all costs.'

People currently creating educational games fall into at least three categories:

- Adult educators or educational publishers
- Adult-run game companies
- Students

And hence, leading to the following 'engagement matrix' (Table 1):

*Table 1: Engagement matrix*

| *Designed by:* | *For school* | *For after school* |
|---|---|---|
| Educators/publishers | Low | Low |
| By game companies | Medium | High |
| By students | Medium to high | Medium to high |

**Games designed by educators/publishers**

As noted, quite often educational games or games for education created by educators or textbook publishing houses 'smell too much like school.' Although various gaming

elements such as narratives, point system, and challenges and levels are integrated into the virtual environment, the environment is often a replication of the existing situation in the school where teachers and textbooks are the fountain of knowledge and students are empty vessels to be filled with knowledge. Students are not empowered to make important decisions and take real actions about the political, cultural and social fabric in such environment. As a result, the opportunities for engaged learning offered by publishers' computer games are unlikely to be low. Nor are these games likely to thrive in after-school environments, since they have so many elements of 'school' in them.

**Games designed by games companies**

Games made by games companies—not, for the most part, the major entertainment games studios and publishers, for reasons previously cited, but rather by more independent games makers focusing on the education market—often have more appeal to students. Some of the companies making these games, such as Muzzy Lane (*Making History*) and Tabula Digita (*DimenXion*) are taking the trouble to align them to school needs, both in terms of time required and alignment to standards. Other game companies such as Firaxis (*Civilization IV*) do not make these efforts, although player created 'schools,' such as Apolyton University (http://apolyton.net) have grown up around this and other similar educational games. The majority of games from game companies that could be considered 'educational' are designed for the after-school market, and their engagement factor is often quite high.

**Games designed by students**

Educational games designed and created by students can address either the school or after-school market, and can be created in a variety of contexts. Some of the contexts in which students have created educational games include: design and technology classes, after school programs, and even as part of their in-school class work. A number of institutions of higher learning, such as Hong Kong Polytechnic (*Eyewitness*), Carnegie-Mellon University (*PeaceMaker)* and MIT (*Revolution*, *SuperCharged*), as well as the institutions represented in the Hidden Agenda contest (winners include University of Central Florida and Pomona College) have their students design games for kids in lower grades.

Some K-12 districts offer after-school or summer classes in game programming, many of which are focused on educational content. One such summer program is Camp Wired, in Austin Texas. Another teacher, as noted earlier, had his students, working in class in teams, creating mini-games to meet individual educational standards.

Many of these student-created games could be used either in class or after school, with good effect.

**A scenario**

Here is one scenario of how student-created games might get made. Calling initially for volunteers to create an educational game, a school sets up a team of students—

typically 3 or 4 individuals with either programming or online art skills—with a faculty advisor. The team begins its work by interviewing teachers to identify particular areas or topics within the math, English, science and social studies curricula that are both difficult to teach and difficult for students to grasp via the traditional lecture methodology. The student team then designs a game, or a series of mini-games, that addresses one or more of those topics in a way that students can grasp more easily. In the process they create storyboards and then prototypes, testing and iterating with their intended audience all along the way.

If, in addition, multiple teams are developing games simultaneously on the same topic, the different games can be tested against each other (and against the traditional methodology) with comparable groups of students to see which approach produces the greatest learning, which produces the greatest engagement, and which produces the best combination of the two. The Web should be used to allow teams to share their work at various points and to learn from each other, so that the final product incorporates the best of all the teams' different approaches.

**Other topics**

In addition to the traditional curricular areas noted above, student teams can also make useful games about important future-oriented topics *not* currently in the curriculum, including genomics, protomics, nanotechnology, biotechnology, bioethics, bio-mimicry, and of course, programming. Topics in human-to-human and human-to-machine communication can also be the basis of games.

Although some assume that there are some topics or objectives of the curriculum that are adoptable to a gaming environment and others that are not, this is not actually the case. With imagination and creativity *any and every* topic can be approached through some type of game. Some areas, however, may take more original thinking than others as the tie to existing games may not be as obvious.

Others assume games cannot be (or should not be) the primary teaching mechanism for a subject, suggesting that educational games be relegated only to the role of review and reinforcement. This, too, is misinformed. There is no reason why well-designed games can't be the primary teachers of information and concepts, with the teachers (or other adult coaches) being the ones who reinforce and underline the key messages and nuances. This is actually a better solution for both students and teachers, as the teachers get to focus their limited time and energy on individual students' understanding, rather than on a 'broadcast' presentation.

**Providing access, maintenance and upgrades**

As mentioned previously, one of the biggest issues around student-created games is figuring out where they will be housed, who will maintain them, who will provide help to users, who will upgrade them so they don't become obsolete, and how the students and teachers who want to use such games will find and access them.

These issues have not, to date, been resolved in any systematic way. Student-created educational games reside on developers' or distributors' servers all over the world, some accessible via the Web, some not. Although some are collected into various kinds of portals, no Web-standard interfaces and methods (other than standard search) exist for locating them, either in their entirety, or by subject and grade.

As noted previously, a natural place for these things to happen is our Educational Colleges, where our teachers are trained. Again, if our future teachers were tasked with finding, maintaining and using educational software (with each school picking the area for which they want to be responsible), teachers would be much more likely to use the software once they get into the classroom.

**Applying the 'rules of engagement'**

When designing educational games (or any kind of learning) it is important to extract from our best commercial games those factors that make the games engaging for players, and then employ these factors in our designs. Whether one is a student designing an educational games or a teacher looking to make their classes more engaging, the same 'rules of engagement,' abstracted from the best, most engaging games, always apply (Prensky, 2007).

What are these 'rules'? Engagement requires:

- ***Goals***. Goals need to be internalized by students as their own, and not just any goals will do. Engaging goals are not the 'learn the material' variety found in our schools, but rather the 'be a hero' type of goals found in complex games.
- ***Decisions & Discussion***. Decisions are engaging. For maximum engagement, decisions must be required, frequent and important to reaching the goals. Decisions are at the heart of the so-called 'learning loop' of decision-action-feedback-reflection, which is so crucial to both learning and engagement. Discussion, both during and after the experience is also important to engagement.
- ***Emotional Connection***. It is widely accepted that an emotional connection makes for stronger learning. The two biggest sources of engagement through emotional connection are *Story* and '*SiSoMo*' (advertiser shorthand for sight, sound and motion).
- ***Cooperation & Competition***. Engagement comes from the careful balancing of these two seemingly opposite, yet related forces.
- ***Personalization***. Research and theory tells us that personalization, ie creating teaching that meets the students precisely where they are, works best for engagement and learning. Students have learned outside of school to expect things to be offered to them at precisely their own level.
- ***Review & Iteration***. Engagement requires that students know whether what they did was wrong or right, and be able to try again. This involves both immediate feedback and what the military calls an 'after action review' (others call this 'debriefing' and still others 'reflection'.) Engagement also requires iteration; that is periodic revision based on the players' experiences and feedback.

- ***Fun***. Although notoriously hard to define fun is absolutely crucial for engaging the generation raised on *Sesame Street*. Game designer Rafe Koster defines fun in games as 'solving a problem mentally.' Whether or not they can define it, it is very clear (at least to students) when fun is missing.

**So why aren't more students learning game designers?**
The fact is that more and more are. The growth has happened fastest at the college level, with several schools around the world offering courses degrees, and even graduate degrees in educational game design. More and more college students are creating games, whether for fun, for contests, or for potential profit. Although, as mentioned, no clear business model or models have emerged for how to monetize educational games, the schools, students, and contests all vie for ownership of these potentially useful games.

In addition to the college students, high school students are creating more and more games in organized programs, and more and more elementary and middle school kids are learning the tools that will allow them to eventually build good educational games.

**The beginning of the end?—transforming culture and practices in schools**
Recently, after hearing a talk by a speaker about coming educational reform, a middle school student in Western Australia went back and told her teacher that 'the people at the talk said I didn't have to be bored anymore in school.' The teacher immediately rang up the Department of Education and accused them of 'fomenting anarchy.' Their answer: 'We don't want our kids to be bored in school either.' (Personal experiences in one of the workshops conducted in Western Australia).

Whether one sees the old paradigm of teaching by 'tell-test' and lecturing as an outdated industrial age system, a social manifestation of power, or just an invalid and ineffective teaching method, it is clearly on the way out, because it is *no longer effective* at getting students to learn. The old paradigm will last, of course, as long as its practitioners can get away with it, since many, if not most, teachers are not motivated or eager to change. But pressure from the students not to be bored, along with the need to move to a 21st century system that works better with technology and, increasingly, pressure from administrators, will, more likely sooner rather than later, spell its demise.

**The new learning paradigm**
What will take its place? Gradually yet inexorably, the paradigm that the students have already evolved for their after-school learning—ie students teaching themselves (with guidance, both from their teachers and from their peers)—will eventually prevail.

Teaching, which has been getting harder and harder to do using the old paradigm, will actually get easier using the new one. A teacher can just think up interesting problems and challenges relative to the curriculum and let the kids use their tools, working in

groups and sharing, to solve them. No more need to prepare detailed lectures and lesson plans—just tell your students where you want them to go and let them get there. (That's exactly what the young people ask for.) Schools can keep the computer lab open till midnight so all can have access to the tools (Another often-heard student request). Keep the students motivated, on track, and watch them learn. The job of the teacher? To ask probing questions, to be sure the students conclusions are accurate, and to help them evaluate the quality of their own work.

**Conclusion: rising demand and supply**

As the educational paradigm shifts to 'students teaching themselves,' the demand for educational games, which allow this to happen in an engaging manner, will increase dramatically. Games that allow students to learn curricular material consistently will come to be seen not as the enemy of good teaching, but as its natural ally. Both mini-games and complex games that teach effectively will be sought after in all subjects at all levels.

Since our students are the ones who both are closest to the learning issues and most fully understand the power of games for learning, they are the natural candidates to fulfill this demand and create these games.

Games built by students for students will become if not the norm, certainly an increasingly important piece of the supply. As game-building tools, more powerful and easier to use, specifically designed for educational games, (including built-in assessments) emerge, and as new business models for funding educational games through contests, school grants, foundation grants, public money, new, unexpected sources, or even the commercial marketplace emerge, new partnerships of students, teachers, professional free-lancers and commercial developers will form. It will seem as natural for a student to develop a game to prove they understand something and know how to teach it, as it is for them to write a paper or student lesson plan. Like 'You Tube' today, the channels of distribution will emerge to suck up these student-created games and distribute them to teachers and learners. User and teacher rankings will bring the cream to the top. The educational game world will come to resemble the commercial game world, with online reviews, discussions, and multiple sequels to the best and most successful games carrying students ever higher up the learning path.

Even if the educational game world does not ever resemble the commercial game world, there is much value of students creating games based on the curriculum. Rieber (2005) has demonstrated in various research studies (that he has conducted with his colleagues since the 1990s) that most learning happens during the creation of the games rather than from the resulting games. This reinforces Aristotle's observation that teaching is the highest form of understanding. As such, the real opportunity of students creating games is not by making their products available to others but rather the process of creation that includes modelling, designing, testing and a lot of meta-learning in between and within phases. As a result, games creation by students will make schools a truly engaging learning environment.

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