

As We May Teach¹

Anticipating Changes in Primary and Secondary Education

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My education was very similar to that of my parents. Theirs didn't differ a lot from my grandparents'. My children's schooling has been enhanced by media, word processing and the internet but the experience isn't fundamentally different from my own. They still go to a classroom, sit at relatively small desks and try to pay attention to a teacher in front of a board. The next generation of children will have a fundamentally different experience. The transformation of primary and secondary education in the United States is beginning now and will be well underway within a decade.

Agilix, my company, produces the Agilix Learning System. Epic Learning² was one of our first customers. Epic offers a set of college-level courses for high school students. Their offerings include subjects College Algebra, Physics, Chemistry, Economics, U.S. History and so forth. Most of the material is presented on individual laptop computers and, upon completing a standardized test, students receive both high school and college credit.

My colleague, Mark Luetzelschwab, visited the sites of many of Epic's first customers in the fall of 2006. One such site was Cirrus High School.³ Cirrus had received a grant which they used to fund one classroom of Epic students. For whatever reason, the principal decided to enroll his list of "students most likely to drop out this year" in the class and assigned the soccer coach, Mr. Wilson, to teach the class.

When Mark visited Mr. Wilson for training he found that he had to start with the basics such as how to set up the laptop computer and plug it into the projector. Mark's expectations for this particular school weren't very high. The teacher's technical skills were limited. The students were to be issued their own laptops that they could take home and Mark expected many to be stolen. And the students weren't exactly college-ready material.

But when Mark visited the class again mid-semester he was pleased to find a success in the making. The teacher had worked with each student to select subjects that would be interesting and beneficial. Each was progressing consistently. Very few had dropped out. The multimedia presentations of the Epic curriculum engaged kids raised on television. Each student could work at his or her own pace and repeat presentations and assessments until the subject was mastered.

Coach Wilson's skills turned out to be ideal for the setting. He used the teacher's dashboard to monitor the progress of each student; getting involved only when special attention was needed. Just as he would on the soccer pitch, he encouraged the kids to do their best and remedy mistakes. Since most of the students' time was spent in independent work the majority of the teacher's time was spent giving individual attention.

Context for Change

This anecdote illustrates a potential framework for future education. However, resistance to change is great. For fundamental changes like these to be anything more than isolated experiments there must be overwhelming pressure for improvement.

Clayton Christensen along with collaborators Michael Horn and Curtis Johnson suggest such a drive. In their 2008 book, *Disrupting Class*⁴, they apply Christensen's theory of disruptive innovation to public education in the United States. They show how previous waves of change have occurred due to external pressures. The current pressure, evidenced by the No Child Left Behind act, is that schools are being held responsible for student success. No longer is it good enough to increase average scores. Now schools are being judged by their lowest scores. Previously, schools were expected to deliver opportunity. If a child didn't avail himself of that opportunity it was his problem – or his parents'. Now schools are expected to ensure that students succeed regardless of their background, regardless of the stability of their home, regardless of anything.

This expectation is controversial. The new emphasis on elevating the lowest performers has left parents asking what is being offered for gifted or even average students. Will the arts continue to suffer? And isn't this an impossible task anyway?

Assuming that it's possible to meet this challenge it certainly will be met. Federal, state and local governments are throwing enormous amounts of money and resources at the problem. So are charitable organizations like the Bill and Melinda Gates foundation. Charter schools have emerged as a testing ground for new educational ideas. And concerned parents are expecting ever more from the educational system.

The Next Generation of Innovation

Ideally, each child would be educated by a personal tutor who would customize the curriculum, keep the subject interesting, overcome learning difficulties and motivate the child to progress. Benjamin Bloom famously showed that one-to-one tutoring combined with mastery learning resulted in two standard deviations better achievement than conventional classroom instruction.⁵ This corresponds to roughly four times the rate of learning. Other have shown that even a few minutes of individual tutoring per day can make a big difference in student performance and motivation.⁶

John Taylor Gatto has claimed that our existing school system squelches the natural curiosity of children converting learning into a chore when it used to be fun and natural.⁷ Luetzelschwab's experience with Cirrus High School suggests that personalizing the

education experience not only increases effectiveness but re-engages students in the learning process.

Requirements

In product development we start with a set of requirements and then design a solution. Even with a disruptive innovation it's reasonable to start with a set of requirements:

- **Student Motivation:** The natural curiosity of children must be cultivated. Students must be free to explore the material in their own way. An abundance of individual attention must be available to assist students in overcoming obstacles.
- **Subject Mastery:** Students must not be advanced until the objectives of each learning unit have been mastered. For most subjects, this requires that students be individually paced. And guidance must be available to keep students from stalling out.
- **Detailed Performance Monitoring:** The progress of each student must be reported to teachers, parents and administrators so that learning problems can be detected early and addressed immediately. Feedback about the system as a whole must be used to improve the overall teaching program.

It's clear that the solution centers on personalized instruction. But with student to teacher ratios of 18 to 1 at the low end and growing as high as 40 to 1 it's also clear that personalization can't be accomplished in a conventional classroom.

Automating tasks and reallocating time

If education is to be individually customized without raising the cost, we need to free up a lot of time and resources. One survey showed that on average teachers spend their professional time in the following activities⁸:

Direct Instruction	20.6%
Organizing	3.4%
Reviewing	4.5%
Testing	5.0%
Monitoring	5.1%
Scheduled Meetings	0.6%
Unscheduled Meetings	10.0%
Exchanges (out of class)	14.6%
Study hall supervision	3.8%
Monitoring assemblies, clubs	1.3%
Control and supervision	2.7%
Desk work	12.3%
Routine tasks	7.5%
Travel time	5.3%
Private time	3.5%

Table 1: How Teachers Spend Their Time

While some of the "Instruction" time may be individualized, the bulk of it is spent addressing the entire class at once. In most classes, the majority of individual attention

occurs when the teacher grades assignments and the student isn't even present. If learning is to be individualized to the extent required, much of the teacher's work must be automated by computers in order to free teacher time for individual attention.

As I approach a process automation problem I like to divide the process into tasks that only need to be done once, those that can be done by artificial intelligence (computers) and those that require real intelligence (people). The following table represents a rough analysis of the teaching process.⁹

Task	Can be done once for all students.	Can be done by artificial intelligence	Requires real teacher time.
Prepare course outline and lesson plan	■		
Exposition / Lecture	■		
Prepare Assessments	■		
Prepare Assignments	■		
Administer Assessments		■	
Grade Objective Assessments		■	
Grade Subjective Assessments			■
Deliver Assignment		■	
Grade Objective Assignments		■	
Grade Subjective Assignments			■
Report progress to students and parents		■	
Drill and Review		■	
Provide individual guidance and assistance			■

Table 2: Teaching tasks that can be automated.

Unfortunately, the tasks in table 2 don't map exactly to teacher time in table 1. So, I have to make some assumptions about how teacher time might be reallocated in a technology-enabled classroom like Mr. Wilson's. Table 3 makes some conservative assumptions in order to project how much teacher time might be refocused on individual attention by using an online curriculum:

	Teacher Time	Fraction to be Automated	Time Saved
Direct Instruction	20.6%	100%	20.6%
Organizing	3.4%		
Reviewing	4.5%	100%	4.5%
Testing	5.0%	100%	5.0%
Monitoring	5.1%	50%	2.6%
Scheduled Meetings	0.6%		
Unscheduled Meetings	10.0%		
Exchanges (out of class)	14.6%		
Study hall supervision	3.8%		
Monitoring assemblies, clubs	1.3%		
Control and supervision	2.7%		
Desk work	12.3%	75%	9.2%
Routine tasks	7.5%	75%	5.6%
Travel time	5.3%		
Private time	3.5%		
Total	100%		47.5%

Table 3: Automation of Teaching Tasks.

If we assume that most of the “Unscheduled Meetings” are with students we can add that to the time saved. This means that approximately 57% of teacher time can be dedicated to individual attention in the new model. This is a very different approach from traditional Computer-Aided Instruction. Instead of drill and review or remedial learning, the focus is on optimizing teacher effectiveness and freeing time for individual attention.

Cirrus High School Revisited

To illustrate how this works, let’s return to the Cirrus High School example.

Course Design and Lesson Materials: The Epic courses were developed by professional instructional designers based on current theories of pedagogy. Since this only had to be done once to serve thousands of students they could afford to hire top talent and spend a lot of effort to produce engaging content including high-quality video lectures, virtual labs, interactive learning modules and so forth.

Course Administration: A Learning Management System is used to present the course materials. It automatically shows the student his or her progress through the course, displays the content, administers quizzes and manages assignment submission. Quizzes that are composed entirely of objectively-graded questions are graded immediately and the student knows whether to move on or review the material and try again. Objectively-graded questions and assignments are forwarded to the teacher where the “speed grading” system makes efficient use of the teacher’s time.

Progress Monitoring: The teacher and administrators can easily monitor the progress of students. A teacher dashboard allows the teacher to observe the progress of the entire class and highlights those who are falling behind or are struggling to understand the subject. Parents likewise have access to progress information and can encourage or assist their children.

The net result was that the Cirrus class offered fully individualized instruction. Students were allowed to choose from a broad spectrum of subjects to find something that suited their interests and needs. Each student progressed through the material at an individual rate advancing only when the each objective was mastered. The bulk of a teacher's time was reallocated to individual attention thereby allowing difficulties to be addressed immediately. Proof of the model comes from the results. Of 32 students that were expected to drop out of school nearly all of them remained in school and earned college credit. Many said this was their first academic success in their entire lives.

Emergence of Computer-Based Learning

With the Cirrus High School example I've shown that Epic Learning Systems is already offering elements of a next-generation learning system. Many other organizations are doing equivalent or similar work. The pressures of the new job given to our schools will encourage adoption of these systems regardless of whether they are disrupting the educational system. For example, the State of Michigan has mandated that all High School graduates must take part in some form of online instruction.¹⁰

Christensen and his colleagues now have done enough research into disruptive innovation that they are able to predict the adoption cycle of such innovations. Chapter 4 of their book details how they go about analyzing the market and the reliability of their predictions. They predict that by 2012 5% of U.S. public high school teaching will be online. At that point adoption will accelerate growing to more than 50% by 2018.

Early adoption will be in the growing field of online or "virtual" schools (which are exclusively computer-based). Florida Virtual School is one of the early pioneers. Created and funded by the state legislature, FLVS taught over 68,000 courses to 31,000 students in the 2005-2006 school year.¹¹ The American Academy¹² and Western Governor's University¹³ are other pioneering efforts.

In the fall of 2009, Utah students will be able to choose from two virtual charter schools. The Utah Virtual Academy launched in 2008 and offers Kindergarten all the way through 12th grade. Curriculum and operations are outsourced to K12.com.¹⁴ The Open High School of Utah will start with 9th grade in the fall of 2009 and add one grade per year until they become a four-year, accredited high school.¹⁵ Like many online offerings, the Open High School of Utah will draw on open content to build their curriculum and will likewise license their courseware free of charge to other schools.

Final Thoughts

The pressures of new government and societal mandates will require disruptive innovation. No other approach will meet the new requirements at acceptable cost. The most likely approach to that innovation will be to bring online learning into the classroom. That will free teachers from repetitive work and reposition them to address individual student needs.

Real-world experience at Cirrus High School and numerous other pilot programs at virtual and conventional schools confirm the potential for online learning to transform education. We are at a confluence of need, opportunity and motivation. Those institutions that are first to adopt these innovations will serve their students better than ever before and will pioneer a new era in education.

¹ The title is derived from the article "As We May Think" by Vannevar Bush and published in The Atlantic Monthly in July of 1945. In this article, Mr. Bush anticipates many of the computer innovations that we presently enjoy. Bush's article inspired Doug Engelbart's work at the Augmented Human Intelligence Laboratory. (<http://www.theatlantic.com/magazine/archive/1969/12/as-we-may-think/3881/>)

² <http://www.epiclearningsystem.com>

³ With the exception of Mark Luetzelschwab, names of individuals and the school have been changed to protect privacy.

⁴ Clayton M. Christensen, Michael B. Horne and Curtis W. Johnson, *Disrupting Class* (McGraw Hill, 2008)

⁵ Bloom, Benjamin, "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring," 1984, *Educational Researcher*, 13:6 pp. 4-16. (<http://www.jstor.org/stable/1175554>)

⁶ The report, "State and Local Implementation of the No Child Left Behind Act," was published by the U.S. Department of Education in June of 2007. Among other findings, they showed that troubled schools that chose the Supplemental Education Services option (a tutoring program) showed "statistically significant improvement" in student achievement while those that chose the school choice option did not show improvement. (<http://www.ed.gov/rschstat/eval/choice/implementation/index.html>).

⁷ John Taylor Gatto, *Dumbing Us Down* (New Society Publishers, 1991)

⁸ T. Cypher and D. Willower, "The Work Behavior of Secondary School Teachers," 1984, *Journal of Research & Development*, 18, pp. 19-20

⁹ Credit goes to my friend, Mark Luetzelschwab who first suggested that we look at how teachers spend their time and reallocate the bulk of that time from shared activities to individualized instruction.

¹⁰ "Michigan First to Mandate Online Learning," *eSchool News*, 3 April 2006 (<http://www.eschoolnews.com/news/top-news/index.cfm?i=36910>)

¹¹ Florida Virtual School (<http://www.flvs.net>)

¹² The American Academy (<http://www.theamericanacademy.com>)

¹³ Western Governors University (<http://www.wgu.edu/>)

¹⁴ Utah Virtual Academy (<http://www.k12.com/utva/>)

¹⁵ Open High School of Utah (<http://openhighschool.org/>)