Stop Teaching!

The Key to Student Learning

By Michael T. Martin

A Misperception of Learning

There is a common misperception of how children actually learn. What actually results in children learning is almost exactly the opposite of what people think: it is not teaching. Indeed, what transforms teachers into expert educators, is that they stop teaching and let children learn.

However, although expert educators who regularly facilitate student learning have a well established idea of what not to do, which is to teach, they have not developed a recognition or vocabulary for what they actually do. And this makes it difficult both to understand expert educators' concerns and to help new teachers develop those skills necessary for children to learn. The stereotype most people have of teaching, including most new teachers, is of the teacher, at the focus of attention, telling or showing children subject matter, but expert teachers feel just the opposite: let the children learn.

Distinguished Professor Emeritus of the University of Wisconsin Milwaukee Martin Haberman long averred that traditional teaching fails to motivate students to learn and instead "The classroom atmosphere created by constant teacher direction and student compliance seethes with passive resentment that sometimes bubbles up into overt resistance."

Described by Education News on December 8, 2011, as having developed more teacher education programs which have prepared more teachers for diverse children in poverty than anyone in the history of American education, Professor Martin Haberman's most widely known program was the National Teacher Corps, based on his intern program in Milwaukee.

In a December, 1991, Kappan article "The Pedagogy of Poverty Versus Good Teaching" Professor Haberman noted that successful teachers have an entirely different repertoire of teaching behaviors "that frequently involve the creation of a learning environment. These

teaching behaviors tend to be evident more in what the students are doing than in the observable actions of the teachers. Indeed, teachers may appear to be doing little and at times may, to the unsophisticated visitor, seem to be merely observers."

This crucial point is what most people miss about expert educators: they stop teaching and they "appear to be doing little." Indeed, one could say that the better the educator, the less there is to observe. What they do so subtly is let children learn.

Fundamentally, what expert educators do, that teachers do not, is so subtle that often even they do not know what it is. Tad Watanabe, writing in Mathematics Education Dialogues (National Council of Teachers of Mathematics, November, 2001), noted about Japanese mathematics teachers: "students' solutions are shared and analyzed critically, and **teachers often appear to stand aside during the class discussion**." (emphasis added) Susan Ohanian, an exemplary teacher and author of several books about education, noted in a personal email: "I think the key factor is knowing when to 'disappear' and when to move in."

This also highlights another one of the subtle misconceptions of learning: that teachers can be evaluated by principals doing "observations." In an email exchange about "Classroom Management" initiated by education Professor Fred Flener on Jerry Becker's listserv about mathematics instruction, one educator wrote:

> One of my principals had an idea of how the class was "managed" and sometimes it didn't agree with mine! Then I invited him in to watch and he still didn't know "what" I was doing! So I had a student video tape a couple of classes and the principal and I watched the tape together and talked about "classroom management." He learned that the class manages itself when learning is taking place. He never commented and used the term again when talking to me. When it came time to make his evaluation observations, he and I decided ahead of time what I was concentrating on and wanting to change with my students at that particular time. I would have to do this "training" with succeeding principals. My classroom was directly across from the office and was visited often by guests to the buildings. I guess it was known that the class would be "managed" and could be observed!

This educator was bold enough to be open with her principal about not teaching, probably because being across the hall from the office it was too difficult to hide. But it took extensive "training" of the principal to reach this understanding because what she did was so invisible that it could not be observed even when she videotaped the classroom to show him. Indeed her secret was to stop teaching with the knowledge "that the class manages itself when learning is taking place." In other words, the students themselves actually will manage the classroom and conduct the learning if you let them. If you stop teaching and let the students learn, the class manages itself.

In other words, traditional teaching, centered on a dominating teacher, primarily arouses resentment and resistance in students, and thus what expert educators do to promote student learning is to essentially stop teaching. It is simply a misperception that students

learn from teaching. Indeed, evidence suggests that it is this misperception of learning that essentially results in most new teachers failing and leaving the profession; as Professor Haberman wrote: "Teachers burn out because of the emotional and physical energy that they must expend to maintain their authority every hour of every day."

The minority of college of education graduates who stay in the teaching profession secretly transform from teachers into educators, an entirely different creature, often in spite of themselves. Once they discern how children actually learn, they become transfixed on exploring this strange world, groping blindly in their quest. And it is a strange world indeed that tends to be masked in uncertainty and shrouded in mystery. A world seemingly upside down and backward from what we have traditionally thought. So strange that few teachers talk about what it is really like for fear of ostracism.

Rita Tenorio, a veteran Milwaukee educator with more than 30 years teaching children in the early elementary grades, was asked by Rethinking Schools magazine to offer advice to new teachers. She offered:

> In college you learn how to teach different parts of the curriculum, how to teach math, how to teach social studies. It's kind of assumed that the kids will come into the classroom and sit down, and you can take what you've learned about and just start teaching it and the kids will learn. And what really happens is very different from that. You need to assess where the kids are coming from. Find out what they know. What is their daily experience like? What language do they speak at home? What past experiences has the family had with schools and learning? And then you need to move them along from that place.
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> Kids are learning all the time, but they're not necessarily learning the curriculum you think you're teaching them. Curriculum is everything that happens. It's not just books and lesson plans. It's relationships, attitudes, feelings, interactions.

Learning requires a lot of things, but it is not teaching. This is a different paradigm: to be successful requires an entirely different view of learning. The paradigm shift that teachers have to make, is to stop teaching and start having compassion for the child's "attitudes, feelings, interactions." The dilemma of becoming a successful teacher depends on how well they learn to stop teaching and let children learn. In essence they have to stop teaching subjects and start helping children to learn.

Part of the difficulty in changing paradigms is the nomenclature. We label a person who heads a classroom a "teacher" and thus presume what that person should do is "teach." For many years that was the way it was done. But in the new paradigm, what we want to occur in the classroom is learning: we want the person who heads a classroom to facilitate learning by students. Calling that person a "teacher" creates paradigm problems because teaching is counter-productive when we want learning.

The Wharton Business college at the University of Pennsylvania publishes a periodical known as Knowledge@Wharton. The August 20, 2008, edition contained an excerpt from the book "Turning Learning Right Side Up: Putting Education Back on Track" by

authors Russell L. Ackoff and Daniel Greenberg titled “The Objective of Education is Learning, Not Teaching” which began with this quote from Oscar Wilde: "Education is an admirable thing, but it is well to remember from time to time that nothing that is worth learning can be taught."

The authors then begin by stating: “Traditional education focuses on teaching, not learning. It incorrectly assumes that for every ounce of teaching there is an ounce of learning by those who are taught.” The authors continued to describe an extensive dichotomy between teaching and learning.

Later in the article, the authors express disdain for “teaching” (saying “unfortunately called teachers, which gives them a status they do not deserve”) stating:

> Let's abandon for the moment the loaded word teaching, which is unfortunately all too closely linked to the notion of "talking at" or "lecturing," and use instead the rather awkward phrase explaining something to someone else who wants to find out about it.

The authors then explain:

> To satisfy the person being addressed, to the point where that person can nod his head and say, "Ah, yes, now I understand!" explainers must not only get the matter to fit comfortably into their own worldview, into their own personal frame of reference for understanding the world around them, they also have to figure out how to link their frame of reference to the worldview of the person receiving the explanation, so that the explanation can make sense to that person, too. This involves an intense effort on the part of the explainer to get into the other person's mind, so to speak, and that exercise is at the heart of learning in general.

Teaching, or telling, from the perspective of what you understand ignores that what you understand is heavily dependent on the internal structure of your idiosyncratic knowledge. This is a key point. Reading expert Frank Smith writing in "Decoding: The Great Fallacy" in Psycholinguistics and Reading (Holt, Rinehart and Winston, Inc., 1973) explained:

> "Extracting the meaning of an utterance -- getting from surface structure to deep structure -- involves complex syntactic and semantic decisions; in other words, the listener uses knowledge of his language and of the world. Without the contribution of this knowledge and the associated process of moving between surface and deep structure, speech just cannot be understood."

Understanding even a simple spoken sentence requires “the listener (to use) knowledge of his language and of the world.” Every child in the classroom has a different individual “structure” in his or her brain that teaching has “to link their frame of reference to the worldview of the person receiving the explanation, so that the explanation can make sense to that person.”

Expert educators understand the crucial point that just “teaching” something has little effect unless the student has the underlying knowledge and understanding to incorporate what is taught into a pre-existing “framework” of ideas. However, these authors

understate the problem by misperceiving this framework as a static model that the teacher can directly perceive. Unfortunately the student's mind is a dynamic system of thought, an interconnected woof and warp of dynamic ideas in tension that only the student can navigate.

One of the classic books in education literature is John Holt's 1964 book "How Children Fail." Holt spent many years of successful teaching in a private school before writing this book. He related what he had observed over those years in a very perceptive manner, almost scientific. There are many books written on education every year, but there was something in Holt's book that grabbed the attention of educators worldwide.

John Holt was not a public school teacher; he was a teacher at an affluent private school. His students were of the social class that typically does well on tests and learns easily. Parents paid heavily for their students to attend his school and they prompted their children to do well because they understood the importance of education not just in economic terms but in cultural and social terms. And yet Holt found that, like a colleague of his stated, "I teach, but they don't learn."

At the very beginning of his book, in his fourth sentence, Holt asked "Kids often resist understanding, make no effort to understand; but they don't often grasp an idea and then throw it away. Do they?" But he then described how one of his students did exactly that. And this formed the main quest for his book. Why is it that teachers can teach but students not only do not learn, not only ignore learning, but actually resist learning?

Holt eventually concluded in a 1982 annotation to the reissue of his 1964 volume:

> "Why don't they learn what we teach them? The answer I have come to boils down to this: Because we teach them – that is, try to control the contents of their minds."

John Holt after writing a classic book about teaching finally conceded twenty years later that teaching is counter-productive when we want learning. Indeed, he admitted

> "I doubt very much if it is possible to teach anyone to understand anything, that is to say, to see how various parts of it relate to all the other parts … we cannot give them our mental structures; they must build their own."

What is needed in the classroom is not teaching subjects but facilitating learning. The concept that Holt called a "mental structure" is the first anomaly that all new teachers encounter in children's learning. The traditional conception of a child's mind is the "tabula rasa," the blank slate that the teacher fills with learning. To most people, including most educators, the mind of a child is seen as an empty vessel into which knowledge is poured. But typically when you try it, it runs out the bottom as quickly as it is poured in. That is the first clue that new teachers discover in finding that teaching doesn't work.

The greatest misperception of learning is that one person teaches a second person anything. As Holt concluded "I doubt very much if it is possible to teach anyone to understand anything." The key to student learning is the understanding that learning

rarely occurs from teaching. This is not really a new revelation. Galileo said "You cannot teach a man anything; you can only help him discover it in himself." Galileo's Copernican concept of the stars required a paradigm shift in thinking, away from viewing the stars as they appeared from Earth, to viewing them from outer space looking down on planets circling our sun. To those who insisted on thinking of the stars as they appeared from Earth, watching the sun rising and setting, Galileo made no sense.

To those who insist on thinking that children learn from teaching, to suggest otherwise makes no sense. It seems foreign because it is not what they see in their everyday lives. They all know that children learn every day in schools, which they attribute erroneously to teaching. They are like the Ptolemaic believers who could see the stars circling the Earth. Similarly, Galileo's concept of not teaching requires another paradigm shift in thinking to understand. It is very difficult for many people to comprehend what educators do if they do not teach, a difficulty particularly for new and marginally successful teachers still groping for their holy grail of student learning, who have not made the transformation into educators.

The inability to teach makes for great frustration among traditional teachers who want desperately to succeed, often because of their psychological desire to control children's minds. They became teachers for the power to control and dictate to children; to "discipline" them. And they see their inability to teach, as Holt described it, as "threats to my authority or sense of personal worth." It is maddeningly frustrating when they find that teaching doesn't work, for which many blame the children.

And, indeed, children do expend considerable effort to thwart teaching. The children know teaching is counterproductive and Holt's book has several chapters on how creative children can be in thwarting it. But there is a deeper more scientific interpretation that requires an understanding of the difference between students having a static mind and students having a dynamic system of thought.

Holt gave no indication he was aware of systems theory, but his "mental structure" is very suggestive of a "system of thought" within each child that the child uses to understand the world in which he or she exists. The seminal educational psychologist Jean Piaget recognized this and called it "schema" for lack of a better term. Teachers soon learn that children's minds are not empty vessels but instead already contain a tightly woven interdependent dynamic collection of ideas and beliefs. A system of thought in which each interwoven belief reinforces and is consistent with the others.

Recognizing, either implicitly or explicitly, that a child's mind is a dynamic system of thought is what differentiates expert educators from everyone else, including teachers. A dynamic system means the child's brain is already active, already engaged with the world around him or her. The child has built an internal multifaceted structure of knowledge that contains myriad ideas that depend on other ideas that influence each other in myriad ways. What is in a child's mind was learned over many years from that child's interaction with the world.

A child's mind is not a mish mash of jumbled ideas and facts that were taught, but that is how traditional education "teaches" children. A child's mind is not a "heap" of things, but rather a highly organized interrelated interdependent structure. The traditional teachers' view of the child's mind resembles that of a heap of bricks and teaching is merely shoveling in more bricks, when in fact a child's mind is more like a cathedral of thought: an elegant beautiful structure that the child has proudly constructed and proudly will defend. Shoveling in more bricks desecrates the beauty and elegance of the child's mind.

For a child to understand anything, as Holt perceptively recognized, means to "see how various parts of it relate to the other parts" of his or her mind as an interacting whole, as a mental structure like a cathedral of thought. At root this system of thought forms the very sanity of the child. Holt was saying that we ultimately have no control over this system of thought. It belongs to the child. To try to put something in that child's head represents a foreign intrusion, a rape of a child's sanity.

It is not too far metaphorically to describe traditional teaching as a mental rape, where teachers struggle to penetrate the child's mind with foreign thoughts while, as Holt and his colleagues noted, the children struggle to resist. Logically it is difficult to understand why so many children fail in school without a recognition of this condition. We persist in describing a "love of education" when the sordid reality of traditional teaching is a rape.

Rape is not what expert educators do; what they do is facilitate the child's building of his or her beautiful cathedral of thought by providing bricks and mortar and elegant suggestions. Only the child can build that cathedral and any number of people who have built stacks of blocks for children will see them angrily swat them down because they want to build their own. The same thing happens to their learning: children resist rape.

If that sounds harsh, it merely echoes what Holt noted in his 1982 annotations to his book:

> "Charles Silberman and a large team of researchers visited hundreds of school systems all over the country. What they found everywhere was what Silberman in ***Crisis in the Classroom*** called 'appalling incivility' toward children on the part of almost all adults in schools."

Holt never used the term "rape" but his description evokes language women use to describe rape. He went on to describe how some teachers' "insecurity, weakness, and fear" resulted in the common practice of

> "mental and spiritual brutality: sarcasm, mockery, insults – what Professor of Education Arthur Pearl, who has spent much time in classrooms himself, calls 'ceremonies of humiliation'."

Holt attributed this, for many teachers, to

> "a widespread dislike, distrust, and fear of children so intense that it would not be off the mark to call it hatred."

A hatred that is a consequence of their frustrating attempts to teach. Simply put, teachers who insist on misperceiving that children learn because one person teaches a second person something are doomed to a humiliating failure that un-nerves them and they angrily blame the students for their failure.

In fact, Holt described how teachers frequently become so un-nerved by their classroom challenges that they respond almost in revenge "by waging an endless psychological war against the children, to make them even more insecure, anxious, and fearful than they are themselves."

The students can sense this animosity in their teachers. For this reason, John Holt explained, for most students it is a "fiction that school is a wonderful place and that they love every minute of it." A fiction similar to that often heard by police from arrested rapists about their victims. Instead, because of the way teachers behave towards students in trying to teach, students primarily seek to avoid what Holt described as the "fear, shame, rage and hatred that school and their teachers had aroused in them." A description very much reminiscent of rape victims.

It is no secret that the vast majority of students do not like to go to school. Yet the vast majority of adults behave as if teachers merely have to ejaculate information into their willing students in order for them to learn. So great is this misperception of learning that few within and without education are willing to question it, and few have any conception of what really occurs and what actually is necessary for children to learn.

Education reform to the vast majority of people, including the vast majority of teachers, consists of increasing the frequency and rigidity of ejaculating information, sometimes through "scripted lessons" where someone thousands of miles and years away from the classroom decided a priori what the teacher will say without any knowledge of the students actually in the classroom. They conceive of education as "teaching" where the students themselves are entirely fungible pieces of meat in the process.

Believing in this misperception is the reason why over half the teachers, who devoted years of hard college work to become teachers, subsequently leave teaching within five years. Five years is the critical period. Research shows that teacher experience has little or no correlation with student achievement except during the first five years. It is in those first five years that teachers must achieve Galileo's education paradigm shift that is far greater than Galileo required with his Copernican theory of astronomy.

Research repeatedly shows that during those five years some teachers learn something that leads to greater student achievement. Experience beyond those five years shows only minor improvements in student achievement. During those same five years, half of the beginning teachers leave education because they no longer want to teach. Something happens in that first five years where some teachers undergo Galileo's paradigm shift and some do not. Expert educators know what that is, and they have explained it quite often, but the peculiarities of paradigm differences is that people in one paradigm rarely can comprehend what someone in another paradigm is saying.

Myron T. Tribus, the former director of the Center for Advanced Engineering Study at MIT explained in 2001:

> If you try to introduce people to a paradigm shift, they will hear what you have to say and then interpret your words in terms of their old paradigm. What does not fit, they will not hear. Therefore, a change in paradigm cannot be brought about by talking. People have to experience the change, or at a minimum see other people experiencing it, before they will begin to understand what you are saying.

Expert educators have proclaimed over and over that the key to student learning is to stop teaching. The problem with this paradigm shift in education is precisely because of the difficulty in "seeing other people experiencing it" because what expert educators do is to not do it: teach. But the evidence is overwhelming, you must stop teaching if you want children to learn. John Holt wrote:

> "A few good principles to keep in mind:
>
> > (1) Children do not need to be 'taught' in order to learn; they will learn a great deal, and probably learn best, without being taught.
> > ….
> > (3) Children learn best when the things they learn are embedded in a context of real life …."

Children have logical brains that they will use very adeptly with classroom chaos and passive resistance to thwart attempts to teach them, but children love to learn about the world around them. Expert educators learn to exploit this, so, when no one is looking, they quietly stop teaching and conspire with the children to help them learn. Or as Martin Haberman wrote: "The few urban schools that serve as models of student learning have teachers who maintain control by establishing trust and involving their students in meaningful activities rather than by imposing some neat system of classroom discipline."

Paradoxically, Haberman noted "For genuinely effective urban teachers, discipline and control are primarily a consequence of their teaching and not a prerequisite condition of learning." Or perhaps more accurately, learning is a consequence of their not teaching. True classroom management does not really mean controlling the students. Kelley Dawson, a fourth grade teacher writing in Rethinking Schools, stated:

> Discipline is an exhausting part of the job that never really goes away. The message that most of us get is that to be a good teacher, you must first be a good disciplinarian. You must control your students' behavior. Only then, when your classroom is under control, can you begin to teach.
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> I disagree.
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> No teacher has to wait until the students are "under control" to start teaching them worthwhile stuff. It's actually the other way around. Over and over again, I have found that the moment I start to teach interesting, engaging content, I experience immediate relief in the area of discipline.

The key word here is "engaging," meaning the students were allowed to become involved in the process of learning. Similarly, in an email exchange about "Classroom Management" initiated by education Professor Fred Flener on Jerry Becker's listserv about mathematics instruction, when using homework as punishment came up a teacher wrote:

> I truly think new and many experienced teachers think that classroom management is a duel with the children over control of the classroom. It is a sorry state to think that is even a consideration. Teaching is to generate learning. If teachers engage students in learning there is no conflict with control. The only concern would be safety of all individuals. Homework does not even enter in this discussion and shouldn't. It gives the appearance that it is a bargaining chip over control, which it is not. If a teacher teaches and a student learns then there is respect emanating from both parties and no one fights for control.

Notice her critical understanding that "teaching is to generate learning" which she crucially describes as something done by students through mutual respect. And equally crucial she described teaching as to "engage students in learning" rather than teaching. Both educators used the term "engage" which could be mis-read to reflect a violent military engagement reminiscent of rape when it should reflect more of a pre-nuptial sense. A mutually respectful marrying of the minds.

Learning in schools occurs in spite of teaching, not because of it. People who start out to be teachers based on what they misperceive their teachers did, learn rather quickly to quit, and they either leave education or they survive by pretending to teach while they actually secretly transform into educators: educators who quietly keep their secret hidden away from prying eyes. Few consciously recognize the necessity to stop teaching, they learn it subconsciously in an almost Darwinian process of learning what doesn't work.

But because of the dominant misperception that students learn from teaching, emerging educators continue to pretend that they are teachers, want everyone to believe that they are teachers, while they "cheat" by stopping teaching long enough for students to learn. Primarily because they recognize empirically that teaching is counterproductive, they learn to avoid it when they can, resorting to it only when they are being observed.

Even the best educators will "teach" when they are being observed, treating traditional teaching as education's ceremonial Kabuki ritual. In most school systems teachers are "evaluated" on the basis of how well they "teach" which is determined by an administrator observing them in the classroom once or twice a year, even though we know that what the best educators do cannot actually be observed. In most school systems these "observations" are scheduled in advance so that the teacher knows when to prepare to "teach" as part of the charade.

The entire modern school system exists in a gigantic misperception of learning, engaging at times in ceremonial rituals of teaching when in reality expert educators know not to teach. The reality of education that expert educators understand is that children want to learn, but they will thwart teaching, and kids are very adept at thwarting it. Holt described

how astounded he was when he figured out how adept children were at thwarting teaching, and how other teachers were equally astounded when he pointed it out to them.

Professor Haberman put it this way: “students actually control, manage, and shape the behavior of their teachers. … And yet, most teachers are not particularly sensitive to being manipulated by students. They believe they are in control and are responding to ‘student needs,’ when, in fact, they are more like hostages responding to students’ overt or tacit threats of noncompliance and, ultimately, disruption.”

Holt explained that the children thwart teaching for a very good reason: to protect their sanity and their logical construct of the world they have developed on their own. John Holt lamented:

> “Children come to school curious; within a few years most of that curiosity is dead, or at least silent. Open a first or third grade to questions, and you will be deluged; fifth graders say nothing. They either have no questions or will not ask them.”

Teaching essentially killed their learning. Children will eagerly learn, if you don’t teach them, simply because learning increases their understanding of the world around them. But they have learned all too well that teaching destroys sanity, and so they thwart it. Teaching lacks a logical opportunity for students to learn.

Expert educators in the new paradigm are quite insistent about this. In the January 5, 2009, issue of New Scientist magazine, Richard Hammond, a producer of science-oriented television programs stated

> “I think it's no coincidence that kids start deserting science the moment it becomes formalised. Children naturally have a blurred approach to acquiring knowledge. They see learning about science or biology or cooking or how not to close a door on your feet as all part of the same act - it's all learning.”

And they love it until you start teaching it. Children naturally think of the world as a logical place, but too often school breaks this down.

Holt called this "our 'Tell-em-and-test-em' way of teaching" noting:

> In many ways, we break down children's convictions that things make sense, or their hope that things may prove to make sense. We do it, first of all, by breaking up life into arbitrary and disconnected hunks of subject matter, ... Furthermore, we continually confront them with what is senseless, ambiguous, and contradictory; worse, we do it without knowing that we are doing it, so that, hearing nonsense shoved at them as if it were sense, they come to feel that the source of their confusion lies not in the material, but in their own stupidity.

And as a consequence, Holt asserted, "To a very great degree, school is a place where children learn to be stupid."

The word “stupid” means to lack reasoning. Children come to school very skilled in reasoning out the world around them. But traditional teaching has no role for reasoning. What made Holt’s "How Children Fail" a classic book on education was the widespread

recognition by educators reading it of their own lives in what he wrote. Holt averred that for most students,

> "school is mainly a place where you follow meaningless procedures to get meaningless answers to meaningless questions."

This is a foundational understanding among expert educators. British mathematician W. W. Sawyer wrote in 1961:

> "The depressing thing about arithmetic badly taught is that it destroys a child's intellect and to some extent, his integrity. Before they are taught arithmetic children will not give their assent to utter nonsense; afterwards they will. Instead of looking at things and thinking about them, they will make wild guesses in hopes of pleasing a teacher."

Holt gave the example of a "Twenty Questions" exercise in which children were to guess a number he was thinking of. The logical method to solve this conundrum is to divide the spectrum of possible answers and ask questions that exclude most of the numbers. But Holt noted that if he asked them to guess a number between one and ten-thousand:

> If they say, "Is the number between 5,000 and 10,000?" and I say yes, they cheer; if I say no, they groan, even though they get exactly the same amount of information in either case. The more anxious ones will, over and over again, ask questions that have already been answered, just for the satisfaction of hearing a yes.

Indeed, Holt described how children soon lose any concept that school has a logical basis and resort to simply following instructions. Holt wrote:

> "Children … get in the habit of waiting for teachers to show them how to do everything, so that they may continue by a process of blind imitation; they never learn how to get information out of verbal instructions. In fact, they do not seem to believe that verbal instructions contain information."

The problem is that teachers never abandon the idea that verbal instructions contain information, oblivious to the complex difficulty of a process that rarely succeeds, but the children learn this very quickly. As Holt recognized, children in school "do not … believe that verbal instructions contain information." They are fairly certain it doesn't.

Holt described in detail how children quickly learn to treat a teacher's questioning as if it were a game in which the goal for the student is to trick the teacher into giving up the answer. The children do not perceive of the teacher's question as having any logical purpose. The children do not perceive a teacher's questions as part of any learning process, but rather as a psychological attack on their sanity, an impending mental rape by the teacher that needs to be thwarted. Holt averred that the majority of children do not comprehend school as a place of learning, but rather as a place of thwarting this attack on their sanity.

What frustrates most new teachers, and escapes most observers, is that learning occurs when teachers stop teaching. Learning occurs when the students want to learn, and it

occurs when teachers help them to learn, but not when they teach. And so expert educators stop teaching and allow children to learn, knowing that teaching is counter-productive. One observer of Japanese mathematics teachers noted “teachers often appear to stand aside during the class discussion.” One of America’s greatest education professors explained that the best “teachers may appear to be doing little and at times may, to the unsophisticated visitor, seem to be merely observers.” One of America’s best teachers described her own key to teaching as “the key factor is knowing when to 'disappear' and when to move in.”

Learning is the process of children expanding their cathedral of knowledge. It involves adding bricks to their system of thought, but not simply by shoveling bricks into a heap, but by helping the students to place the bricks carefully into their system of thought, forming intellectual flying buttresses and supporting arches to produce intellectual cathedrals.

Systems of Thought

Understanding systems of thought provides an important foundation for understanding student learning. But the key understanding is that children's brains are dynamic systems. There are certain characteristics common to all dynamic systems: they seek a steady state and resist efforts to change their behavior from the outside. The change in behavior has to occur from the inside and that only occurs through a reorganization of the dynamic relationships within the child's system of thought.

Unfortunately, understanding dynamic systems is very difficult at first because there is a paradigmatic difference. People tend to interpret new information about dynamic systems in terms of their existing knowledge and thus misinterpret what they encounter. It is the same problem that children have when they encounter new ideas that conflict with their preconceptions.

People, both children and adults, will keep thinking what makes sense to them, even if it doesn't make sense to us. They have a system of thought that may be radically different from our own. These differences will seem incomprehensible without an understanding of how dynamic systems function. Much like the Copernican paradigm changed the way people thought of the universe, understanding dynamic systems changes the way the education world appears.

For example, in Esther Thelen and Linda B. Smith's book "A dynamic systems approach to the development of cognition and action" that described how children learned to walk and reach for things in terms of dynamic systems, they wrote "Once we began to view development from a dynamic and selectionist approach, we found the ideas so powerful that we could never go back to other ways of thinking. Every paper we read, every talk we heard, every new bit of data from our labs took on new meaning."

These experts probing how children learn to walk or reach for things found the most appropriate way to understand how children's brains work was to consider it a dynamic system, and they were startled at the transformation that occurred in themselves with this understanding. Understanding that a child possesses a system of thought requires first of all an understanding of what a dynamic system entails.

The easiest way to begin grasping the meaning of a dynamic system is to consider an artificial simple example such as a turntable that turns clockwise if one polarity of electricity is applied to the motor and turns the other way if the opposite polarity is applied. Now consider a cardboard tube with a light sensitive detector inside that supplies electricity depending on how much light it senses.

If you hook one of these light sensors so that it supplies one polarity of electricity to the turntable, it will cause the turntable to turn one direction whenever the sensor detects light. And if you hook up an identical light sensor in a tube so that it supplies the opposite polarity, the two should offset each other when pointed at a light source. But suppose you glue each tube on either side of a pencil attached to the turntable. Each sensor would only "detect" light when it was pointed at the light, and the pencil would block light getting to the other sensor unless the pencil was pointed right at the light.

Now, place a candle in a dark room with the turntable. If the sensor that turns the turntable to the right is on the right of the other sensor, then whenever the candle is placed somewhere to the right of where the pencil is pointed, the light sensor on the right will send a little electricity to the turntable motor and the turntable will turn in the direction of the candle. As it moves it will detect even more light and send an even stronger signal to turn the turntable. Similarly, when the candle is placed to the left of the pencil, the turntable also will turn toward the candle because it is detected by the left sensor.

If there were only one sensor, the turntable would turn past the candle until the pencil was pointed away from the candle and it no longer sent electricity to the turntable motor. But with the two sensors, when the turntable moves the pencil to where it points toward the candle, suddenly the other sensor is energized and it sends electricity to the turntable motor to turn it back in the opposite direction. Thus when the pencil is pointed right at the candle, the two sensors are each driving the turntable to turn in opposite directions and the turntable is in dynamic equilibrium with the pencil pointed correctly at the candle.

This is analogous to the dynamic "steady state" that is characteristic of systems. If you move the candle so that the pencil no longer points at it, the pencil will automatically move so that it once again points at the candle. It does this because if the left sensor gets more light than the right sensor then it will provide a stronger electric signal to the turntable motor to turn it left than the right sensor is providing to turn it right. So the pencil moves to point at the candle no matter where you move the candle. The "steady state" is a dynamic relationship of equilibrium.

Suppose you physically turn the turntable so the pencil no longer points at the candle. As soon as you try, the turntable exerts a countering force to turn the pencil back towards the candle because one sensor loses illumination. This is a crucial characteristic of dynamic systems: they resist outside efforts to change them.

Even if you succeed in overpowering that force, as soon as you release, the system will return to its former steady state. The turntable and light sensors have become a simple dynamic system of interdependent forces. The system by its design will point the pencil at the candle. You cannot change that from the outside. That is a fundamental internal characteristic of a system: it seeks a dynamic steady state and will overcome forces from the outside that try to change that.

In this case, we assumed a priori that the two sensors produced equal electricity for the same level of light. Thus when the pencil was pointed at the light each would supply the same electricity to the turntable motor. But suppose they were not exactly equal. In that case the pencil would have to point to one side of the candle for the "system" to be in equilibrium. In one sense we would say that the pencil now pointed in the "wrong" direction, much as we might think a student gets a "wrong" answer.

To get the turntable to point in the "right" direction we would have to have a calibrating circuit that compensated for the output of the two sensors to have equal outputs when pointed at the candle. In electronic terms, this is called a "bias circuit" that adjusts the bias of the two sensors. There is an analogy with student answers to test questions where the questions might have a bias toward one student over another.

Consider next that we add another light sensor in a tube on top of the existing two, but this sensor supplies electricity to a motor that raises or lowers the edge of the turntable where the pencil is pointing. With the proper circuit connections we could have this "elevation" motor driven by offsetting this third sensor's output with the outputs of the other two sensors and place the new sensor on the pencil above the other sensors.

Now, if we were to raise or lower the candle, the pencil would track the candle both up and down and left and right. Again, any effort to move the turntable would result in the turntable "fighting" against that effort. No matter what you did, the "system" would now attempt to keep the pencil pointed at the candle even if you picked up the turntable and moved it through space. You could move the turntable around the room, turn it upside down, and the "system" would seem to have a mind of its own fixated on the candle.

The turntable does not "know" what you are doing; it only reacts to changes in the amount of light falling on the light sensors that reach dynamic equilibrium only when the pencil is pointed at the candle. But it will appear that the system has a mind of its own. This simplistic "system," by its physical design, by its "structure," will point in that direction regardless of what you do to the system from the outside. You can only change where the pencil points by making changes to the internal structural elements or to the bias circuits of the system itself.

It is this fundamental characteristic of systems that quality management expert W. Edwards Deming, for whom Japan named its top industrial prize, recognized about organizations. You cannot change the output of an organization by replacing the employees, or exhorting them to do better work, or any other external factors that do not change the organizational structure. In many cases you can alter the bias of the system to get it to "adjust" but in other cases you need more fundamental structural changes. Without the structural change, dynamic systems, by their fundamental nature, will counter attempts to change their behavior.

To change the behavior of a system requires altering the fundamental dynamic interactions of the forces internally within the system. This is just as true of the system of thought in a child's brain. People who think of education as shoveling bricks of facts simply cannot comprehend that a child's mind is a dynamic system with intellectual ideas that are in dynamic equilibrium. The child has to make internal changes in the structure of his or her understanding of concepts in order for that understanding to incorporate new knowledge. The new knowledge can be presented from the outside, but only by reorganizing the structure of the child's understandings inside the brain will there be any learning.

Otherwise the child's brain will react just as the turntable by countering changes from the outside. The child already has a dynamic understanding of the world that was developed from previous experience of the real world. Sometimes that dynamic understanding is "wrong" like the pencil pointing askew was "wrong." Sometimes there are other factors involved, but frequently what needs to be adjusted is a smaller component of understanding such as a bias circuit that involves misconceptions about the relationships between ideas, even though the ideas themselves are well understood.

In the turntable case we are dealing with a fundamentally simple model of a dynamic system that employs the basic concepts of interdependent feedback comprising any dynamic system. However, systems can often be much more complex where the sensors have complex components and the bias circuits change dynamically. In humans, for example, bias circuits are dynamically influenced by fear and other emotions. One may behave one way one moment, but when the body dumps adrenaline from fear into the circuit the equilibrium point changes dramatically.

Complex systems can contain multiple feedback networks that are intertwined in complex ways that produce a dynamic equilibrium that doesn't actually point at a single candle that it focuses on, but rather follows a path of behaviors influenced by the many interactions of the component subsystems. Our breathing is a dynamic system but we may cough, or yawn, or pant, or wheeze depending on circumstances. We do not think to control our breathing, it is controlled by dynamic relationships of internal forces.

Children's behaviors are similar. They may be reacting to the consequences of ideas or interactions outside of the classroom as well as what occurs in the classroom. You may be trying to teach evolution to a child whose parents are creationists. The child's brain

may be capable of understanding what you are teaching but that child's brain is in dynamic equilibrium with ideas that involve separation anxiety with his or her parents.

The child's brain has a dynamic system of thought that will focus on what that system of thought in the child's brain demands regardless of what you do in the classroom. Teaching that does not fundamentally consider the circumstances of the individual child will result in complex consequences to the point that the child can refuse to learn evolution or even algebra regardless of your knowledge or teaching ability. And more subtly, the child may not consciously be aware of this, just reacting to the psychological pressures of the system dynamics in the child's brain.

A child's brain seeks "normality," the mental state that matches the many different internal conflicts to reach an equilibrium. This can also be considered the child's "sanity," the mental state where the child behaves in accordance with logical decisions based on this equilibrium condition. Depending on circumstances, on moods and chemical/hormonal conditions, the equilibrium may not be the same on every occasion. The system will behave the same in seeking equilibrium, but its equillibrium state will vary dynamically.

Only the child can comprehend what constitutes sanity or normality, in terms of what makes sense to the child, and therefore only the child can make the internal structural changes by altering brain neuron connections to achieve understanding. That is asking a lot of a child and requires an enhanced level of trust between teacher and student. A child whose relationship with a teacher is based on fear will interpret teaching as an attack on his or her sanity. Only when the child has a firm relationship built on trust with a teacher will the child venture to alter his or her sanity at a fundamental level.

This explains why Professor Haberman could state from his empirical experience that "The few urban schools that serve as models of student learning have teachers who maintain control by establishing trust and involving their students in meaningful activities." The meaningful activities provide the child the opportunity to see the relationship of the real world to his or her internal ideas, and to trust that the teacher is not attempting to rape his or her sanity.

Thinking in terms of children having a dynamic system of thought, particularly with an understanding of how dynamic systems function, is a different paradigm from teaching. To stop teaching transforms education with "ideas so powerful that we could never go back to other ways of thinking." In essence, once educators stop teaching and respect their students as capable of producing knowledge on their own, the transformation itself becomes extremely powerful.

Professor Haberman stated that traditional teachers "too frequently repudiate the students and their home lives. The vision of good teaching as a process of 'drawing out' rather than 'stuffing in' is supported by diverse philosophies" and that "The effort to educate thoughtful people should be guided by school activities that involve thought. The

acquisition of information – without the ability to think is an insufficient foundation for later life."

When children are taught to be active reasoners rather than passive listeners, it also unleashes an internal esteem that empowers them as students to develop an intellect far beyond what a subject matter driven education could ever achieve. Expert educators understand the importance of facilitating learning by emphasizing student reasoning over rote knowledge. Expert educators enhance logical thinking and point out logical fallacies that reinforce students' natural understanding of the world around them as a logical place.

To have children learn, one must stop teaching and start leading them logically to knowledge. The ancient Chinese philosopher Laozi, sometimes known as Lao Tzu, wrote in the 6th century B.C.:

> A leader is best when people barely know that he exists, not so good when people obey and acclaim him, worst when they despise him. Fail to honor people, they fail to honor you. But of a good leader, who talks little, when his work is done, his aims fulfilled, they will all say, "We did this ourselves."

This is the key to understanding Professor Haberman's assertion that teaching "seethes with passive resentment that sometimes bubbles up into overt resistance" because teachers enforce discipline with fear. But expert educators respect (honor) their students' intelligence and seem to become observers in their classrooms so when the children learn they will all say "We did this ourselves." A teacher is best, to paraphrase Laozi, when the students barely know that he/she exists. One might even say that expert educators are Laozi teachers.

This presumes, of course, that children can and will think. Something that infants have been shown to do, but, as John Holt noted, may be missing once they spend time in school. Thinking is something that develops over time. Piaget demonstrated that certain logical concepts are missing at certain ages and have to be learned. Not "taught" but learned. And teachers can play a crucial role in helping children to learn how to think. But the ability to think is literally destroyed by teaching.

The New York Times interviewed senior Harvard Professor Eric Mazur (July 17, 2007) about his teaching introductory physics to undergraduates. The interviewer noted that a task force on teaching at Harvard presented its final report in January of 2007 with the chairwoman specifically citing Professor Mazur as "one of Harvard's most innovative teachers."

Professor Mazur stated "It's important to mentally engage students in what you're teaching. We're way too focused on facts and rote memorization and not on learning the process of doing science." Professor Mazur cited a 1990 study by Arizona State University Professor David Hestenes on "how abysmally students in his region did in science" when tested on concept comprehension before and after they had taken their physics classes. He found that even after completing a course of instruction their understanding had barely improved.

Professor Mazur tested his own Harvard students in the same manner and found similar results. It was a life changing moment for him. He wrote:

> When taking the concept test "one student asked me: 'How should I answer these questions? According to what you taught me? Or according to the way I usually think about these things?'"

After being taught, the student had "learned" the subject for the purpose of the test but had not incorporated any of it within his own understanding. It was just a pile of bricks, not something he had incorporated into his cathedral of thought.

Professor Mazur concluded "I used to get in front of my students and do all the science for them. I should have been showing them how to do it themselves. If they were studying the piano, I wouldn't have gone, 'sit down. I'll play the piano for you.'"

Professor Mazur blames teaching for most of the problems in learning physics. Not bad teaching, but the very process of teaching. He noted:

> "I used to get fantastic evaluations because of charisma, not understanding. I'd have students give me high marks, but then say, 'physics sucks.' Today, by having the students work out the physics problems with each other, the learning gets done. I've moved from being 'the sage on the stage' to 'the guide at the side.'"

He essentially abandoned being a stellar teacher in order to facilitate learning.

The primary goal of education should be to have students learn how to think: to see the logical basis for knowledge. Students should learn the logical basis of deriving knowledge rather than the knowledge itself. Students need the opportunity to practice the methodology of logical thinking. That process comes from having students inductively learn on their own through guided inquiry. Students cannot learn logical thinking if we don't allow students to think.

Again, as Professor Haberman explained: "The effort to educate thoughtful people should be guided by school activities that involve thought. The acquisition of information – or even skills – without the ability to think is an insufficient foundation for later life." We may utilize subject matter as real world "authentic" examples of how to apply this reasoning ability. But the primary goal is students learning to think, not learning the subject matter.

The secondary goal of teaching should be to have students learn how to differentiate between truth and falsity. This involves using logical reasoning such as in detective stories. Logical thinking may also utilize computer programming to learn sequencing and symbolic logic. But the sine qua non of knowledge is to know what is true and what is false, and why. This necessarily involves learning what throughout history humans have stumbled with before as logical fallacies.

Students should be able to recognize that correlation is not causation and more importantly to know that association has import only when it is anomalous. Thus the fact

that the nations having the highest student test scores have a centralized curriculum is NOT compelling logic for adopting a centralized curriculum if the nations having the lowest test scores also have a centralized curriculum. Students need to learn that logical connections must possess a logical structure as well, that just because something is plausible does not make it true. Conversely, to be true something should at least be logically plausible, to conform to rational thought.

For the same reason, what may be the most critical function of education is exposing children to rational thought in their day to day schooling. What we teach is not as important as how we teach it. When we teach children that a Tyrannosaurus Rex ate meat and therefore had sharp teeth, as I observed at a science fair once, we teach irrational facts. If we had taught that fossils show a Tyrannosaurus Rex had sharp teeth and therefore we could logically conclude it likely ate meat, we would at least provide a basis for logic. But if we demonstrated that Tyrannosaurus Rex fossils had sharp teeth and then asked the children what that indicated about those dinosaurs, they would confront the need to deduce it themselves.

John Holt reported that children are very good at inductive reasoning but not in deductive reasoning. Thus we need to "induce" the skills of deductive reasoning in students. For this is their basis for future learning. Mystery stories and brain teasers may go farther in inducing children to reason deductively than trying to teach subjects. But more importantly we must allow children to learn. We must allow children the opportunity to think about the world around them and to help them figure out ways to incorporate that thinking into blocks of knowledge they can incorporate into their cathedrals of thought.

The Counter-intuitive Brain

As John Holt carefully pointed out, children have logical minds adept at thwarting teachers' efforts to alter their view of the world around them. They have within their heads a "system of thought" that consists of their own experiences and learning that form a consistent logical interdependent dynamic understanding of the world they live in. And we have seen, this understanding may contain misconceptions or incomplete conceptions from the child's limited experiences in the world. But external attempts to change these "misconceptions" will typically fail because of the natural characteristics of dynamic systems to resist changes from external forces.

General Systems Theory as developed by biologist Ludwig Von Bertalanffy in the 1930s, explained that there exist numerous common physical phenomena that behave as a "system." Seemingly independent attributes can become interacting and interdependent to the point they act as a single "system" which exhibits a general set of common characteristics. Bertalanffy detailed how those characteristics often seemed counter-intuitive and even violative of the laws of thermodynamics, but in reality just behaved with certain peculiar consequences, such as dynamically seeking a steady state that is resistant to change by outside forces.

A "system" is often misconceived by thinking of it as just things working together like a clock, or as organized protocols, or methods or procedures. Systems theory refers to an entirely different concept of natural countervailing interdependent phenomena locked in dynamic tension that self-organize to behave as a unitary organism. Natural organisms, such as animals and people, are dynamic systems of organs and processes that behave radically different than just the organized sum of their parts. A dead cat has all the organized parts of a live cat, but there is something fundamentally different in a live cat. That fundamental difference is that the live cat is a dynamic system of interacting interdependent phenomena.

But not all systems are living biological organisms. Anytime there are countervailing interacting phenomena that become interdependent, these phenomena can and often do interfere with their individual actions and self-organize into a dynamic system. When that occurs there are very characteristic behaviors that are exhibited by dynamic systems that "emerge" from their interdependent interactions and are frequently misperceived because they often exhibit counter-intuitive behavior. Unless one has learned to recognize and understand the "emergence" of dynamic system behavior they will appear baffling and often irrational. Dynamic systems, however, can be extremely adaptive to internal changes.

Understanding systems theory provides an important foundation for understanding student learning once you recognize that a student's system of thought behaves as all dynamic systems do. Thus a child does not "behave" as a consequence of "good" or "bad" intentions, but rather the child's behavior "emerges" as a consequence of the dynamic system of thought the child has acquired. The child is exhibiting systems theory in behavior and thought.

Systems theory, however, is not easily comprehended. People have great difficulty understanding the manner in which systems alter the physics of the world around them. One of the pioneers of systems theory, Jay W. Forrester, in an article titled "Counterintuitive Behavior of Social Systems", (Technology Review, Vol. 73, No. 3, Jan. 1971, pp. 52-68.) wrote:

> It is my basic theme that the human mind is not adapted to interpreting how social systems behave. Our social systems belong to the class called multi-loop nonlinear feedback systems. In the long history of evolution it has not been necessary for man to understand these systems until very recent historical times. Evolutionary processes have not given us the mental skill needed to properly interpret the dynamic behavior of the systems of which we have now become a part.

A child's system of thought behaves counter-intuitively just like a social system, because a child's thought process has the same typical general characteristics of all systems. Substitute "system of thought" for "social system" in Forrester's essay to gain an insight into how systems of thought complicate the teaching of children.

Jay Forrester continued in the same article to describe his encounters with social systems. When reading his text one should recognize that it also aptly applies to children's systems of thought. Forrester wrote about how people tend to react to social problems:

> First, social systems are inherently insensitive to most policy changes that people select in an effort to alter the behavior of the system. In fact, a social system tends to draw our attention to the very points at which an attempt to intervene will fail. Our experience, which has been developed from contact with simple systems, leads us to look close to the symptoms of trouble for a cause. When we look, we discover that the social system presents us with an apparent cause that is plausible according to what we have learned from simple systems. But this apparent cause

> is usually a coincident occurrence that, like the trouble symptom itself, is being produced by the feedback-loop dynamics of a larger system. ….
>
> A second characteristic of social systems is that all of them seem to have a few sensitive influence points through which the behavior of the system can be changed. These influence points are not in the location where most people expect. Furthermore, if one identifies in a model of a social system a sensitive point where influence can be exerted, the chances are still that a person guided by intuition and judgment will alter the system in the wrong direction. ….
>
> As a third characteristic of social systems, there is usually a fundamental conflict between the short-term and long-term consequences of a policy change. A policy which produces improvement in the short run, within five to ten years, is usually one which degrades the system in the long run, beyond ten years. Likewise, those policies and programs which produce long-run improvement may initially depress the behavior of the system. This is especially treacherous. The short run is more visible and more compelling. It speaks loudly for immediate attention. But a series of actions all aimed at short-run improvement can eventually burden a system with long-run depressants so severe that even heroic short-run measures no longer suffice. Many of the problems which we face today are the eventual result of short-run measures taken as long as two or three decades ago.

These characteristic pitfalls apply to systems of thought. When we understand systems theory, and recognize that a child's mind holds a system of thought, it becomes easier to understand why we cannot teach.

First, as Forrester pointed out, the problems teachers typically perceive are "the very points at which an attempt to intervene will fail." Teachers will think the problem is something that actually has nothing to do with the problem the child is having. Second, Forrester explained, "the chances are still that a person guided by intuition and judgment will alter the system in the wrong direction." Thus even if a teacher did somehow correctly perceive the problem, teachers will teach precisely the things that do not work and likely complicate the problem. And third, from Forrester, "there is usually a fundamental conflict between the short-term and long-term consequences" of our teaching. If a teacher succeeds in teaching a child somehow to pass a test, it will likely be at the expense of the child's long term learning.

Despite their best intentions, teachers invariably do the wrong thing and make the problems worse while finding short term success that creates long term problems. Educators, on the other hand, avoid this because they do not attempt to alter the child's system of thought directly, but rather ask the students to explore their knowledge to find inconsistencies and thus the student resolves the issue internally by altering the student's internal system of thought in the correct direction, and as a consequence creates long-term learning.

If we really could teach, then teachers could stand in the front of a room and tell students things that the students would understand and remember, just like what we continually misperceive as education. But we cannot teach; it doesn't work because students' minds are a system of thought, and it doesn't work because of the counter-intuitive nature of systems such as those in a child's mind. And this is consistent with the ancient knowledge of Laozi: a teacher is best when the students barely know he/she exists.

Teachers such as John Holt describe students as being resistant to learning. But this is what we previously identified as being the classic characteristic of a dynamic system: resistance to change from outside influences. Arnold Arons, described as "one of the founding fathers of U.S. Physics Education Research" by Professor Richard Hake of Indiana University in his essay "The Arons Advocated Method" wrote in 1985:

> Most of our students come to us imbued with intuitive rules or notions that we are strongly tempted to call, pejoratively, "misconceptions." These intuitive notions are, however, neither perverse nor idiosyncratic; they are rooted in everyday experience, and they were initially held by all our predecessors. Our pedagogical orientation becomes sounder and more reasonable when we characterize these notions as "preconceptions" to be altered through concrete experience, rather than as ignorant "misconceptions" to be removed instantaneously through verbal inculcations and a few demonstrations in which the student does not participate.

Thus the crucial concept to be understood about dynamic systems is that students necessarily must participate in the fundamental process of altering the internal system of thought that conflicts with what we are attempting the have the student learn.

The crucial characteristic necessary for students to participate in this manner is that they are adept in logical reasoning. As John Holt explained, the recognition that the world is logical represents the fundamental characteristic of successful students. Students who can reason a problem from within the problem exhibit the necessary processes to become intelligent students, and thoughtful citizens.

The concept of focusing on reasoning rather than rote facts reflects a dynamic way of thinking, or what is commonly called "nomothetic thinking." Donald R. Prothero, Ph.D., writing about the origins of "Punctuated Equilibrium" in paleontology (Skeptic vol. 1, no. 3, Fall 1992, pp. 38-47) explained:

> "Perhaps the student activism of the sixties penetrated paleontology, or maybe the emphasis on ecology and holistic viewpoints were influential. In any case, a new generation of 'young Turks' who finished their Ph.D.'s in the late sixties led a revolution that shook up the musty old profession. They emphasized thinking of fossils as organisms, rather than dead objects to be described, catalogued, and put away in a museum drawer."

Prothero noted that

> Before the seventies, most college paleontology classes were little more than rote memorization of fossil names and anatomy. In his preface to the 1972 book Models in Paleobiology (where the punctuated equilibrium paper first appeared),

> Tom Schopf pointed out that a typical dissertation in paleontology consisted of describing some new fossils, with little thought about their broader theoretical implications, or about the possibilities for asking novel questions of the fossil record. … This approach was called ideographic by Gould (1980a), since it focuses on studying the objects for their own sake.

In contrast, Prothero explained, the new concept of thinking in terms of systems – organisms – involved developing a system of ideas, or as Holt referred to it – a mental model of reality. Prothero: "Gould (1980a) called this the nomothetic approach, since it seeks to find general, law-like properties among all the ideographic details." Essentially finding the logical connections among the objects and their context. "Gould," of course, referred to Stephen Jay Gould, the late Harvard University Professor who became a popular author of books on science as well as one of the most important thinkers in the theory of evolution.

Nomothetic thinking means to abstract individual elements into rules and laws. When children are confronted with a world of infinitely complex individual elements, children seek to make sense of this world through logical abstractions and logical processes. They learn, for example, not the many different plurals of words, but rather the rule that the plural is formed by adding an "s" to the singular: dog, dogs.

Children tend to think in nomothetic ways while schools tend to teach in ideographic ways. Children typically think in logical terms for knowledge within a nomothetic context, while schools typically teach isolated disconnected facts. Thus learning involves children placing things into a logical context within their cathedral of thought, while teaching involves remembering Pavlovian responses to "taught" stimuli.

The crucial point here is that children have nomothetic minds, as Arons noted "imbued with intuitive rules or notions" that they developed on their own. The students' resistance to change occurs because the ideas that students possess already form a self-reinforcing system of thought that their sanity depends on. Attempts to change this system encounter the same phenomenon that was described by Forrester for social systems. The child's brain is not an illogical collection of rote facts, but rather an interacting relationship of nomothetic ideas, a system of thought.

This is why Holt described students as trying to maintain their sanity within the classroom. Too often what students are taught conflicts so violently with their already existing system of thought, that to accept what the teacher is telling them would undermine their entire conception of their sanity. Without a nomothetic context, the child cannot learn. From the child's point of view the teacher insists on them doing something they consider stupid and they resist. From the child's point of view it is a mental rape, forcing them to do something they consider wrong.

Children's brains exhibit all the characteristics of a system of thought. As such, we should consider the things that people who deal with systems have learned about them. Two clinical psychologists, Esther Thelen and Linda B. Smith, in their book "A Dynamic

Systems Approach to the Development of Cognition and Action," described infant behavior, specifically the development of walking and reaching, as manifestations of a dynamic system. They, in turn, relied on Edelman's theory of neuronal group selection (TNGS) which represented a dynamic concept of brain organization.

According to Thelen and Smith the fundamental structural organization of the brain operates in accordance with systems theory, a non-linear steady-state-maintaining structure of self-reinforcing conceptual development. Thelen and Smith explained:

> From a lofty view, human cognition has been characterized as symbolic, rational, encapsulated, structured, and algorithmic. But the data on how we develop mind does not fit these descriptions of the end-state. When we turned up the microscope on how real children did real tasks, we found that thinking looked messy, fluid, contextual, and often less than rational. (pages 321-322)

This is what educators confront in attempting to facilitate learning in children. Children's minds are dynamic systems of thought that often contain preconceptions that are woven into their understanding of the world. Thus to displace those preconceptions requires an internal logical reorganization of thought that may very well undermine and discredit what the child had already woven into his or her sanity. Thus true learning, in Thelen and Smith's words, is typically nonlinear, messy, fluid, contextual and often less than rational to an outside observer.

The child may well have understood what was taught, but unable to incorporate it into a nomothetic system of thought without extensive reorganization of concepts that previously depended on the now discredited concept. The problem then for the child is not to understand the concept being taught, but rather to redevelop dependent concepts, concepts previously thought to be understood but not in accordance with this new knowledge. These concepts may be in entirely unrelated topics or ideas that were contingent on that previous understanding.

The child appears not to have learned the concept when the true problem is an inability to logically apply the concept because it contradicts other concepts already in the child's system of thought. The teacher erroneously attempts to focus on what has already been understood much as Forrester explained as a common response to systems "These influence points are not in the location where most people expect."

What the child is struggling with is reconciling new knowledge within the entire context of the child's understanding of the world. What may be baffling the child is something learned many years before that now conflicts with the new knowledge, and thus the child is not struggling with the new knowledge but rather how to reconcile old knowledge with this new understanding that the child has learned quite well.

Toward the end of his book How Children Fail, Holt states "We cannot have real learning in school if we think it is our duty and our right to tell children what they must learn. We cannot know, at any moment, what particular bit of knowledge or understanding a child needs most, will most strengthen and best fit his model of reality. Only he can do this. He

may not do it very well, but he can do it a hundred times better than we can. The most we can do is try to help, by letting him know roughly what is available and where he can look for it." In other words, we cannot teach but we can facilitate learning.

Holt averred that "Schools should be a place where children learn what they most want to know, instead of what we think they ought to know. The child who wants to know something remembers it and uses it once he has it; the child who learns something to please or appease someone else forgets it when the need for pleasing or the danger of not appeasing is past." Children can learn things quite well for passing a test, but they completely quarantine those things from the logical content of the child's worldview.

The ideographic things taught for tests become a rubble of bricks that must be discarded in order for the child to enhance his or her cathedral of knowledge. Thus it was Holt's contention that teaching was counter-productive both because it was inefficient in that it only superficially taught things that were quickly forgotten, and because children were capable of learning far more on their own if they were provided structure and guidance in pursuing their interests. Their interests, after all, are about understanding the world around them.

Children naturally have a desire to understand the world around them as a consistent whole. They will enthusiastically seek a logical path to that understanding which the educator can help them to discover through patient Socratic questioning. But it may be that the child will encounter concept B before concept A while the curriculum says to teach concept A before concept B. The educator's job is to ensure that both concept A and concept B are learned, but only as the child is ready to encounter them.

Expert educators allow children to take responsibility for their own learning and thus harness this deep seated desire in children to understand the world around them. By refusing to teach, they allow children to learn and the expert educator can often steer their learning in ways that accommodate the desired educational program, but in ways that bring it alive for the students.

Teaching has students spending hours of effort to accomplish very little, often just enough to get the teaching to stop and then the students forget what was taught and go back to learning what really interests them. On their own initiative they learn prodigious amounts without seemingly any effort. Thus we don't see what actually works, we only see what fails to work because it requires the most effort and consumes the most time. Teachers spend enormous efforts with little to show for it despite their best efforts.

When Total Quality Management guru W. Edwards Deming was asked by the Wall Street Journal about the problems of American manufacturing, Deming described the problem with American industry as: "Everybody is doing their best. And that's the trouble. Hard work and best effort - and doing it wrong."

One could make the same statement about teaching: "Everybody is doing their best. And that's the trouble. Hard work and best effort – and doing it wrong." The key to education

reform is to realize, to recognize, and to proselytize that we want learning, not teaching. Teaching is doing the wrong thing.

Forrester explained from his own experience:

> Our first insights into complex social systems came from our corporate work. … In a troubled company, people are usually trying in good conscience and to the best of their abilities to solve the major difficulties. Policies are being followed at the various points in the organization on the presumption that they will alleviate the difficulties. One can combine these policies into a computer model to show the consequences of how the policies interact with one another. In many instances it then emerges that the known policies describe a system which actually causes the troubles.
>
> In other words, the known and intended practices of the organization are fully sufficient to create the difficulty, regardless of what happens outside the company or in the marketplace. In fact, a downward spiral develops in which the presumed solution makes the difficulty worse and thereby causes redoubling of the presumed solution.

Similarly, Deming taught managers that employees naturally tried to do good work, and thus they would always try to do what they understood was what they were supposed to do. As a consequence, imposing change on them resulted in the employees feeling that the new ways were doing things "wrong." And employees psychologically felt they would be punished for doing things "wrong." So they resisted change just as a light sensor turntable resisted pointing in the "wrong" direction.

Deming preached that employees could be harnessed toward developing ways to improve production as long as management made it clear that changes would not end up hurting the employees. Deming preached that fear was the primary reason that employees did not work to improve corporate production. He explained that employees would change their behavior to thwart changes if they were afraid that the imposed changes would hurt them.

Holt too makes much about students living in fear when he states: "What is most surprising of all is how much fear there is in school. Why is so little said about it?" To Holt it is fear that explains why some children do not learn:

> I have been asking myself why intelligent children act unintelligently at school. The simple answer is, "Because they're scared." … What I now see for the first time is the mechanism by which fear destroys intelligence, the way it affects a child's whole way of looking at, thinking about, and dealing with life. So we have two problems, not one: to stop children from being afraid, and then to break them of the bad thinking habits into which their fears have driven them.

Teaching involves exactly the kind of downward spiral that Forrester explained to corporate managers. The more we teach students the more unintelligent they become and the more they act unintelligently the more teachers threaten them with consequences that leads to fear that causes students to act even more unintelligently until the students just

want to escape from these attempts to rape their intelligence.

Let the Children Learn

The fact that teaching students is counter-productive represents one of many counter-intuitive developments that modern research shows about pedagogy. Perhaps the best example comes from Rosalind Driver's work in science education. Driver discovered that students entering science classrooms already have an understanding of the science in the world around them. The problem is that their understanding often conflicts with the science being taught.

Driver noticed that, ironically, many times the students have concepts of science that represent ideas once held by all scientists in prior years. As science developed, new concepts replaced the old, often after rancorous disputes among scientists. So in many ways the children who resist the new concepts are simply reprising the actual historic progress of science. The students' resistance to learning makes sense. But teachers never work them through the logical transformation that occurred in real science. Instead, teachers try to teach, which, of course, conflicts with the logical context of what the students already "know" is true.

Driver disliked the use of the word "misconceptions" in describing these students' understandings. She preferred to call them "alternative understandings." Starting with her Masters thesis in the early 1970s, Driver investigated how these "alternative understandings" manifested themselves and interfered with students' learning of accepted science. Driver showed that these "alternative understandings" were generally logical and deeply embedded in the way the children perceived their world simply because they were derived from the students' own experiences.

What Driver noted and explained in her books on teaching science is that students have a consistent logical explanation of the world around them when they enter a classroom. The consistency of this logical explanation forms the context which confronts the teacher, as person one, attempting to talk to the student, as person two. Driver explained that

everyone who listens to someone else has to filter what is said, ignoring some words and focusing on others that seem to "make sense" in fitting in with what they already know.

As a consequence, students who have an alternative understanding of the topic being taught frequently discard crucial information that is being taught. If the words being heard do not seem to fit logically into the context of what the student already knows, the student simply does not extract the correct meaning from the words. The student might later say "I thought you meant …." because the student has to extract meaning from the words within the context of what the student already knows.

When John Holt concluded after many years of experience "Why don't they learn what we teach them? The answer I have come to boils down to this: Because we teach them – that is, try to control the contents of their minds" he was basing this on the recognition that children attribute meaning in their own minds according to their understanding of the world around them. Holt explained:

> A child learns, at any moment, not by using the procedure that seems best to us, but the one that seems best to him; by fitting into his structure of ideas and relationships, his mental model of reality, not the piece we think comes next, but the one he thinks comes next. This is hard for teachers to learn, and hardest of all for the skillful and articulate, the kind often called 'gifted.'

Thus Holt averred that the better, or more "gifted", a teacher was, the less likely the teacher was to really understand how children learn; the more one is gifted in teaching the less likely a student is to learn. A student understands only that which fits within what Holt called "his mental model of reality," what I suggest is his/her "system of thought." A student may be able to distinctly repeat what the teacher has taught, but this may not have anything to do with what the student understands.

John Holt gave the example of a student who had great difficulty understanding how to divide "4 orange and 2 white rods … evenly among 3 cups." The orange rods can be exchanged for 10 white rods, and vice versa. Holt recounted:

> When a child asked me to change an orange rod into whites, I asked him instead if he could tell me, without actually making the change and using the rods, how many whites each cup would get. If the division factor was one he knew, he could usually tell me; but it never occurred to him to do it when I did not ask the question. Left alone, he went back to his old system, in which he felt that he knew what he was doing. We cannot overestimate the importance of this. The idea of doing the dividing mentally rather than with white rods did not stick in the minds of these children because it was my idea, not theirs; there was no place for it in their minds; it did not meet any felt intellectual need. …. The only answer that really sticks in a child's mind is the answer to a question that he asked or might ask of himself.

Holt clearly pointed out "We cannot overestimate the importance" of recognizing that children will rely on their own system of thought "in which he felt that he knew what he was doing." In other words, the recognition that a child's system of thought dominates

learning is more important than any other conception in education. It simply overwhelms teaching.

George Lucas, the Hollywood director who created Star Wars, established the George Lucas Educational Foundation (GLEF) to promote this concept as part of Social and Emotional Learning (SEL). In an interview (Edutopia Magazine, November 2007) he stated:

> A really good teacher is not a person who is dictating information to students. We have discovered that if a teacher approaches teaching saying this to the student, "You are a bright intelligent person who can figure this out on your own, and if you need help, I'll help you" – if you take the teacher out from the front of the classroom dispensing information, and you encourage students to find the information on their own with the teacher as a guide or facilitator in their information-finding adventure – the students will learn a lot more and be much more empowered.

If you can stop a teacher from teaching and instead help children to learn, "the students will learn a lot more and be much more empowered." This concept is difficult to understand without an appreciation of how a child's system of thought is a dynamic system that behaves like all dynamic systems.

Roger Schank, in his book "Engines of Education," states that "Schools cannot simply tell the answers, they have to motivate the questions first. Schools that fail to do this will simply not work." Schank notes:

> Early in his career, Piaget, one of history's most significant psychologists, went to work with Simon, the co-author of the Binet-Simon IQ test. Piaget realized that the Simon team, who were focusing on the total number of correct answers in their intelligence tests, were overlooking what was perhaps the most interesting data - the kinds of answers students were giving.
>
> Piaget felt that by looking at the answers themselves (rather than their correctness), he could see how the children were thinking. He noted that while many children were giving the same incorrect answers this important pedagogical fact was not even noticed by the Simon team because they looked only at the numbers of correct answers. He studied these wrong answers and learned that although children were giving incorrect answers, they were reasoning in ways similar to each other. Piaget recognized that teaching needed to focus on how children were reasoning rather than focusing on how well they might recall facts for a test. Nevertheless, while his work is lauded by most researchers, it has had little effect on the school system.

The key point here is recognizing "teaching needed to focus on how children were reasoning" and to help the students in that process. Expert educators recognize that what children need to have in order to learn is a path of reasoning that extends what the student already knows to their understanding of new concepts. To find that path frequently involves having the student discover it through Socratic questioning.

Arnold Arons, described as “one of the founding fathers of U.S. Physics Education Research” by Professor Richard Hake of Indiana University in his essay “The Arons Advocated Method” wrote in 1985:

> One must learn to ask simple sequential questions, leading students in a deliberate Socratic fashion. After each question, one must shut up and listen carefully to the response. [It is the tendency of most inexperienced questioners to provide an answer, or to change the question, if a response is not forthcoming within one second.] One must learn to wait as long as four or five seconds, and one then finds that the students, having been given a chance to think, will respond in sentences and truly reveal their lines of thought. As students respond to such careful questioning, one can begin to discern the errors, misconceptions, and missteps in logic that are prevalent. One learns nothing by giving students “right answers” or “lucid explanations.” As a matter of fact, students do not benefit from such answers or explanations; they simply memorize them. Students are much more significantly helped when they are led to confront contradictions and inconsistencies in what they say and then spontaneously alter their statements as a result of such contradiction.

The crucial point being that those “contradictions and inconsistencies” can only be recognized by the students themselves, and thus only the students can make the internal changes in their system of thought to reconcile them.

Notice one of the founding fathers of physics education insisted that teachers should “shut up” and that “Students are much more significantly helped when they are led …” rather than when they are taught. Leading is the foundational etymological meaning of the word to educate. Leading the child to learn. But more importantly, notice Aron’s admonition to stop teaching: “students do not benefit from such answers or explanations, they simply memorize them” instead of reasoning about them.

John Holt claimed that children had two fundamental strategies in solving problems at school, which he called "problem-centered" and "answer-centered." He wrote "The problem-centered person may use a formula. …. But the point is that he would get this formula, this problem-solving process, out of the problem itself, not out of his memory." It was a logical, nomothetic, approach to knowledge.

It involved reconciling context. Problem-centered children learn to extract answers from reasoning within their own logical nomothetic context. They each have a very strong logical context they have built up over the years that is part of their own being, their own sanity. School too often asks them to give that up, and the children resist and thwart teaching. The secret that expert educators understand is to tap into that logical context.

Unfortunately that very rarely happens. Holt reported, "most children in school are answer-centered rather than problem-centered. They see a problem as a kind of announcement that, far off in some mysterious Answerland, there is an answer, which they are supposed to go out and find. …. But this answer was elsewhere, not in the

problem, and the answer-getting process had to be dredged up out of blind memory." This was “the school way” to knowledge with ideographic answers lacking any logical context.

What “most children,” that Holt identified as the idiographic answer-centered children, learn about school is that their logical minds do not belong there. Children who are “taught,” learn not to think logically but simply to set aside what the teacher tells them so they can regurgitate it back without contaminating their sanity. They learn to warehouse rote information into categories of answers according to what they are being taught. They learn that authority rather than reason is the source of knowledge.

For many adults this respect for authority is the primary purpose of education. Children who are taught that knowledge derives from authority are consequently less likely to question authority, religion, laws, and social mores such as Jim Crow. But knowledge that is based on Pavlovian responses becomes too easily obsolete or mistake prone as contexts change. More importantly, authoritarian based knowledge depends on some authority giving instructions and stifles the independent thinking necessary to resolve real world problems.

In a 1986 article "Learning Math by Thinking" Fred M. Hechinger noted:

> Dr. Hassler Whitney, a distinguished mathematician at the Institute for Advanced Study in Princeton, says that for several decades mathematics teaching has largely failed.
>
> Dr. Whitney … cites the responses to a problem on a recent test given by the National Assessment of Educational Progress: John and Lewis are planning a rectangular garden 10 feet long and 6 feet wide, and they want to put a fence around it. Ignoring such real matters as the need for a gate, the question was simply how many feet of fencing was needed.
>
> Of the 9-year-olds who took the test, 9 percent choose 32 feet; 59 percent chose 16 feet; 14 percent chose 60 feet, and the remaining 18 percent gave other answers. Of the 13-year-olds taking the test, 31 percent said 32 feet; 38 percent said 16 feet; and 21 percent said 60 feet, with 10 percent giving other answers that apparently did not use any arithmetical formulas.
>
> "Why did not all children get the correct answer?" Dr. Whitney asks. "If they were involved in it as a real problem they could have drawn a picture or made it real in some way, and looked to find the answer." Instead, he said, they did it "the school way," guessing at what kind of "operation" to use--multiplying or adding the numbers.

The Hechinger article points out that given the dimensions 10 feet and 6 feet, well over half of the 9-year-old students (59%) ignored the logic of the text and merely added the two dimensions together while 14% merely multiplied them together. In other words,

nearly three-fourths of the 9-year-old students (73%) reacted in a mindless Pavlovian knee-jerk rote fashion to apply what they were taught.

Similarly, among the 13-year-old students, well over a third (38%) merely added the numbers together while over a fifth (21%) merely multiplied them together. Thus well over half of the 13-year-olds (59%) also reacted in a mindless knee-jerk rote fashion. These students tried to do what they were *taught*, without even considering doing it the obvious logical way. As Dr. Whitney said, "they did it the 'school way'." The way that our (per Holt) "teach em and test em" education system favors.

A rectangular perimeter problem is perhaps the simplest logical mathematics question you can ask. The perimeter problem is easy to conceptualize, obvious to interpret, and the arithmetic involves only simple addition. But the results of this test show that the great majority of the children, like John Holt explained, did not consider the problem logically. They made no attempt to find the answer IN the problem. Instead they did it 'the school way' and got the wrong answer. They obediently did what they were taught, and we failed them for it.

"The school way" is the dash into Answerland to find some Pavlovian rote response that the teacher will accept. You can always spot this kind of thinking in classrooms because students answer questions with a question: "42?" or "George Washington?" The rare rebellious student who uses logic knows the answer and states it, is even ready to defend it. But most students are only offering something to please the teacher.

There is a perhaps apocryphal story about the great mathematician Carl Friedrich Gauss, often called the "prince of mathematicians." When Gauss was a child in school the teacher angrily told her chaotic class to add all the numbers from one to one hundred. The students set off dutifully to do the work. Gauss pondered this a moment and then wrote down the answer and turned it in. His reasoning was simple. Every number from one to 49 could be paired with a number from 99 to 51 to equal one hundred. Thus there were 49 one hundreds, plus the middle 50 and the top one hundred for a total of 5,050.

This story is told as an example of the genius of Gauss, but this is not genius. It is simple reasoning. Children are not taught to reason in school, so it might have been amazing that Gauss could conceive of this, but it is not genius. Because, even if "The Prince of Mathematicians" had tried to solve the problem "the school way" he likely would have gotten the answer wrong. Somewhere in the repetitive addition he likely would have made at least one simple mistake.

Thus doing it "the school way" does not really give you a trustworthy answer. When the other students were done, the students all would have proffered an answer and asked if it was correct. They answer a question with a question. Gauss did not need to ask. By reasoning, he knew his answer was correct. He could defend it. He could argue with the teacher. He didn't have to ask the teacher, he had the power within his head to overrule the teacher. But it wasn't genius, it was simple reasoning. He didn't need the teacher and the teacher had not taught him how to get this answer. He learned it himself.

The fact of the matter is that children naturally think logically. It is the way all children learn real things, by making sense of what they encounter in terms of their own sanity. They learn, however, that logical thinking has no place in school. The problem is, as Holt noted, they generally perceive of school as "mainly a place where you follow meaningless procedures to get meaningless answers to meaningless questions" that attacks their sanity.

That is the consequence of teaching. Expert educators who stop teaching learn that they can leverage that innate logical sanity within their students in order to help them learn. But that is not something as teachers they can do out in the open, for fear they may be punished for it. And even when they do it out in the open it usually is misunderstood.

An excellent educator once told me of the time she was caught educating by her principal. Her lesson involved helping children learn about the slave trade. She cleared the desks to the side of the room and had the children lie down in a masking tape duplication of the places slaves were shackled on slave ships. It allowed the children to experience directly the crowding and recognize the despair of the slaves. In the midst of this endeavor, the principal came into the class to do an unscheduled observation. He asked what was going on, and the educator explained it to him. He shook his head and said, “I’ll come back when you’re teaching.”

He was right, she wasn’t teaching, she was educating. The administrator was probably one of many who quit an unsuccessful teaching career to become an administrator. They still believe in teaching. Despite their own history of failure, they believe teaching can work if you just do it “right,” when in fact it will never work, regardless of how you do it. In many respects this principal was an alchemist visiting a chemist’s laboratory and insisting that lead could be turned into gold if only it was done “right.” Even though by all scientific accounts it has never been done.

That principal probably encountered a noisy classroom in dynamic flux with children talking among themselves and engaged in the thoughtful recognition of the physical experiences of slaves in another era. The teacher may well have been sitting off to the side seemingly observing, or even ignoring what was occurring. Some students may well have been discussing off-topic concepts, exploring what was important to them at the time. There was no “control” of their minds; no classroom “discipline” nor attentive focus on the teacher.

Of course, this is just the constructive reverse of the destructive traditional classroom where Professor Haberman noted “students actually control, manage, and shape the behavior of their teachers. Students reward teachers by complying. They punish by resisting. In this way students mislead teachers into believing that some things ‘work’ while other things do not.” Traditional teaching primarily involves overcoming the resistance of students who undermine attempts to teach them, while educators know that by allowing students to learn “the students themselves actually will manage the classroom and conduct the learning.”

The Rethinking Schools series on advice for new teachers included this description from a 26-year veteran Chicago educator:

> In all, says Williams, running a classroom is not about being the "big, bad, savior." It is about encouraging students - something that cannot be done without mutual respect on both sides. "I had to realize that when I was starting out," she says, "And it was a good learning experience for me."

Ironically, LouAnne Johnson, in her best-selling book that later became the popular award-winning movie "Dangerous Minds" about teaching, wrote of her background

> "I joined the Navy when I was eighteen and worked to put myself through college at night. After I finished my degree, I took a commission as an officer in the Marine Corps."

Obviously, when becoming a teacher she very easily could have taken a no nonsense drill-instructor approach to teaching, for whom "engage" could mean a military style control. But Johnson described her classroom transformation as:

> "It was a wonderful feeling and it completely changed the dynamics of the classroom. When the students truly believed that I liked them just as they were, it was no longer Teacher versus Students. It became Teacher and Students versus Curriculum. Together, we hated vocabulary exercises, grammar exams, reading proficiency tests, and spelling quizzes, but we had to do them."

In essence, the foundation of her success was respect: "When the students truly believed that I liked them just as they were." It was only then that Johnson could stop teaching and begin collaborating with her students. It was only then that she found success.

Learning is a collaborative process. What LouAnne Johnson described in her book that became the movie Dangerous Minds is not a teacher/student relationship, but rather a collaborative relationship between an educator and students. She chose not to teach her students, but rather to treat them with respect and help them learn. As Holt averred, learning was something that students had to do on their own, with the help of their teacher.

John Holt easily recognized this because he also was not simply some young ivory tower theorist fresh from some college of education. He had already experienced success in other careers before teaching. As he noted in his book, "Fortunately I did not start teaching until I was thirty. By then I had had three years of experience as a submarine officer, some in combat. I had worked six years in responsible positions in the world government movement" and as a consequence "I could see the trial and failures of the classroom not as threats to my authority or sense of personal worth but only as interesting problems to think about and try to solve."

Holt was a hardened practical person who had supervised young adults in combat and in civilian pursuits. Within the confines of a submarine he had undoubtedly learned the importance of working together as a team with his crew. He undoubtedly developed his

ideas about the futility of teaching both from those adults as well as from children. He naturally understood the importance of leadership in both endeavors. Leadership that is a collaboration between the leader and crew/students.

Conversational Education

Expert educators have consistently explained that for students to learn requires that teachers collaborate with the students and facilitate their learning rather than teach. Education is the converse of teaching, and one technique utilized by expert educators is conversation. Another teacher in the email thread on classroom management stated:

> I have come to the conclusion that I must think of my classes as a "conversation" with my students about mathematics. They will listen if the conversation is of interest to them. Since I, the person who believes that "Mathematics is the Language of the Universe," am charged with beginning the conversation each day, it is my responsibility to manage that conversation so that my students remain engaged.

Collaboration in the sense of a conversation is what allows students to learn. They can offer their own understanding of the world around them and puzzle about questions they have encountered in observing the world around them. They really deeply want to understand the reality in which they live actually makes logical sense.

In one sense of the word, collaboration means to 'coach' rather than to teach. Jaime Escalante, immortalized in the Hollywood film ***Stand and Deliver***, in an interview by Technos Quarterly was asked: "Your style seems to be that of a coach with his team. Is the teacher really a coach?" Escalante replied: "This is true. I'm just a coach. In some of the classes – for instance, in period five – the kids call me 'Coach.'" Escalante was asked by GovTech magazine "What does a teacher need?" To which Escalante said there were three primary things.

The first was subject knowledge, but the next two were very collaborative. Escalante said "The second thing is I have to motivate the concept I'm going to be teaching. For example, I introduce the concept of illegal defense – that in mathematics you cannot divide by zero. … With each new concept I have to … use some toy or something for the concept itself. So from that you start." Escalante recognized that the context of the

children's minds was crucial to their understanding. He stated "What we teach in class has to reflect what the kids will use in real life."

The third "need" for teachers, according to Escalante, "Third, you have to understand human relations. You have to look at the kid as a person, and you respect the kid. And that way you motivate them. And you develop that gradually over a whole semester or two weeks or three weeks, that good relationship. And if you do that, when you have the feedback from the student, mathematically speaking, then the kid speaks back, and you know he is learning."

Note his subtle "respect the kid" as a foundational concept, and that you listen to the "feedback from the student" to "know he is learning." Respect is a word mentioned earlier by expert educators. Notice Escalante insists that you must show respect and listen to your students, much as Physics education pioneer Arons said "shut up and listen" to your students. This is a conversation. Too often people think of a coach as an autocratic disciplinarian, much as a teacher. But that is not the way legendary basketball coach John Wooden described it.

Soon after Holt wrote his book, a truly phenomenal example of not teaching was startling the nation. The University of California at Los Angeles (UCLA) men's basketball team coached by John Wooden won 10 national NCAA championships in 12 years, including seven consecutive national championships from 1966 to 1973, four perfect 30-0 seasons, and in one streak from 1971 to 1974 won 88 straight games. This despite graduating students and acquiring new recruits each year. And after Wooden retired it was 20 years before UCLA won another national championship. Obviously Wooden knew something few others understood about teaching.

An ESPN series about sports legends asked this legendary college basketball coach, "What is the key to being a good teacher?" John Wooden replied "I think anyone in a position of supervision, if they're not listening to those under them, they're not going to get good results. The supervisor must make sure that all of those under his supervision understand they're working with him, not for him."

It seems pertinent to ask "Why would the greatest college basketball coach in history 'listen' to his students instead of requiring them to listen to him?" Wooden says because that was what made him the greatest basketball coach in history. Wooden did not "teach" basketball, Wooden essentially said he considered his role as collaborating "with" his students. Note also that Wooden described his role as "supervision" rather than teaching, and he described "supervision" as "must make sure that all of those under his supervision understand they're working with him, not for him." Collaboration, not teaching.

More importantly, note that Wooden did not abandon basketball. Wooden's students did not abandon drills. There is a common false conception that student-centered education implies the teacher should allow students to learn anything and therefore nothing. Wooden may not have "taught" basketball, but his students learned it well enough year after year to establish a record of dominance that is unlikely to ever be equaled. Therefore

if educators “shut up and listen,” as Arons put it, listen instead of teach, and utilize collaborative student-centered education, they are likely to succeed far beyond what they would achieve by teaching.

Ironically, at about the same time Wooden dominated men’s basketball, coach Vince Lombardi dominated professional football. The trophy awarded each year to the winner of the Super Bowl by the National Football League is called the Lombardi trophy. Vince Lombardi, the legendary American professional football coach noted "They call it coaching but it is teaching. You do not just tell them...you show them the reasons." Clearly Lombardi defined "teaching" as "not just tell them" but rather to educate his players in the reasoning of what they were doing. Football to Lombardi was a nomothetic process.

More importantly, Lombardi stressed that learning required a collaborative effort between the teacher/coach and the students/players. Lombardi, speaking at a corporate seminar, said of leadership: "A leader must identify himself with the group, must back up the group, even at the risk of displeasing superiors. He must believe that the group wants from him a sense of approval. If this feeling prevails, production, discipline, morale will be high, and in return, you can demand the cooperation to promote the goals of the company." Or of the school or the classroom.

Teaching implies that someone "tells" another person something and that is what teachers do, and why they fail. As Wooden and Lombardi proved, successful "education" requires that you stop teaching and start collaborating with students so they understand the reasons why they should do what it is you want them to do and they do it with you. Teachers do not collaborate and that is why they fail.

Washington Post education columnist Jay Mathews told the story of Dave Levin, a co-founder with Mike Fineberg of their nationally recognized charter school “Knowledge is Power Program” (KIPP). Mathews started by describing how an administrator in New York City schools first encountered Levin in 1997:

> The minute she stepped into one of his classrooms, she realized this particular young man had something to offer. The students were alert and interested in the lesson. They responded quickly to frequent and friendly teacher questions. The classes seemed almost completely devoid of the chatter, inattention and mischief that characterized many of the schools Winston visited.

Levin used “frequent and friendly” Socratic questions to elicit from his students their attention and interest. Mathews describes his 2005 experience observing Levin visit a KIPP classroom in New York City.

> After several minutes in one classroom, he winched *(sic)* when he stepped into the hall. The instructor's tone was too didactic for him and, he thought, for the students. "I hate that kind of fake teacher voice," he said. "You should be having a conversation with the kids."

The word “didactic” is defined in Webster’s dictionary as an adjective meaning “used or intended for teaching or instruction.” In other words, didactic means “to teach” and the founder of a successful nationally renowned school reform program specifically denounced a teacher for teaching, averring instead “You should be having a conversation with the kids.” Conversation.

This was also what Coach Wooden meant in saying “you have to listen to those under your supervision,” and what ‘coach’ Escalante meant crediting feedback from the student as a crucial “need” for an educator to be successful. Teaching implies passive empty-headed students sitting in rows of desks listening to the sage on the stage ejaculating information into them, but passivity is the exact opposite of what Wooden, Lombardi, Holt, Johnson, Arons, Levin and Escalante credit for success: student feedback. As Arons so emphatically stated, you have to “shut up and listen” to involve the students in a “conversation.”

The National Academy of Sciences published their report "On Evaluating Curricular Effectiveness: Judging the Quality of K-12 Mathematics Evaluations (2004)" explaining the widespread failure of mathematics education. The authors noted in the Case Studies section that “We found one study particularly informative in illustrating the evaluators’ view of the importance of classroom discourse that draws on students’ ideas.”

Note right away that the National Academy of Sciences, the premier collegium of professional scientists, described their (“the evaluators”) investigation into learning mathematics as recognizing “the importance of classroom discourse that draws on students’ ideas.” The word “discourse” means and implies a “conversation” with students, and that this conversation was about “students’ ideas.”

Therefore it is important to carefully note that the NAS spotlighted one “study” as particularly “informative” precisely because it reflected the “importance of classroom discourse” with the focus on “students’ ideas” rather than teaching some predetermined topic. That “study” formulated “Three particularly important norms”, the first of which was “Extend students’ thinking.” The NAS report notes:

> In attempting to understand why so few teachers implemented “extend student's thinking,” they deduced that teachers needed to shift from talking about “their” and “the text's” mathematics to talking about the children's mathematics.

It then explained "A curriculum's program theory may presume an instructional discourse style that requires significant changes in teachers' beliefs and practices. It may also be designed with the anticipation that teachers will foster certain social and sociomathematical norms when it may be uncommon that they do."

In other words, the report that the National Academy of Sciences published to counter the lack of mathematics learning complained that “teachers” were “talking about ‘their’ and ‘the text’s mathematics” and they needed to stop that and instead become educators “talking about the children’s mathematics.” The premier scientists of the nation conceived of teaching mathematics NOT as injecting some preconceived knowledge into

students' minds. Not talking "to" students but talking "with" students in a "discourse" about what the children understood about mathematics. A conversation.

Notice also that the top minds in American science, reflecting on the failure of teaching mathematics, the fundamental language of their realm, said these cryptic things that we have to attempt to derive meaning from, just like children listening to teachers. The phrase "extend student's thinking" means having children extend the existing context of their own already existing understanding of the world; and the phrase "certain social and sociomathematical norms" means an instructional protocol involving a respect for the students exercising logical thinking.

And notice particularly that their suggested way to have children learn about mathematics is to converse with children, "talking about the children's mathematics" with respect for their logical understanding of mathematics.

Deborah Loewenberg Ball, Dean of the School of Education at the University of Michigan was quoted in an article titled "Equity and Mathematics: An Interview with Deborah Ball and Bob Moses" (Phi Delta Kappan, October 2009, Volume 91, Number 2, pp. 54-59) explaining how she came to be involved in the "Algebra Project." She told about teaching math in elementary school and her students not absorbing her teaching.

Like John Holt and others, she taught but her students failed to learn. She decided to take math courses at the University which seemed of little use at first, but then:

> I began to notice that the math I was taking was influencing what I could hear and what my students said. I noticed them saying things that I had never noticed before. I realized that the kids were doing all kinds of mathematical things that teachers were missing, which, to me, had everything to do with kids' failure in math. Kids would say interesting things and their teachers would say, "No, don't do it that way" or "We're not talking about that" or "That has nothing to do with what we're talking about." Then, it would be pretty easy to explain why lots of kids would end up thinking, "This is a dumb subject and I'm checking out of this," because they were thinking things that were mathematically viable but most primary teachers couldn't hear it.

Notice how closely this relates to Holt's claim that school is a place where children learn to be stupid. The children in those classes where teachers failed to listen to their students end up thinking mathematics is stupid ("This is a dumb subject").

The students were expressing their quantitative ways of thinking, what the National Academy of Sciences called "their mathematics," and in the process providing enormous clues about the ways they reasoned. The students were trying to learn, expressing their ideas about the world around them, but being ignored by their teachers. Instead of helping the students reconcile what they already knew, the teacher attempted to teach concepts that the students had no interest in. Dean Ball discovered the secret to teaching was that teachers should listen to the students like John Wooden suggested. Or Piaget. Or Arons.

Gordon Pask, a legendary college educator, wrote a book about teaching and called it "Conversation Theory." Pask implemented an instructional method called "teach back" in which he had his college students explain their learning to him. A complete paradigm shift where the teacher asked questions and the students taught, instead of vice versa.

These giants of education – Wooden, Lombardi, Holt, Arons, Johnson, Levin, Pask and Escalante – all eschewed any concept of student passivity, indeed they explained their success in terms of just the opposite, of engaging their students in conversation. They all explained that successful learning required collaborating with the students to extend their already existing innate thinking about what needed to be learned.

Escalante told Technos Quarterly something else that dovetails with Coach Wooden. When asked his opinion about reforming education, Escalante said "it's very important for us to treat the kids in the classroom as if school was their job." Remember that Professor Haberman, Tad Watanabe, and other expert educators described teaching as standing almost "as observers" while the students taught themselves. Adults have jobs producing something and have the responsibility for organizing their efforts productively. Children should be trusted to do the same.

This subtle insight that "school was their job" is very much at the root of the misperception of learning. Learning is produced by children, not by teachers. It is the students' job to produce learning under the supervision of the teacher, just as Wooden referred to his role as a supervisor working "with" students.

One of the giants in corporate management, W. Edwards Deming, for whom Japan named its top industrial prize, described supervision as: "The job of a supervisor is not to tell people what to do or to punish them, but to lead. Leading consists of helping people do a better job and of learning by objective methods who is in need of individual help." Deming was a physicist who developed a concept of statistical management often called "Total Quality Management" which emphasized worker empowerment as the foundation of leadership.

Deming, whose expertise was in corporate industrial management, described the proper role of a supervisor as being someone who collaborated with employees. Considering how Vince Lombardi and John Wooden described their relationships with their players as collaboration, Deming's definition of supervision seems apropos to education as well.

Thus it seems cogent that when Escalante was asked to describe his view of reforming education he averred "it's very important for us to treat kids in the classroom as if school was their job" and to educate students as if the educator fulfills what Deming described as "the job of the supervisor" which "is not to tell people what to do or to punish them, but … of helping people to do a better job and of learning by objective methods who is in need of individual help."

The crucial transformation of teaching into education essentially requires a mutual respect between teacher and students and a recognition that learning is created by students, not by teachers. It is the students' job to learn in the same way that employees in any quality organization collaborate with their supervisors to produce quality output. The teacher and student are not involved in some meaningless exercise or duel, but should rather form a team to achieve a beneficial education. As LouAnne Johnson attributed her success to "Teacher and Students versus Curriculum" working as a team.

Harvard University education leadership professor Richard Elmore explained to an interviewer in Australia's Professional Voice magazine (Vol. 4, No. 2, pp. 50) "Central to my theory of learning is what I call the 'transfer of agency'. The primary purpose of education or learning is to transfer control over the process of learning from the teacher to the student."

As Fred M. Hechinger concluded in his "Learning Math by Thinking" article: "The mathematics teaching Dr. Whitney talks about makes children want to know the answers in situations that are real to them. It makes mathematics come alive for them as they do their own thinking and take control over their work, not for tests but for themselves."

Fast Company magazine in December, 2001, published an article about teaching as supervision in the corporate world. The article noted:

> In a fast-moving economy that is driven by ideas, an essential part of being a leader is being a good teacher. How else do you persuade everyone in an organization – whether that means 50 employees or 50,000 – to move in the same direction. …. Simple: You teach. That's different from giving a speech in a company-wide meeting or giving orders to a subordinate. That's not teaching; that's dictating. Telling people what to do doesn't guarantee that they will learn enough to think for themselves in the future. Instead, it may mean that they'll depend on you or their superiors even more and that they will stop taking chances, stop innovating, stop learning.

This non-education business-oriented magazine described teaching as "different from giving a speech … or giving orders…." The crucial point being that education ultimately means to "guarantee that they will learn enough to think for themselves in the future." The goal of both leadership and education is for the students to learn to think, otherwise they will "stop innovating, stop learning." If you teach, students will stop learning.

The Fast Company article focused on William Rando, described as the person "who has been training college-level teachers for 15 years" and who "runs the Office of Teaching Fellow Preparation and Development at Yale University." Rando explained:

> It's not enough to know your material. You need to know the people you're teaching – their talents, prior experience, and needs. Otherwise, how can you know for certain what they already know and what they need to learn? "I tell my teachers to imagine that someone called and said, 'I'm trying to get to Yale.'" says Rando. "The first question you have to ask is, 'Where are you?' You have to know where the person is starting from before you can help him reach the

> destination. It may sound obvious, but as teachers, we sometimes begin the journey and forget to ask our students, 'Where are you? Where are you starting from?'"

If you look up the etymology of teaching and education you will see that the root word of teaching is to "show or demonstrate" while the root word of education means to "lead" and is related to the word "educe" which means "elicit." The difference is crucial. Teachers think and behave as if it is their duty to show or demonstrate or tell students what to do, and frequently to punish them if they don't do it the way they were "taught." But education means to lead students in discovering the truth within the context of their logical understanding of the world they inhabit, to elicit knowledge. Expert educators think and behave as if their duty is to help children to learn to think.

In Edutopia magazine (October 2005), published by the George Lucas Foundation (George Lucas of *Star Wars* fame), Todd Oppenheimer wrote:

> Curiously, Japan – the very symbol to many Americans of technological success, as well as lock-step thinking – has long practiced quite the opposite approach in its elementary schools. In science classes, for example, exercises typically begin with a simple question, followed by active exploration with basic materials: water, dirt, pendulums, and so forth. Rather than rushing from topic to topic, as most American schools do, Japanese students linger on individual problems, examining them from every angle, sometimes for weeks on end.

Japanese schools do not simply "tell" their students about science. Telling does not work, in science or any subject. They involve students in reasoning about it.

In April of 2004, the Eisenhower National Clearinghouse (ENC) on teaching mathematics published an article on the SummerMath program at Mt. Holyoke which quoted a returning teacher in the program describing the program as: "The ideas of listening and asking questions rather than telling someone how to perform a task are themes that are repeated often and that are modeled often."

Expert educators ask students what they need to know and help them find it by what the National Academy of Sciences described as "the importance of classroom discourse that draws on students' ideas." The concept of asking the student represents Socratic teaching because Socrates always asked questions rather than telling his students the answers. Asking students questions about what they know helps them to discover and confront the misconceptions and gaps in their existing knowledge at the same time it organizes their thoughts to incorporate the existing topic.

As we have noted in several examples, expert educators stop teaching and listen to the students. Notice that commonality of listening to students in what Arons detailed about science education to what Wooden explained about listening to his students as the key to his success. Arons was adamant that "After each question, one must shut up and listen carefully to the response." Indeed he ridiculed teaching: "It is the tendency of most inexperienced questioners to provide an answer." In other words, shut up and don't teach!

It is not just listening, but listening to understand where the students are having problems and are in need of help, just as Deming defined the role of the supervisor is to find out by objective means who is in need of help. And then, responding not by a condescending explanation, but by a collaborative conversation that respects the student's intellect. A respect that the students find greatly motivating.

The SummerMath teacher described how she once encountered difficulties with educating her students to a particular concept and how the students reacted negatively when she tried to simply tell them: "I realized then that I couldn't go back to the old method of teaching. We had already made such a change in the way students were learning math that just to get up and show them how to do something wasn't going to work anymore." It damaged their mutual respect and the status of their intellect.

And it probably didn't work well in the first place, which is why she had adopted this new form of working with students that stopped teaching. There have been other examples of experts attempting to change the "teaching" of mathematics by stopping teachers from teaching. For example, in "Delay the Teaching of Arithmetic?" Andrew M. Gleason, Professor of Mathematics Emeritus at Harvard University, states:

> Suppose we drop the arithmetic algorithms from the curriculum of grades 1 to 5. Children could still deal with problems germane to their own experience. They could learn to think primarily in terms of the plausibility of an answer.
>
> ….
>
> Such a major change in the curriculum would have to be accompanied by a major change in the style of teaching. I suspect that many grade-school teachers, uneasy themselves with mathematical ideas, take refuge in the simple right-wrong dichotomy and thereby avoid any serious effort to get students to think mathematically. A curriculum with little emphasis on precise calculation would force the teaching of ideas and the careful expression thereof. The required change in teaching style might easily prove to be the principal difficulty in making the change in the curriculum.

Note that his conception of "learn" means "to think in terms of the plausibility of an answer." Learning is first something to be logically reasoned. The emeritus author is essentially saying we should stop teaching arithmetic until after children have already learned it on their own. His title says "Delay the Teaching" when he should have said "Stop the Teaching" because his point is that we should instead have "children … deal with problems germane to their own experience. They could learn to think primarily in terms of the plausibility of an answer." They would learn arithmetic as part of their own lives, just as the National Academy of Sciences highlighted.

Thus, unlike the perimeter problem, which showed that the students who are taught subsequently never even consider the problem logically and instead employ whatever answer technique they were most recently taught, the SummerMath teachers expected their students to think about a problem logically. Teach children to think instead of using rote formulas for plug and crank techniques that you employ on problems given by a

teacher. Plug and crank won't work in the real world where logically determining the nature of the problem dominates the question.

The idea of not teaching children plug and crank arithmetic was also suggested in a 1935 journal article by a New Hampshire school superintendent L. P. Benezet who wrote:

> In the fall of 1929, I made up my mind to try an experiment of abandoning all formal instruction in arithmetic below the seventh grade and concentrate instead on teaching the children to read, to reason and to recite …. For some years, I had noticed that the effect of the early introduction of arithmetic had been to dull and almost chloroform the child's reasoning faculties.

By "early introduction" he meant "teaching." Echoing Holt's claim that teaching makes kids stupid.

Researchers wrote of Benezet in 1958:

> He forcefully advocated "postponement of arithmetic" to Grade 7 or at least until Grade 6, though the reader will discover that he advocated postponement only of formal arithmetic. Actually he filled the early years with "meaningful" and "significant" arithmetic experiences. This study, often misquoted, has been used to support postponement of all organized arithmetic teaching.

In other words, Benezet allowed children to participate in arithmetic, and to learn arithmetic, but he refused to teach it. In Andrew Gleason's article "Delay the Teaching of Arithmetic?" Dr. Gleason states "By the age of 11 or 12 children would have sufficient experience with mathematical ideas to understand the algorithms and perhaps sufficient control of their own attention to get precise answers. According to Benezet, they do at least as well as students with several more years of instruction."

The April 23, 2010, edition of the American Association for the Advancement of Science (AAAS) journal Science had a special section on "Science, Language, and Literacy." In the article "Arguing to Learn in Science: The Role of Collaborative, Critical Discourse" Jonathan Osborne wrote: "a U.K. classroom-based study using 30 lessons dedicated to the teaching of reasoning over 2 years ... from grades 7 and 8. ... 2 years later, these students significantly outperformed a control sample not only in science, but also in language arts and mathematics, which led the authors to argue that their program had accelerated students' general intellectual processing abilities."

In other words, when educators experimented with teaching reasoning instead of subject matter, students thrived and the improvement in their "general intellectual processing abilities" allowed them to succeed in other courses in other subjects. When given the opportunity to reason, and instructed in how to reason, they were able to learn far more than when they were taught.

To repeat Holt's admonition "Children do not need to be 'taught' in order to learn; they will learn a great deal, and probably learn best, without being taught." In the Fast Company article on corporate teaching, they quoted Tom McCarty at Motorola University as recounting an old adage: "When the student is ready, the teacher will

appear." The Fast Company article made the common error of calling educators "teachers" but it made clear the difference when it noted:

> To some people, being a teacher – or a leader – means appearing as though you have all the answers. … Those people can make the worst teachers, says Parker Palmer, a longtime instructor and author of The Courage to Teach: Exploring the Inner Landscape of a Teacher's Life (Jossey-Bass, 1997).

They make the worst teachers because they think knowing all the answers is the point of teaching. They make the worst teachers because they think what is in their head is more important than what is in the student's head. Arnold Arons wrote "Nothing is more ineffectually arrogant than the widely found teacher attitude that 'all you have to do is say it my way, and no one within hearing can fail to understand it.'" In short, they suffer from the common misperception that teaching is the source of learning. It is also why expert educators scoff at those who claim people with great subject knowledge make the best teachers. They actually make the worst teachers because they will teach.

The Invisible Educator

The irony of education is that if a child learns, it usually occurs quickly in a realization of how it naturally flows from what the child already knows. Therefore little time is needed learning it. It is only when children fail to learn something that we observe teachers teaching it. Thus what we typically observe teachers doing is failing but we then think that is what should be done.

We think teaching is what should be done because it is what we see most often occurring before children learn, but it is because children are not learning that we keep teaching. What really occurs if children learn is that the students alter their internal systems of thought to reconcile it with what they are being exposed to, and then there is an almost instantaneous "aha!" moment when they recognize (re-cognize) how the topic fits into their system of thought. When that learning occurs we stop teaching and think it succeeded.

The largest problem with reforming education is that what works is rarely observed. When children learn, they learn quickly and subtly, and thus we rarely observe it. When children are having problems learning, we observe both teachers and students struggling, flailing and groping at the topic, and we think this involves instruction. But typically teaching does not result in learning, although it may accidentally occur on occasion.

When children learn, you cannot observe them learning because nothing happens. In the same way, when education occurs it also is invisible. What successful educators do frequently cannot be observed. What occurs is extremely subtle and occurs quickly. It is very much like the sleight of hand performed by magicians: it is there, but you don't see it. You have no idea how it was done even though you watched carefully. Even if it is video taped and pointed out to you. It is magic.

Reading expert Frank Smith wrote in Kappan magazine (Apr 1995)

> Learning is also like physical growth in that it usually occurs without our being aware of it, it is long-lasting, and it requires a nurturing environment. It takes place as a result of social relationships (including relationships with the authors of books and with characters in books), and it pivots on personal identification. We learn from the kind of person we see ourselves as being like. Such conditions are annihilated by information-transmission teaching and constant tests.

Learning isn't a result of teaching, but rather a matter of collaborating with students for facilitating their own learning, with educators, as Susan Ohanian testified, "knowing when to 'disappear' and when to move in." Educating is not teaching; educating is supervision that allows the students to do the work while the supervisor learns from objective means who is in need of help and then moves in without impugning the student.

Teaching mostly distracts students while they are learning. The adept educator elicits from the student the learning that is desired by respecting the student as a responsible employee in producing knowledge and facilitates that by learning through objective means who needs help. And struggling students enjoy the help that respects their abilities rather than impugns them.

The misperception that teaching causes learning in American schools stymies reforms that could vastly increase the learning that students are capable of. Reform that focuses on teachers and teaching will be counterproductive: More teaching means less learning. Reform that focuses on education and educators will ensure greater success. But it may not be the success you can measure with typical tests. As in all systems, short term success may actually create long term failure, and vice versa.

Joseph Ganem, a professor of physics at Loyola University Maryland, writing in the "The Back Page" of the journal of the American Physical Society, took up the issue of why American students receive credit for more and more math courses in high school and yet colleges are more and more requiring students to take remedial math. He explained that he had seen this phenomenon both in his students at Loyola University and in his own daughter.

Ganem began his essay with: "We are in the midst of paradox in math education. As more states strive to improve math curricula and raise standardized test scores, more students show up to college unprepared for college-level math." He proffers three reasons for this paradox.

"1. **Confusing difficulty with rigor**. It appears to me that the creators of the grade school math curricula believe that 'rigor' means pushing students to do ever more difficult problems at a younger age. It's like teaching difficult concerti to novice musicians before they master the basics of their instruments. … Attempting difficult problems without the proper foundation is actually an impediment to developing rigor." In essence our emphasis on teaching is undermining student learning.

"2. **Mistaking process for understanding**. Just because a student can perform a technique that solves a difficult problem doesn't mean that he or she understands the problem." In other words, high school students have learned to give the answers, but what they lack is understanding the problem. What the students were being taught in high school was more and more rote procedures that allowed them to pass tests, but less and less real understanding of quantitative thinking needed to actually apply math in college. Indeed, the very last sentence of Ganem's essay is "Memorizing a long list of advanced techniques to appease test scorers does not constitute an understanding."

"3. **Teaching concepts that are developmentally inappropriate**. … When it comes to math, all teachers dream of arriving at a crystal clear explanation of a concept that will cause an immediate 'aha' moment for the student. But those flashes of insight cannot happen until the student is developmentally ready." Those moments do not come from teaching them, but from guiding the students in achieving the logical basis for developing that concept within their own system of thought.

A similar finding was reported on April 10, 2009, in a press release about research by Bethany Rittle-Johnson, assistant professor of psychology and human development at Vanderbilt University's Peabody College, and Percival Mathews, a Peabody doctoral candidate (in press at the Journal of Experimental Child Psychology). Rittle-Johnson reported "Teaching children the basic concept behind math problems was more useful than teaching children a procedure for solving the problems - these children gave better explanations and learned more,"

Their press release noted:

> In math class, teachers typically demonstrate a procedure for solving a problem and then have children practice solving related problems, often with minimal explanation for why things work. "When you just show them how to do the problem they can solve it, but not necessarily understand what it is about. With conceptual instruction, they are able to come up with the procedure on their own."

As previously cited by other researchers, they found that "When you just show them how to do the problem they can solve it, but not necessarily understand what it is about," this is the same paradox that Ganem wrote about. Their research was conducted under the existing paradigm of "teaching" and they then profess that if you teach it differently they "learned more." However, the evidence is that if you "teach," regardless of methods, students will essentially end up being taught, meaning "show them how to do the problem." Teaching understanding is still teaching, when the evidence is clear that teaching does not result in learning.

Education involves leading students rather than teaching them. The expert educator is a good leader in the etymological sense of the word to educate. To believe you can teach students is to believe you can push a string. No matter how well you teach students, nor what method you employ, it will not engender the success of leading students to learn on their own. As Laozi averred "Fail to honor" students, "they will fail to honor you." They won't listen to or value what you teach. But if educators "talk little" and instead facilitate

student learning with respect for their students, they will learn far more and "they will all say, 'We did this ourselves'" and possess that knowledge as their own. Having respect, "honor," for your students' ability to learn is crucial.

In posting #961 of "Tomorrow's Professor Blog," self identified as "A partnership between the Massachusetts Institute of Technology and Stanford University to create a forum for comments and discussion about articles from the Tomorrow's Professor Mailing List and about general issues concerning higher education," Richard M. Felder of North Carolina State University and Rebecca Brent of Education Designs Inc. posted "The Ten Worst Teaching Mistakes" in what they described as in the "increasing order of badness."

Some of the ten mistakes were common pedagogical errors such "Mistake #9. Call on students cold" but "Mistake #5. Fail to establish relevance" explains that teachers should:

> "begin the course by describing how the content relates to important technological and social problems and to whatever you know of the students' experience, interests, and career goals, and do the same thing when you introduce each new topic. (If there are no such connections, why is the course being taught?) Consider applying inductive methods such as guided inquiry and problem-based learning, which use real-world problems to provide context for all course material. You can anticipate some student resistance to those methods, since they force students to take unaccustomed responsibility for their own learning, but there are effective ways to defuse resistance, and the methods lead to enough additional learning to justify whatever additional effort it may take to implement them."

Again, this is very close to a call to stop teaching and allow the students to learn by using "guided inquiry" where the students "take responsibility for their own learning" that leads to "additional learning." But the crucial point is to provide context for the students so that they can view the topic in terms of their own "experience, interests, and career goals." Students have to learn for themselves how the topic applies to what they already know, want to know, and need to know to succeed in their life quest.

However, in "increasing order of badness" the number one mistake in teaching described on this list is "Disrespect students. How much students learn in a course depends to a great extent on the instructor's attitude." The authors then echo the disrespect and incivility that Holt documented from the research of Silber and Pearl nearly a half century before: "Even if you genuinely respect and care about your students, you can unintentionally give them the opposite sense" from the futility of trying to teach. If you are going to lead students to knowledge, you must first respect, "honor," their ability to do so. For the crucial point of education is not the topic itself but rather the intellectual ability of the students to master the topic and say, "We did this ourselves."

Expert educators know that the fundamental basis of education is respect for the student and the student's intellect and they seek to increase the logical rationality of that intellect (what educators refer to as "higher order thinking skills") mostly by leading students

through exercises where they discover through their own intellect how the world around them makes nomothetic sense. It is really this nomothetic sense, the ability to think logically about the world around them and to understand the processes involved, that is most valuable to the students. The subject matter is largely irrelevant, something that perplexes non-educators when they observe universities offering courses on what seem trivial or faddish subjects. The subject matter is simply not the point.

Joseph Ganem, in his "Back Page" essay about the three problems that he suggested explained the paradox of students learning more math in high school but increasingly requiring remedial math in college concluded: "All three of these problems are the result of the adult obsession with testing and the need to show year-to-year improvement in test scores. Age-appropriate development and understanding of mathematical concepts does not advance at a rate fast enough to please test-obsessed lawmakers. But adults using test scores to reward or punish other adults are doing a disservice to the children they claim to be helping. It does not matter the exact age that you learned to walk. What matters is that you learned to walk at a developmentally appropriate time."

For this reason, expert educators teach children rather than subject matter. And this is something completely foreign to outsiders attempting to reform education. Outside reformers are so focused on the subject matter that the children disappear entirely. Outside reformers see children as commodities to be stamped out on a production line complete with student serial numbers and uniform packaging.

They do not think of children as dynamic systems, as live cats, but as dead cats. As things rather than beings. They talk about children becoming productive workers in some future world that they believe will resemble their world or the past, but, in reality, today's children as adults will mostly be doing things that haven't even been invented yet.

It is instructive to consider what John Wooden said about winning championships. He said he never mentioned winning to his players, but exhorted them to succeed at being their best. Roger Barta, a Kansas high school football coach profiled in the 2009 book "Our Boys: A Perfect Season," had a record of 289-58 but averred "We don't talk about winning and losing. We talk about getting a little better every day, about being the best we can be, about being a team." Notice his emphasis on "we."

The "we" is crucial because it means the teacher and students work together to succeed as a team. It means to stop being the "teacher" apart from the process of student learning. The key to successful education is to stop teaching and instead collaborate with students in an extended conversation of learning; as Arnold Arons emphasized, "shut up and listen" in order to facilitate students in producing knowledge. The students, in turn, will succeed, like John Wooden's students, far beyond what we could imagine by virtue of their knowing where they need help.

The Six Keys to Facilitating Learning

From the expert criticisms of traditional education one can extract ways to improve the process of facilitating learning. All of the great educators emphasized that the most obvious process is to respect children as individuals capable of producing their own learning when given proper guidance. Most also indicated the need to converse with those students to establish the context and the importance to them of the topic to be learned. But the sine qua non of education is to stop teaching, shut up, and listen.

Fundamentally, the first step in educating a child is to allow that child to proudly reveal the elegant structure of his or her cathedral of knowledge. The cathedral of each child's knowledge should be respected as a sacred place for that child's being and sanity.

Expert educators avoid at all costs the incivility that Holt and Pearl and Silberman found too often in classrooms. Not the incivility of children, but the incivility of teachers toward children. The very fundamental basis for student learning is a foundation of mutual respect between educator and student, a respect that must be earned by the teacher and granted to the students.

The second step is to develop a relationship with each student. As Rita Tenorio advised beginning teachers: "Find out what they know. What is their daily experience like? What language do they speak at home? What past experiences has the family had with schools and learning? And then you need to move them along from that place." Accord the children the respect of being individuals with uniquely beautiful cathedrals of thought.

The Wharton Business School essay, "The Objective of Education is Learning, Not Teaching," averred:

> To satisfy the person being addressed, to the point where that person can nod his head and say, "Ah, yes, now I understand!" explainers must not only get the matter to fit comfortably into their own worldview, into their own personal frame

> of reference for understanding the world around them, they also have to figure out how to link their frame of reference to the worldview of the person receiving the explanation, so that the explanation can make sense to that person, too. This involves an intense effort on the part of the explainer to get into the other person's mind, so to speak, and that exercise is at the heart of learning in general.

You can only do that by having a respectful relationship with your students to monitor their progress and understanding as their minds alter their frames of reference.

The third step is to join your students in discovery. The old cliché was to transform teaching from the "sage on the stage" to the "guide at the side" but the new paradigm goes farther to make the teacher part of the discovery process. "Dangerous Minds" author LouAnne Johnson revealed her secret to student learning: "It was a wonderful feeling and it completely changed the dynamics of the classroom. When the students truly believed that I liked them just as they were, it was no longer Teacher versus Students. It became Teacher and Students versus Curriculum." It became a collaboration between teacher and student that began with convincing the students you respect them just as they are.

As stellar basketball coach John Wooden revealed, the successful educator must "make sure that all of those under his supervision understand they're working with him, not for him." Vince Lombardi, the legendary professional football coach revealed his secret: "A leader must identify himself with the group, must back up the group, even at the risk of displeasing superiors." You must become one of the students, learning with them, within them, if only to model how it is done.

The fourth step is to recognize that students need to take responsibility for their own learning. Remember Professor Elmore's admonition "The primary purpose of education or learning is to transfer control over the process of learning from the teacher to the student." They are the workers who produce learning, the teacher is only the facilitating supervisor. Jaime Escalante stated it best: "it's very important for us to treat kids in the classroom as if school was their job."

Remember George Lucas, the genius behind the Star Wars sensation, who advised educators to respect the ability of children to learn and to say to them: "You are a bright intelligent person who can figure this out on your own, and if you need help, I'll help you." And when they ask for help, shut up and listen. Don't deny their learning by giving them answers. For the most part ask them questions that direct them to their own thinking about the logic of what they are learning. For it is the primary goal of education to get children thinking.

The fifth step is to focus on the logical reasoning of knowledge. Have the children work through the logical process of the topic on their own, watching carefully where you can question that logic for them to reflect on their thoughts: "why do you say that?" Recall Roger Schank's citation of Piaget: "Piaget recognized that teaching needed to focus on how children were reasoning rather than focusing on how well they might recall facts for a test." Respect the child's reasoning and guide it to the mental conflict underlying the difficulty they have encountered.

Recall that Arnold Arons, the founder of physics education in America advised "As students respond to such careful questioning, one can begin to discern the errors, misconceptions, and missteps in logic that are prevalent. One learns nothing by giving students 'right answers' or 'lucid explanations'." The goal is to have students use logical thinking.

The sixth step is to make education a conversation. Most importantly, don't teach. If all else fails, have the students teach. For nothing more exposes the logical problems in one's mind than to try to provide a logical explanation from this fractured sense. Respect the child's intelligence and fundamentally listen to what the child says. The National Academy of Sciences, in explaining how to provide the mathematics learning necessary for their future, stated clearly DO NOT teach them the mathematics in the book, but rather "teachers needed to shift from talking about 'their' and 'the text's' mathematics to talking about the children's mathematics." Converse with the children. Listen to them, ask them questions, respect what they tell you.

Deborah Loewenberg Ball, Dean of the School of Education at the University of Michigan and a leader of the Algebra Project found that when she carefully listened to her students "I noticed them saying things that I had never noticed before. I realized that the kids were doing all kinds of mathematical things that teachers were missing."

The venerable teaching method of (1) telling students what you are going to teach them, (2) teach them, then (3) summarize what you told them, unfortunately has three flawed methods: telling doesn't work, teaching doesn't work, and what you told them has little relevance to anything. Instead of these three steps for teaching, follow a six step methodology to increase student learning.

Rapport.
The 6 step methodology involves beginning each instructional class with an effort to create real rapport with the students. This can be a joke or funny story, or a brief discussion about some common event, or other means of creating a rapport with the students. The point is to establish a mutual identity of respect and create what John Wooden called the feeling that they are working with you instead of for you.

Respect.
Once the teacher has created a rapport with students, the topic being instructed should be referenced in terms of the teacher's experiences with the topic. Learning involves mutual respect, and that includes having the students respect the knowledge of the teacher. In essence, this also involves subtly informing the students of the teacher's respect for this topic, and hopefully informing them of the teacher's interest. But more importantly it should demonstrate how that the topic is one that the teacher has found useful in his or her endeavors.

Relevance:

The teacher should next segue from how important the topic is to the teacher into why this topic is important in the greater scheme of things: into how the topic affects people in the world. In other words, the teacher should ask questions such as "why is this topic important?" The teacher should try to have the students provide examples of where they may have encountered the topic and discuss what this implies about the importance of the topic. As Jaime Escalante averred as number two in his crucial three things necessary to be successful teaching: "What we teach in class has to reflect what the kids will use in real life."

As noted in Professor Felder's "The Ten Worst Teaching Mistakes" the antidote to "Mistake #5. Fail to establish relevance" is that teachers should "begin the course by describing how the content relates to important technological and social problems and to whatever you know of the students' experience, interests, and career goals, and do the same thing when you introduce each new topic."

Relativity.
The crucial next step is to have the students consider what effect the topic would have on them if they were in the situations that encounter the topic. The point being to get the students to imagine how they would be affected, and what they would do in encountering the topic, as a way of discussing how other people behaved. The students are expected to expend efforts to learn the topic and thus they should be informed of its importance to them, personally.

In "The Ten Worst Teaching Mistakes" the penultimate "Mistake #2. Teach without clear learning objectives" could be misconceived as learning objectives for you as the teacher. I believe the authors make a crucial error here by describing learning in terms of what the teacher wants rather than as an objective statement of what students need. The authors define learning objectives as "explicit statements of what students should be able to do if they have learned what the instructor wants them to learn." They even suggest giving these objectives to the students as "study guides." Here it is critical to understand that there is probably an underlying assumption that teachers teach what students need to learn. But they are making the mistake of trying to teach.

Even in their discussion of mistake #5 they recognize that having students take responsibility for their own learning is much more efficient in leading to "additional learning" yet they still think in terms of themselves instead of the student. Thus effective learning objectives should rather be "explicit statements of what students need to be able to do to be successful." The expert teacher is one with the students explaining why it is important for them to know the topic in terms of their own needs, not their instructor's wants.

The authors conclude Mistake #2 with a continuation of this misperception of learning. They state "The clearer you are about your expectations (especially high-level ones that involve deep analysis and conceptual understanding, critical thinking, and creative thinking), the more likely the students will be to meet them, and nothing clarifies

expectations like good learning objectives." However, expressed this way they are teaching objectives, not learning objectives.

Expressed as learning objectives, this would far better be described as "The clearer students are about the importance of the topic to their future abilities (especially high-level ones that involve deep analysis and conceptual understanding, critical thinking, and creative thinking), the more likely students will be to meet them, and nothing clarifies this like good learning objectives." The key to overcoming Mistake #2 is to remember Mistake #1: you have to respect your students and explain the topic in terms of why it is important to them to learn it.

Reasoning.
This then brings the class into the domain of logically considering the topic. Remember Roger Schank's recognition of what the seminal child psychologist Piaget understood: "teaching needed to focus on how children were reasoning." There should be a conversation with the students about the logic of the topic. A Socratic conversation where the teacher primarily asks questions.

It is possible to teach a topic entirely from questions. Google "Socratic and binary numbers." You will find several references to Rick Garlikov and his teaching a class of third graders about binary numbers, without telling them anything until the very end. When students converse they have a tendency to appeal to the teacher as an authority, for which the Socratic educator has an almost universal question: "why do you say that?"

Socratic teaching can involve little more than having children reason from their own experience. If you are teaching the phases of the moon, one way to "teach" it is to show a graphic of the relative positions of the earth, moon and sun and explain the sunlight illumination as seen from the earth.

However, a more Socratic method is to ask students whether the points on a quarter moon point up or down near the horizon. This could then become a discussion among the students. Asking further questions about where the moon would have to be in order for the phases of the moon to exist will further provide discussion. Have the students devise the graphic. But the discussion involves the students in a conversation where their own logical reasoning is exercised.

The reasoning of a topic should be discussed in terms of the previous discussion about how it affects the students directly and then abstract this to how other people were affected, giving what are pedagogically called "case studies" of prior experience. In this case the teachers can "teach" certain subtopics by introducing them as "authentic" examples of the discussion, the students cannot be expected to generate actual cases from their past, but they can be expected to deconstruct the meaning of these cases in terms of the reasoning involved of the topic.

Traditional teaching of subjects focused on the rote facts rather than the logical process. You occasionally hear people talk about what if we could go back in time to kill Hitler as

a youth, as if Hitler were some isolated individual and not part of a greater context of social movements and antipathies. It is difficult for many people to think of history as anything but names and dates, but the true importance of history is the logical process involved. Understanding the processes involved in order to reason through the possibilities represents the essence of what students need to know, so that in their own lives they can look for subtle nomothetic processes influencing the context, and reason through the possibilities.

Thus the importance of the topic is not the topic itself but rather the logical context, and more importantly the logical context within each student. As such, each student has a unique logical context that needs to be expressed and recognized that can only come to expression through a conversation. The important point is the reasoning rather than the context, but the two are necessarily inextricably combined within each child.

Reflection

After a logical discussion of the reasoning about the topic, then instead of the summary that traditional education invokes, there should be a time for the students to reflect on what they have learned. Of considering how the topic impinges upon their existence and how they relate to it, particularly in terms of current events. If they cannot do this, then they haven't learned the topic. The whole point is their learning how the topic logically involves them.

At the same time, they should be essentially walking back through the prior steps of reason, relativity, relevance and rapport in order to create a complete package of context for the topic. This helps to embed what was learned into the cathedral of their thought.

This version of the 6 'R's was developed from communication concepts taught to me by Professor Stites of Arizona State University not for the purpose of teaching, but for the purpose of writing speeches for adults. The speech writing course presumed that the speaker had something important that needed to be communicated to the audience and thus the 6 'R's were designed to prime the audience for understanding the message.

It was only when I was substitute teaching a semester soon after completing the course, with the usual difficulties encountered by substitute teachers entering a foreign classroom, that it occurred to me that the techniques of speech writing should be applicable to teaching. The students needed to know who I am and what I knew about the topic, so I began using the 6 'R' technique. I soon discovered that whenever I had difficulties with a class I could always think back and find where I had made my mistake in not respecting the 6 'R's. And student misbehavior turned out always to be my mistake not theirs.

The major point of this exercise is that educators must involve these same preliminary steps of speech writing: achieving rapport with the students and the topic, explaining your credence in this matter, raising their awareness of the context in which the importance of the topic becomes apparent, relating how others have either suffered or succeeded by virtue of knowing the topic, and then presenting the opportunity for students to learn.

Thus what education really involves is: creating an environment of rapport and respect for the learning of the topic, it has nothing to do with the topic itself or teaching. For in essence you are merely telling them the rules of the game: the learning occurs when students apply their logical skills in playing the game.

In fact, Professor James Paul Gee of Arizona State University has opined that computer games often have complex rules and methods that students have to master over long hours, and yet students pay to do this. He suggests that computer games be adapted to create an environment of learning for academic subjects.

Professor Gee co-authored with Tashia Morgridge, "Good Video Games and Good Learning." Their essay explains: "Some people think of learning in school—for example, learning biology—as all about learning 'facts' that can be repeated on a written test. Decades of research, however, have shown, that students taught under such a regime, though they may be able to pass tests, cannot actually apply their knowledge to solve problems or understand the conceptual lay of the land in the area they are learning (e.g., Gardner 1985)."
(http://www.academiccolab.org/resources/documents/Good_Learning.pdf)

In a 2003 interview by Louis Bedigian on Gamezone, Professor Gee cited three reasons why games can improve learning: "First, humans are terrible at learning when you give them lots and lots of verbal information ahead of time out of any context where it can be applied. Games give verbal information 'just in time' when and where it can be used and 'on demand' as the player realizes he or she needs it." And this is what an educator does in a classroom, in essence supporting the learning of students.

Gee noted that computer games typically have levels of difficulty that players gradually acquire competence to play and continued: "Second, good games stay inside, but at the outer edge of the player's growing competence, feeling challenging, but 'doable.' This creates a sense of pleasurable frustration. Third, good games create what's been called a 'cycle of expertise' by giving players well-designed problems on the basis of which they can form good strategies, letting them practice these enough to routinize them, then throwing a new problem at them that forces them to undo their now routinized skills and think again before achieving, through more practice, a new and higher routinized set of skills. Good games repeat this cycle again and again—it's the process by which experts are produced in any domain."
(http://www.gamezone.com/news/07_03_03_06_17PM.htm)

And it's the process by which students learn in any domain. Games allow students to learn experientially. They learn by actually confronting the problems and circumstances that actually confronted historical characters or participants in events. Science is learned by doing it, math by implementing it, all in simulated real "authentic" circumstances. The students are not "told" about the topic, they experience it in their own endeavors. Everyone learns best from experience.

This is simulated in educators' classrooms when the Relevance and Relativity have the students understand and assume the context of the topic where they reason much as if they were characters in those circumstances.

Professor Gee has a blog post (August 6, 2009) on the MacArthur Foundation website about the "Our Courts" game (http://www.ourcourts.org) developed to teach civics at Arizona State University for the Sandra Day O'Connor School of Law. Professor Gee commented:

> "The ultimate goal is based on a specific view of learning. Schools treat subjects like physics as if they were just a set of facts and information ('content'). But physics is not first and foremost a set of facts, it is first and foremost a set of activities through which people engage with the world and see it and understand it in new ways. So, too, with 'civics.' Civics is not first and foremost a set of facts, it is a set of activities through which people can participate in the societies and transform them. We want to make civics part of an engaging game that ultimately spills out into the real world in demands for justice."

(http://spotlight.macfound.org/main/entry/james_paul_gee_the_our_courts_project/)

Previously in a March 10, 2009, post on his MacArthur Foundation blog he argued "why can't we design learning in science (for example) so well that finishing it guarantees 'proficiency'? In my view, the reason assessment does not work in school like it works in [the game] Halo is that we trust good game designers to create good learning more than we trust teachers to do so. And that is, in part, due to the fact that we view game designers as professionals, but we have ceased to view teachers as professionals." (http://spotlight.macfound.org/main/entry/james_paul_gee_games_as_their_test/)

"We trust good game designers to create good learning more than we trust teachers to do so" because we know game designers won't teach. Indeed game designers think it would be abhorrent to teach. An educator once pointed out that the most difficult students to teach are the middle school kids. Yet these kids are the major audience for the television show Mythbusters where the main characters experiment to test common misconceptions. But the kids don't watch this show to see the characters teach, they watch the show to see the characters learn. Learning is what children most want to do.

The way to educate rather than teach involves the 6 R's instead of the 3 R's. To facilitate student learning, create Rapport with your students, establish why students should Respect the topic, discuss the Relevance of the topic in the context of the real world, converse about the Relativity of the topic to the students themselves, Reason out the topic during a conversation with the students, and review each of the preceding in reverse order as students Reflect on their understanding. The class should be a conversation among the students, or subgroups of students, with the teacher participating as a learner or learning supervisor. Stop teaching and facilitate learning.

Participating as a learner does not mean the teacher knows the subject, it means when the students run into a problem or ask the teacher for an answer, the teacher asks (always use

a question) “how would we find that out?” or “well, let’s think about that.” The teacher participates with the class in reasoning out the issues. Reasoning is the fundamental goal.

A conversation with the students does not mean “teach” by another name. Conversation means to listen to your students and let them tell you their reasoning. But don’t make judgments about their reasoning; ask them questions about their reasoning. Have them discuss it with other students. Conversation is an assessment tool to discover where students are on the path to knowledge. Listen to the students as they ask and answer each other. Let them learn.

The point is that the students do not know the correct path to learning. They have to find this path by exploration. The exploration teaches them the path through logical abstraction. The role of the teacher is one of knowing when to recognize they are too far off path and to raise questions for the students to recognize this themselves. It is very much, like Susan Ohanian explained, knowing when to disappear and knowing when to step in.

But the key is that learning is produced by the students; it is their job and they need to be involved in doing it. As Professor Mazur averred, don’t play the piano for your students, they must play it. The educator is the supervisor, as John Wooden called it, and as Deming defined the role of supervisors, "The job of a supervisor is not to tell people what to do or to punish them, but to lead. Leading consists of helping people do a better job and of learning by objective methods who is in need of individual help."

In simple words: Don’t tell students what to do; Don’t punish students; Do supervise them and provide help by asking Socratic questions. Mostly, “shut up and listen” to your students in order to better understand where they are having problems with reasoning. Then converse with them about what they are doing. Only they can know the complex system of thought that must reconcile this information.

In the popular book, “Enders Game,” that envisions using simulations to train future warriors, Orson Scott Card subtly provides examples of management techniques in gaining expertise among “students” in taking creative and independent action. But I was also impressed by the parallels in his concept of communicating a story and how it seems so applicable to communicating knowledge in general. Wikiquote attributed to him this cogent statement:

> This is the essence of the transaction between storyteller and audience. The 'true' story is not the one that exists in my mind; it is certainly not the written words on the bound paper that you hold in your hands. The story in my mind is nothing but a hope; the text of the story is the tool I created in order to try to make that hope a reality. The story itself, the true story, is the one that the audience members create in their minds, guided and shaped by my text, but then transformed, elucidated, expanded, edited, and clarified by their own experience, their own desires, their own hopes and fears.

In many respects, this is the same for the educator: learning is not what exists in your mind; it is certainly not the written words in the textbook. You have only a hope that a student will learn. What you as an educator must do is create a conversation that communicates an experience as a tool to make that hope a reality. A conversation that evokes in the students' minds an experience, guided and shaped by your topic, "but then transformed, elucidated, expanded, edited, and clarified by their own experience, their own desires, their own hopes and fears." Learning is done by the students.

More importantly, it is something that is done, not something that is known. It occurred to me recently that this is really profound: most schools teach subject matter as something to know, not as something to use. There is no intent that students should incorporate what they are taught into their day to day doing, or that what they are taught should be something they would actually utilize to their benefit.

As Harvard professor Mazur was asked by a student: "How should I answer these questions? According to what you taught me? Or according to the way I usually think about these things?" Harvard students are some of the most accomplished thinkers in the world, and yet even Harvard students don't typically believe there is any connection between what they are taught for the purposes of school and learning about the world around them.

That is what changes when you stop teaching. There is nothing else to do but to help students learn. The fundamental process of teaching remains one of presenting subject matter to know, and to be tested on what is known; it is not conceived of, nor presented as something to use, and it is not tested as something to use. But what if you start out with the idea of helping students find out things they really want to use.

The fundamental secret of expert educators is that they understand you can teach, but not if you want children to learn. Learning is done by students. You cannot push a string. As Harvard Professor Elmore avowed: "The primary purpose of education or learning is to transfer control over the process of learning from the teacher to the student." Respect your students, converse with your students, but let them do the learning. It's their job.

Educators can only elicit learning by establishing the environment, the story, where learning can occur, perhaps "greasing the skids" or guiding students in this endeavor, but as John Holt ultimately recognized "We cannot have real learning in school if we think it is our duty and our right to tell children what they must learn. We cannot know, at any moment, what particular bit of knowledge or understanding a child needs most, will most strengthen and best fit his model of reality. Only he can do this. He may not do it very well, but he can do it a hundred times better than we can." But only if we stop teaching and let children learn.

And that is what expert educators do, even if they won't admit it; even if they don't completely understand it. Even if they have to hide it from peers and administrators; they stop teaching because it works. To stop teaching is the fundamental key to student learning.

Teachers teach subjects; educators educate children. Remember Professor Haberman's assertion that "The effort to educate thoughtful people should be guided by school activities that involve thought. The acquisition of information – or even of skills – without the ability to think is an insufficient foundation for later life." And again, his assertion that "The vision of teaching as a process of 'drawing out' rather than 'stuffing in' is supported by diverse philosophies."

At some point, all great educators stop teaching because they learn from experience that it doesn't really work. Students are very adept at thwarting teaching. They will control you, frustrate you, burn you out if you teach. To succeed in having children learn, educators must stop teaching and instead facilitate student learning by the students themselves. So, stop teaching! D'oh.

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