

Cognition!

Teaching Kids To Think

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Preface

My father always told me that I would be a teacher. He didn't mean it in a nice way. My father talked in riddles. As the only child in the house I had plenty of time and opportunity to figure out what he was really saying. This was it: *I am afraid that like me, the best you will be able to do in life is to be a civil service worker.* He was also saying: *if he had realized he was going to be a civil service worker, at least he could have been a teacher, which he might have enjoyed.* He wasn't really talking about me at all.

I never had any intention of being a teacher. I didn't particular like school and later when I became a professor, the part of the job I disliked the most was teaching. One might wonder how I wound up being a professor if I disliked teaching, and one might wonder, why I am writing a book about teaching if I dislike teaching. One might also

wonder if I still dislike teaching. Yes. And no. It depends on what one means by teaching, which is, after all, what this book is about.

The other day my 3 year old grandson Milo told me he was going to teach me how to throw rocks. It seemed an odd idea. What could he mean by this? To Milo, “teach” means to tell someone what to do and how to do it and then have them do it too. Teach is part of *tell plus imitate* for Milo. Milo is three. It is not too surprising that this is what “teach” means to him. It is a little surprising that he thinks he should be his grandfather’s teacher but that is another issue. But it is really no shock that Milo thinks this is what *teach* means. It is what nearly everyone thinks that “teach” means. The commonly accepted usage of *teach* is *tell and then have the person who was told do what they were told*. This certainly is not what “teach” ought to mean, or more importantly, is not what good teaching is. And, every good teacher knows this. The problem is that the system that employs teachers doesn’t know it and more or less insists that Milo’s definition be the one that is followed.

Actually I am being too generous here. Milo’s view, namely that after he tells me I will do what he has said is a better definition of teaching than the one actually employed commonly today. Milo at least thinks that the end result will be the student doing something that the teacher did. In school, *teach* usually means the students *knowing* something that the teacher told him. Milo doesn’t know about that definition of teaching yet since he hasn’t been to school, but, unfortunately, he soon will.

I have been thinking about teaching for more than fifty years. First I thought about it when my father said that was what I was going to be. Then I thought about as I watched my teachers teach me and no less importantly, watched my father teach me.

My father eventually retired from his civil service job and became a junior high school teacher in Harlem. He loved his new job and, I have to assume, became a good teacher. I say it that way because he was certainly not a good teacher for me, at least not when he thought was trying to teach me. I remember him trying to teach me algebra and it making no sense to me whatever. I remember him teaching me sports and I mostly think of him as being totally

frustrated with my inability to perform as well as he had hoped. (Being a jock was a big thing to my father.)

I did fine in algebra without his help and, in fact became, unfortunately, a math major in college. But, as I look back at it, my father was my first and best teacher. Why do I say this after all the bad things I have just said? Because my father was at his best when he wasn't teaching but when he was just saying what was on his mind and arguing. He often talked about history because he liked history. And when he talked about history and I asked questions, he became a good Socratic teacher. He forced me to think and question in our discussions. The conversations were often very heated but also were a highlight of my intellectual life at that time. My father didn't teach me anything except how to think. Better than algebra actually. For this I am grateful.

So, I thought about teaching then and I thought about it again when I went to college. As part of my father's conversations about life with me he spent a fair amount of time on his own college experiences. He was sent by his mother to New York City to go live with his aunt in Brooklyn and to go to college. He was fifteen and had, until that time, spent his whole life on a farm/hotel run by his parents in upstate New York. He was unprepared for the city, had no money, missed his family, and had no idea why he wanted to go to college at all. Did I mention that he was fifteen? He had graduated first in his class (a class of sixteen I think) and had skipped a few grades on the way. Suddenly he found himself at New York University, which in those days was located in the Bronx.

This is what he remembered about college in 1923: Apart from the poverty stories, the how hard he had to work to support himself stories, the watching the Yankees from the elevated train and wishing he could go to a game stories, this is what he remembered most: He remembered that teachers lectured, that you had to memorize what they told you and then tell it back to them on a test. He thought college was stupid, but he assured me (in 1960) that college had surely changed by now and that teachers wouldn't still be doing this. Oh yeah? In 1962, when I entered college, they were doing exactly that. And, in 2000, when I retired from 32 years of professoring, not that much had changed.

So I was thinking about teaching before I got to college and I was thinking about it while I was a professor and I am thinking about it now that I have, for the most part, finished teaching. To make sure I have been thinking about it correctly, I asked former PhD students of mine, (now tenured professors mostly and some industry executives) what they had learned from me while they were spending 4-7 years studying with me. I thought their answers might help me think about teaching in a new way. I sent an e-mail to maybe 20 former students whose e-mail addresses I happened to have and most responded. Here are some pieces of them:

1. I remember quite specifically a homework presentation I made in your class. When I presented it in class, I was a junior in college, and all the other students in that class were grad students. When I was done you smiled at everyone (a rare event) and said, "anyone care to follow that act?" Your clearly heartfelt endorsement of my little research product was a key moment in my coming to trust my own ideas. I just submitted a \$16.7 million proposal to NIH that would create the first all computational genome center. The kind of chutzpah embodied in that proposal is one consequence of my experience with you.
2. The way you assigned me to a project – you sent me to each existing project for two weeks until I hit on a project with a good fit (I was enthusiastic and coherent talking about it). I used this technique when I was assigning people at Accenture.
3. You taught me to teach by telling students stories that are meaningful to you. I think to be a real teacher you have to let yourself be vulnerable. So the students can see that you are a human with feelings and fears and goals. And then being able to say to the students: this is the way I do it; it fits who I am; it helps me be successful; and don't let anyone tell you that you can't do something
4. You taught me that not everyone will like you no matter what you do and no matter how hard you try. I came back from a Deloitte course evaluation, and the deans just hated me. Instead of being upset with me, you assured me that you have to just say what you believe, and some people won't like you, and oh well.

5. You taught me to start by collecting data. I recall watching most of your papers start by collection of data. I recall watching your criticisms of work that was just abstraction on abstraction, with no data at its roots

6. You taught me that often our theories get so complex that it takes a specialist with years of training to understand them. When we get our theories this distant from everyday life and everyday people, it is awkward explaining what we do when in conversation with our family, friends, the press, and even upper level executives, etc. You taught me to test to see if what you are doing matters and is of interest to the everyday person seeking distraction and some entertainment, but not entirely brain dead, with some curiosity left about life and what others think

7. Nobody really understands their Ph.D. thesis until several years after they are finished. You told me this, when you had an insight that I had not had, and I was working much closer to the details. I now take this to be an issue of perspective, and I come across it all the time when I am working with my students. I don't think I understood it at the time you told me, but I trusted it, and I started to see this with my own students, with people I met at conferences and talked to, and with people who came to interview at Georgia Tech. I've repeated it many times. Other faculty now repeat it back to me when some student doesn't realize the implications of what they are proposing.

8. Because there are so many things you could be working on at any time (especially while working on Ph.D. research and thesis), do the one you are most excited about at that time. Don't force yourself to do something you think you should do if there are other things on the list that you need to do that you are more excited about.

9. You once told me to imagine that my mother was my audience - if I could explain it to my mother, I could explain it to anyone. Incredibly, this seems to work for every audience out there. So I've passed that tip along to my students and it seems to work for them too.

10. I remember that you used to tell us we need to be excited to get up and go to work in the morning, that that was the most important thing. For some people, it's because of the people you will be with. For some, it is because of the passion about whatever it is. But, in general, I still give people that advice (and it is advice I've also been giving my own kids). You have to love what you are doing.

This is a sample but it reflects what these former students, now all in their forties and fifties, remember about what I taught them. Hadn't

they learned any facts from me? Didn't I teach them some real stuff? Some said in passing that they had learned the actual content of the subjects I taught as well, but that that wasn't as important to them as the things they chose to write about. Why not?

I think that there are two answers to this question and those answers are what this book is really about. My father offered these same answers to me, not explicitly by any means, when I thought about the good and bad of having him as my teacher. When he tried to teach me facts, I learned nothing much. When he engaged my mind, I learned a lot. As a professor I never forgot this lesson. I rarely tried to teach facts, upsetting many a student along the way. I just argued with them, or encouraged them. I never told them much, except maybe some good stories.

So here are the answers:

The first is that

Teaching isn't what outsiders to the profession think it is.

The profession I am referring to here is of course: the teaching profession.

The second is that

Learning isn't what outsiders to the profession think it is.

In this case, the profession I am referring to is not teaching at all.

Let's start with teaching.

A professor friend of mine once asked her class what they thought a professor's biggest fear while teaching a class was. They all agreed it was *not knowing the answer to a question a student might ask*. When she told this story to a group of professors, they all laughed out loud.

Why am I telling this story? Because a student's view of teaching varies greatly from teacher's view. No teacher worries about not knowing the right answer to something a student will ask. You can always fake it (say – *What do you think?* or *Class, can you help here?*) if you think it is important, but answers don't matter very much. Teachers are not supposed to be encyclopedias. They are supposed to be something else. The question is: what?

My student's responses above give a hint. Teachers are supposed to be people who help students find their interests in life, think about how to make decisions, understand how to approach a problem, or otherwise live sensibly. Teachers are never shocked to be asked to provide personal or professional advice to a student having a problem - any problem. Teaching means being available to help if one takes one's job seriously. But then, this important advisory job is confused by lesson plans, and class hours, and lectures, none of which matter very much.

Why do I say that these things don't matter very much? This is the essence of what this book is about - the move from content-based instruction to cognitively-based learning, assisted by good teaching. This means we will have to define this "new" kind of learning (its not really *new* of course, just *new to schools*) and the "new" kind of teaching that is a natural consequence of using this *new learning method*.

Most teachers understand and appreciate that delivering the required material is not their real job, at least it is not the reason they signed on in the first place. The employers of teachers on the other hand, administrators, governments, department heads, and so on, expect certain material to be covered. Exciting students is not on their worry list. This is a big problem for teachers and for students and one that we will address here.

But my more serious concern is our conception of learning, not teaching. Teaching follows one's conception of learning so getting learning right is of prime importance. When I said earlier that outsiders to the learning profession wouldn't get the real point I was being ironic. There is no learning profession. Why not?

In 1989, I moved from Yale to Northwestern to establish a new institute, funded by Andersen Consulting, devoted to issues of changing training and education by the use of new technologies. I needed a name for the institute and came up with *The Institute for the Learning Sciences*. I made up the term “Learning Sciences.” There was no such field in academia. Most people thought I meant we were planning to work on how people learned science. The only academic fields that “studied” learning were Psychology, and Education. Psychology, being an experimental field, only allows faculty to work on experiments about learning that provide data in a controlled environment. Education faculty study how schools work and very rarely think about learning outside of the school context or in a way different from the paradigm already extant in schools. I wanted to create a learning profession. In 1989, there certainly didn’t seem to be one.

Today this is less true. Cognitive Science, a field I also had a big part in creating, has become more important in the academic world. Training, and e-learning, the first new field to come about as a result of our work at my new Institute (for better or for worse – I am not too fond of most e-learning work) has become more important to think about within the academic context, in part because on line courses are seen as potential revenue producers.

So, while there is still no learning profession *per se*, there is much interest in what learning is about. This book is meant to address the issue of what learning really is, in or out of school, and to answer the question: ***how does learning really work?*** The questions that follow from the answer to that question are:

1. What kinds of learning situations occur naturally?
2. How can we focus education (and training and e-learning) on those types of situations in a new paradigm?
3. What would teaching look like in this new paradigm?
4. If what we know about how learning works is antithetical to how school works, then what can we do?

Answering these questions is one goal of this book.

Another goal of this book to think seriously about what it means to teach. Typically, we look at teaching in precisely the way that our system forces us to look at it. There are subjects and there are experts and experts talk about their subjects to students who listen to what they have to say. This idea is not only archaic -- it is wrong. In the history of mankind teaching could never have looked this way.

Teaching always meant apprenticeship until recently. We are set up to be apprentices, to learn by doing with help from a mentor. We have done this since the beginning of time. When learning became academic in nature, when students were expected to become scholars, all this changed -- and it didn't change for the better. Teaching started to mean talking and talking is a terrible way to teach. People aren't really that good at listening after all. Small children don't listen to their parents. They may copy their parents. They can be corrected by their parents. They may be impeded from doing something by their parents. But listen? Not really. We listen in order to be entertained, not in order to learn.

This lack of understanding about what learning really is like, and what teaching must be like in order to be useful, has caused us to set up school in a way that really does not work very well. When students complain about school, when politicians say school isn't working, we understand that there is a problem. But we don't understand what the problem is. We think we can fix the schools by making them more friendly, or safer, or paying teachers better, or having students have more say, but none of this is the case.

The problem with the schools lies in our conception of the role of school. We see school as place to study academics, to become a scholar, when in, fact very few students actually want to become scholars or study academics.

As a society we have gotten caught up in a conception of school from the late 1800's that has failed to change in any significant way, despite the fact that universal education has made the system unstable. Universities dominate the discussion and everyone listens to what academics have to say because they don't see the alternative or know whom else to listen to. But, if we understand how learning

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Cognitive Processes

actually works, and how teaching actually should work, the alternative becomes much clearer.

It is establishing that clarity that is my goal in this book.

Chapter 1

Cognitive Processes-Based Education

Learning begins with a goal. When we think about education and school we often forget this. Someone, somewhere, decides that a student must learn about Napoleon but they fail to ask how such learning might conform to a goal that the student consciously holds. We don't forget this when we try to teach a child to walk or talk because we know that the child does want to learn to do these things. When we teach a child to hit a baseball we usually determine beforehand that the child wants to learn to do this. But, we forget this simple idea of goal-directed learning as soon as we design curricula for schools. Who cares if the child wants to learn long division? Make them learn it. Full speed ahead!

Somewhere along the way, students get lost. They may get lost in high school, or in college, or in job training. But somewhere they learn to shut off their natural learning instincts, the ones that drive them to improve because they really want to accomplish something. Instead they try hard to do what they were told to do -- they study, they pass tests, and eventually their love of learning is gone. The feedback that they have previously gotten from accomplishing a real goal, one that was truly held, has been replaced by pleasing the teacher, or getting a good grade.

Designers of courses must contend with this truth:

The students that you have may not want to learn what it is that you want to teach.

What to do?

First, we must establish if they *can* learn what you want to teach. I always wanted to teach my daughter to throw a ball properly. She threw a football astonishingly well at the age of six. But, she never got it about how to throw a softball. I don't know why. She just couldn't learn to do it right. She can't do math either. Believe me, I tried.

Second we must determine whether what you want to teach can be taught. Not everything can be taught. It is hard to learn to be a nice guy if you are inclined to be nasty. You can learn to be nicer, or at least to fake it, perhaps, but certain things are hard to learn after a certain age. You can teach a two year old to be nice; a twenty two year old is another story.

Third, we must figure out what method of learning would actually teach what we want to teach. This is an important question that is made more important, in part, by the fact that the learning methods available in the schools tend to be of a certain type. The things that the schools desire to teach are of a type that conforms with the available methodologies for teaching. Content that lies outside the range of the currently available methodologies is typically not considered as something worth teaching.

Fourth, we must decide if a selected learning methodology will actually work, given the time constraints and abilities of the students, and other constraints that actually exist. This is, of course, the real problem in education. It is easy to say, that students would learn better if they had real experiences to draw upon. This isn't that hard to figure out. What is hard is implementing this idea within the time constraints of the school day and the other demands of the school year.

Fifth, we must determine a way that will make what you want to teach fit more closely with goals that your students may actually have. Why is it that teachers, or more accurately school systems and governments, want to teach things that are not in accord with a student's real interest? What is the real cause of this problem? Are the people who run schools simply out of touch with students or is something else more complex going on?

I will summarize these five issues as follows:

ABILITY
POSSIBILITY
METHODOLOGY
CONSTRAINTS
GOAL ALIGNMENT

School is subject-based. Without giving a history of how this state of affairs came to be¹, or why it is an issue, it is first necessary to note that it is the case. I say this because when we were students in school we accepted the fact that school is the way it is, and we assume that it was the way it was supposed to be. We may not think each subject we learn is valuable or interesting and perhaps we long to learn different subjects, but never do we hear people suggest that there shouldn't be subjects in school at all. This is a very difficult idea to swallow. There have always been subjects.

¹ It all stems from a meeting of the *Committee of Ten* chaired by the President of Harvard in 1892

What else would there be? What would it mean to not have subjects?

Answering this question is the key to understanding what goes on in schools and what would be preferable. The issue is not the schools at all really, but how learning actually takes place in the human mind.

Ask a student how they are doing in school and they will tell you the subjects they like. *I like English but I am bad at math*, they might say. This is such a normal sentiment among students that we never think about how weird a sentiment it really is. *How are you doing at life?* we could ask a teenager and they could say: *I am good at dating but bad at driving*.

But, actually, you would never hear them say something like that. This too is weird because, in general, dating and driving are much more important subjects in a teenager's world than English and math. But they don't talk about whether they are good at it or bad at it.

They continue to practice and get better at these things because they care about them. Saying *I am bad at math* means in essence *I don't care and have stopped trying because I don't see the point*. Saying *I am good at English*, typically mean *I am getting a good grade in English*. This state of affairs defines the main problem in education:

There are subjects that are school subjects and there are subjects that are life subjects and teenagers can tell the difference. They work harder at the life subjects.

And, what is the difference between these two different kinds of subjects? Goals. It is as simple as that.

Instead of simply saying what is wrong with schools and what teenagers are really like in school, I want to take a different tack.

Some teenagers wake up in the morning wanting to learn history

or algebra but they are a very small minority of the school population. There is no minority however, when it comes to dating or driving for teenagers. They all want to do these things. So the question I want to ask is:

Are there other things that all teenagers want to do and are those things connected in some way with learning?

Or, to put this another way, if school had been designed around something other than *subjects* what would it have been designed around? Driving and dating, which we know are winners in a teenager's world can be seen as *subjects*, or they could be seen as instance of something else, and that something else might be something important to learn.

Students everywhere might want to learn whatever that is and they would work hard to learn. If we can turn the question around in that way, maybe we can design better learning situations for everybody.

So, the question is:

What are driving and dating instances of, with respect to learning?

Or, to address this from the Cognitive Science point of view:

What is it that students are doing when they learn to drive and date that they might be getting better at while doing those things?

Can we view whatever it is they are *getting better at* as an example of the kinds of things we want to teach and students would want to learn? Answering these questions will allow us to look at education in a new way. We need to think about how people actually learn, regardless of the subject, in order to address them.

Let's think about dating then. I was never any good at it as a kid. I know how the non-cool guys feel. But, later on, much later on, I

got very good at it. So, I must have learned something. What?

What was I bad at as a kid? Meeting girls for one thing. Other kids could do it easily. I always needed to be fixed up.

Talking to girls for another. I hardly knew any girls. I went to an all boys high school. I was sixteen when I went to college and the other freshmen were eighteen, so that didn't help either. In other words I had no confidence.

But mostly, I had no idea what to say to a girl. What did they talk about?

And, one more thing. I really didn't get the point. I didn't know why one wanted to go out with girls anyway. I mean I eventually got the idea, at least I think I did.

Why am I saying it this way? I am trying to get an insight into the learning process and I am a fine example. I didn't know how to do it and then I did. I didn't get the point and then I did, sort of. So I must have learned something between the ages of sixteen and sixty. What?

Here are some things I learned:

Human relationships are important, but they aren't easy to establish or maintain. They require work.

The work involves, among other things, learning how to listen and respond to the needs of another human being. It involves subjugating one's own interests from time to time for the interests of another.

Girls, and later women, feel good. Being with someone who loves you feels good. Learning to love feels good. More than feeling good, these things are critical for staying alive. This is not so obvious when you are surrounded by love from your family. But eventually you are alone, and alone is not so much fun.

As this is not a chapter on love so I will stop there. Suffice it to say that I learned how to meet girls, how to gain their interest, and how

to form relationships with them. I also learned why I wanted to do that.

Now let's see what we have learned about learning from my little diversion into teenage angst.

We have learned that learning about how other people behave is very important.

We have learned that learning about one's own emotions and feelings is very important.

We have learned that building confidence is very important.

We have learned that learning to listen is very important.

We also learned that learning how to express oneself is very important.

Now let's go back to discussing learning.

Why is it that teenagers are more interested in thinking about dating than they are in thinking about algebra? Why is that they don't rate themselves on their success in dating as in the same way as they do when they are discussing how they are doing in science?

What do teenagers know about learning that their school doesn't know?

This is it:

Teenagers know that the issues I have mentioned above will be important for them for the rest of their lives in a large variety of arenas, not just dating.

No matter what they do in life they will need to form relationships, assess their own abilities, gain confidence through practice, need to learn to listen, need to learn to love, need to try things out and see how well they work, and need to learn why they do what they do. To put this another way:

Dating is way more important than algebra and every teenager knows it.

Dating is much more important not because teenagers have raging hormones and they must have sex as this phenomenon is often described. It is important because what they learn while dating serves them in a multitude of areas in life and relates strongly to who they will be and how well their lives will go.

Algebra relates to none of this and they know that too. So, let me ask a simple question:

If we must have subjects in school, why wouldn't dating be rated as way more important than mathematics?

The answer to this is simple enough. School was not designed to help kids live better lives. That was never the point. But shouldn't it be?²

From a cognitive growth point of view. School wasn't even designed to teach us things that relate to learning *per se*.

Scholars designed the subject matter of the current school system. You hear sportscasters describe football players as scholar-athletes. Really? Scholars? Why would that be what we are seeking to create? There are only so many places for scholars and while scholarship is very nice it ought not be the goal we seek in school in a system of universal education.

Yes, but dating? Is that the subject I am proposing? Really?

Let me explain the real issue here. Take a look at the items I mentioned above.

We have learned that learning about how other people behave is very important.

We have learned that learning about one's own emotions

² John Adams, the 2nd President of the U.S., said that School should teach us how to live and teach us how to make a living. No subsequent U.S. President has ever understood this point however.

and feelings is very important.

We have learned that building confidence is very important.

We have learned that learning to listen is very important.

We also learned that learning how to express oneself is very important.

Now, I will transform these slightly:

Students need to learn about how other people behave and why, and they need to learn how to interact with different kinds of people.

Students need to learn about their own emotions and feelings and how to deal with them.

Students need to learn how to rely on themselves and feel confident in their own abilities.

Students need to learn how to listen to others and really hear what they are saying.

Students need to learn how to express themselves effectively.

Now this list doesn't seem so crazy does it? In fact, most parents will tell you that they try very hard to teach all these things to their children. So one argument might be that the school doesn't have to do it since parents do it.

Another argument might be that if the schools worked on these issues they would have students memorize the twelve principles for building self confidence and learn to express themselves by analyzing classics in world literature.

Here is the key point.

These issues, the ones that I said that could be learned from dating, transcend all aspects of our lives.

And, more importantly, students know this. I started with the idea that learning starts with a goal. The points I listed above are goals that teenagers actually have. They would not have to be talked into them. Moreover they are, as all students imagine anyway, way more important than algebra. They aren't interested in becoming scholars.

Now let's consider the cognitive science behind this. Everything we do as human beings is goal-directed. We go for a walk for a reason, we shower for a reason, we get a job for a reason, we talk to people we meet for a reason. We pursue goals as soon as we are born. We try hard to learn to walk, talk, get along with our family, get our needs satisfied, and find out what we like and what we don't like. We do this from birth. If school related to the goals that children actually have, that they were working on at the very moment that they enter school, school would seem like a natural and helpful experience. Students wouldn't stress about satisfying their teachers any more than they stress about satisfying their parents when they are learning to walk and talk. Yes, they want to please their parents, but that is not exactly the same thing.

People know what their goals are and they know when something they are being offered, a parasailing lesson or a pomegranate, for example, doesn't fit with their goals. They can be convinced to try out a new activity that they believe will not satisfy any of their goals, but for the most part, it is difficult to convince them that weird things that were not on their goal list actually should be on the list. We say things to students like *you will need this later*. But this is usually a bold faced lie. You don't need algebra later. Making up nonsense convinces nobody.

There is a more important issue here. Later on in this book I will detail the sixteen kinds of learning that make up what it means to learn. If you get good at learning these things, you get good at what life has to offer. The list above is part of the Conscious Process group of learning tasks that I detail in Chapter 4. It is really quite important. I have used dating as a simple way of explaining it because no one has to explain why that matters to a teenager. They know that they have to learn the processes that I

discuss in Chapter 4. As things are now, these important issues are not considered significant enough to deal with seriously in school. World History is always considered more important. But why should that be the choice?

Earlier, I mentioned that students want to learn how to drive as well as how to date. This is a pretty universal goal that teenagers have so we should ask of it as well, if it is important and what it might be an instance of that is inherently significant in real life.

On the surface driving seems a skill that is an important part of daily life. So, one is led to ask why driving isn't a school subject? The answer is that it is. Driver's education has been taught in the schools for many years. Not every school offers it, but many do. So what is the problem? It is a skill not a scholarly subject, so surely I am not suggesting that it is more important than Physics. That is, of course, exactly what I am suggesting.

In our test-driven society, when Driver's Ed is taught it is taught with a clear goal and a clear notion of success. When a student has passed the tests and gotten their driver's license, everyone is satisfied.

Well, not everyone. I was once called in on a consulting assignment for a university hospital that was working on a study to prevent teenage car accidents. The study was funded by an insurance company that would have been happy to pay less out in damages and, presumably, also thought less dead kids would be a generally good thing. What is the problem?

Students may have their licenses but they don't know much about driving and responsibility. It shouldn't be a shock anyone to know that kids drink and drive, text message and drive, and generally yell and scream and goof around while driving. They often die from this behavior. Could we teach them not to do that? The answer always seems to be to put up posters that say *don't drink and drive* and to make them watch scary movies about car accidents. The school system strikes again.

If we tell them then they will do it never seems to work, but we

keep trying.

I have often used the Motor Vehicle Bureau (the DMV) as an example of the best there is in testing. They have two tests. Dumb multiple choice questions that make no sense and a real test that tests to see if you can drive. The schools don't typically have the real test at all, one that test if you can actually do something, so the DMV is a least smarter than the school system.

But the real issue is something else entirely. Driving is an instance of a piece of very complex behavior that exemplifies one of the ways in which we learn. Perhaps more importantly, driving entails a great deal of other things, which could be learned and should be learned.

A simple example of this is car mechanics. Once upon a time schools taught kids to fix cars as well as to drive them. Perhaps they still do. But vocational subjects like that have been relegated to the back burner of education so that more testable subjects can be taught. And, also cars have gotten more difficult to fix. This is too bad, because if car mechanics were required instead of physics, students might actually learn science.

What do I mean by this?

When we hear an outcry about the nation's need to make children learn science no one ever asks *why*. The standard answer, if this ever asked, is that *Science is important in tomorrow's world* or some such nonsense. Push harder and you might get some remarks about soon all the scientists will be Indians and Chinese which may be the real fear of those who push science in the U.S. To address this question properly one has to ask what exactly is meant by "science."

Imagine that you are a student working on fixing a car in a car mechanics class. As I write this I am imagining a scene from the musical *Grease*, which was set in the 1950's when there were actually cars to work on in school. I never got to work on a car because I went to a *science* high school where such a thing

would be looked down upon. So when I graduated from high school and drove to college and my car broke down I hadn't the slightest idea what to do. I wish I could tell you that at least I understood the physics of the engine but I didn't. I just knew $F=MA$ and other stuff that wasn't going to help me fix my engine.

Now let me ask you, how is fixing one's car engine like fixing one's air conditioning or plumbing? The answer to this question has embodied within it what it means to *do science*. When science means learning facts about science we are talking about useless information that is readily forgotten after the test. I have no idea why anyone learns to balance chemical equations or apply physics formulas or learns about biology classifications in high school. None of is of any use to most adults. (It *is* easy to test however.)

When the stuff that is being taught does not relate to the inherent goals of the students it will be forgotten. You can count on it. Why this stuff is taught is simply that it derives from a conception of science prevalent in the 1890's that has not been since modified. It is defended by people as a way to produce more scientists, which makes no sense since it probably deters more students from entering science than it encourages.

Scientific reasoning, on the other hand is worth teaching.

Why?

Because car mechanics, plumbers, doctors, and crime investigators, to name four random professions, all do scientific reasoning on a daily basis. As a society we only anoint doctors with the glory of doing actual scientific reasoning. The other professions get less glamorous interpretations. But they are all doing the same stuff. This is what they are doing:

They are taking a look at evidence and trying to determine the probable causes of the conditions that they have found.

To do this one must know what causes what in the real world, which is science, what counts as evidence of known conditions,

which is science, and previous cases that are similar which any good scientist must know. So while we may not see a plumber as doing scientific reasoning, that is exactly what he is doing.

Science is about creating hypotheses and gathering evidence to support or refute those hypotheses. Children are natural scientists. They often try stuff out - skipping rocks on the water or dropping stones from the roof or lighting things on fire - to see what happens. But, there is more to science than trying stuff out. One must seek explanations and make sure those explanations are correct. Knowing what constitutes a correct explanation is really the essence of what scientific knowledge is about. But notice that there are correct explanations for hypotheses in plumbing as well as in medicine and that these explanations exist for repairing a faulty engine and for understanding who committed a crime. It is all scientific reasoning.

The difference between plumbing and medicine is in the complexity of the science. Not a lot of invention goes on in plumbing and there aren't all that many explanations to choose from. The degree of difficulty in understanding what is going on and why is what separates those fields and makes one science and one not. But, the basic thought processes are the same.

This is important to notice because all these areas of inquiry are what might call diagnostic.

So, and this is the important part, the real issue from a cognitive science point of view is not in teaching science *per se*, but in teaching *scientific activities*, one of which is *diagnosis*. And, since diagnosis is a similar process no matter what you are diagnosing, it makes sense that all through school, diagnosis would be a subject, and not physics or literature. The things that children are asked to diagnose might start with things little kids like, like finding out what is wrong with their pets or their toys and then moving on to things bigger kids like, like cars and crime, and then moving on to large issues like why a business has failed or why our foreign policy doesn't work.

Diagnosis matters a great deal in our lives, yet it is not a subject in

school. This is not surprising because the origins of the school subjects areas, as I have said, are scholarly. But if we want to teach children to do things that matter, and we want to retain their interest because they know intrinsically that these things do matter, then we must be having them practice diagnosis all through their school lives, in a variety of venues that correlate with their interests. They don't all have to be diagnosing the same stuff. It is the diagnostic process itself that matters, not what is diagnosed.

I have been using the word *subject* for an idea like *diagnosis* but it is not a subject and should not be seen that way. I was only using the word to contrast it to existing *subjects* in school. Diagnosis is a fundamental cognitive activity. Cavemen did diagnosis. They may not have done it well, but they did it well enough to continue the species. The diagnostic process is as old as people. Knowing why, being able to prove a hypothesis, is a fundamental cognitive process.

School needs to be organized around fundamental cognitive activities. It would be easy to demean what I have said here by saying *he wants to teach kids to date and drive better*. What kind of school is that?

But this trivializes the point. I do want to teach students to date and drive better. But, these are just a few instantiations of general cognitive processes. Forming human relationships and figuring out what is going in the physical world are two of many very important cognitive abilities that manifest themselves in myriad ways in real life.

A properly designed school system needs to focus on cognitive abilities not scholarly subjects. Kids will recognize instantly that these activities are the ones they know that they need to get better at. If we allow them to choose what areas of knowledge they would like to focus on while learning these skills, they will be attentive and interested students.

A society that organizes schools around cognitive abilities would become one where people were used to thinking about what they

do and how and why they do it. They would not find school stressful.

This wouldn't be a bad thing.

Chapter 2

Teaching Kids to Walk and Talk

Teaching is a serious issue. Teachers matter. Or at least they should matter. But, we have the sense that it is the job of the teacher to tell us stuff. Students expect it and teachers do it. Often, teachers get criticized if they do anything else. And, this is pretty much the beginning and the end of the problem with teaching. We force teachers to teach wrong.

I am beyond the age where I have little kids that I have to teach how to walk and talk. But when I did, I don't remember preparing any lesson plans. In a cognitive process-based model of education, all teaching looks like the teaching you do when you teach your children to walk and talk.

Lately I have been personally interested in being taught. Thus is because at the age of 55 I started to play softball in an old guy's softball league in Florida. I discovered I wasn't really very good. This was a bit surprising since I had played in the University softball leagues while I was a professor and had only stopped playing in my forties. I wasn't a bad player then. There hadn't been that long a hiatus. And, I was playing against people a good deal older than myself since I am rather young as recent Florida transplants go. I used to be a good hitter and I wasn't now. The reason was easy enough to understand. In the university leagues they play **fast pitch**. A batter has a second or so to decide about swinging. It is all instinct. At least it was after having played for forty some odd years.

But, in Florida, old guys play **slow pitch**. The pitcher throws the ball in a high looping arc and it is a strike if it lands on the plate. Quite a different experience from trying to hit a ball that is zinging by your head. Should be easier, no? Not for me. It took a bit of thinking to figure out why.

I analyzed how I was swinging, when I was swinging, what kinds of pitches I was swinging at, and I came to many different conclusions. I realized I needed to wait longer before I swung. I realized I had to stop swinging at inside pitches (the ones that almost hit you.) I realized that I had to stop swinging at pitches that looked good but yet dropped in front of my feet. I realized I had to see the bat hit the "sweet spot" on the bat. I realized I needed to change my whole approach to hitting, in fact.

OK. I realized a lot. I had come to many conclusions. Now what? Just do it, right? Aha. Not so simple.

You can't just do what you know you should do. Why not? Because your unconscious isn't listening to what you have to say. This is why you don't tell a little kid how to walk and talk. Apart from the fact that he wouldn't understand you anyway, even if he could understand you, the part of his mind that would be doing the understanding is the conscious part. Cognitive process-based teaching teaches non-conscious processes a good deal of the time.

A child learns a lot more from falling down than he ever will learn from hearing Mom say *watch your step*.

We are wired to learn from failure. Those who don't learn from failure typically die young. We are descended from people who learned to not eat certain poisonous plants, and not to travel in a way that would expose themselves to danger, and to stay near their mates, and to protect their offspring. Those who didn't do these things, those who didn't learn from their own failures and from the failure of others, didn't get to have surviving offspring. The human race exists precisely because it is capable of learning from failure both individually and collectively.

Did you ever wonder why what you learned in school isn't still in your head, or why you can't remember what your wife wanted you to get from the store on your way home? Or, why the things you have decided to do to improve your business or make more money or be a better person don't actually ever get executed? The answer is simple: you can't learn by listening – not from teachers, not from your wife, not from helpful suggestions from wise people, and not even from yourself.

Why not? Because it is your unconscious that is in charge of executing daily activities -- from swinging a bat to driving home to talking to people you want to make an impression on, to getting along with your wife. Your conscious can make decisions, but your unconscious pretty well does what it is in the habit of doing. The unconscious is a habit-driven processor.

Bad habits, as they say, are hard to break. Actually, all habits, good or bad, are hard to break. A new swing is really hard to develop, as is a new way of selling, or a new way of treating people, or driving a new route home.

This is the real use of education: the creation of new habits. This can only be done in one way. The unconscious only learns in one way.

The unconscious learns by repeated practice.

The only teaching that can work then, is the kind of mentoring that helps someone execute better while they are practicing.

How is a high school football coach different from a high school history teacher?

Before we attempt to answer this question we need to consider why it is an important question to consider. In general, I think most people would agree that the behavior of these two types of teachers is likely to be quite different. In our mind's eye, we see images of yelling and crude behavior versus refined lecture and discussion. But, let's get beyond the superficial stereotypes and think about what they teach rather than their style of teaching it.

The history teacher at his worst, teaches facts, and at his best, teaches careful analysis of sources of facts.

The football coach at his worst, teaches that someone could never possibly do something and, at his best, coaches someone to do something better.

The history teacher teaches the conscious. The football coach teaches the unconscious.

This makes sense if we view education (in school) as a conscious affair. It certainly seems to be a conscious affair. We discuss history we don't do history. And, it makes sense in football since the coach doesn't need players who can discuss football -- he needs players who can execute.

It begins to make less sense when we consider how the conscious and the unconscious interact.

As long as we see ourselves as rational beings who can think logically and make carefully reasoned decisions about our daily lives, then education indeed should be about the promotion of reasoned deliberation and the gaining of knowledge that will enhance our ability to reason. But, suppose this conception we have of ourselves and our ability to reason logically is simply

wrong?

All of our education system depends on this debate. Actually the word “debate” is really not right here as there is no debate. The other side, the side that says we need to teach our unconscious because our conscious isn’t capable of listening, has not really been expressed directly very often. It is, however indirectly referred to often enough.

Plato comments:

The most important part of education is right training in the nursery. The soul of the child in his play should be guided to the love of that sort of excellence in which when he grows up to manhood he will have to be perfected.

Why should this be the case? Why should it be the nursery where real training takes place? And what kind of training could the nursery provide -- the kind of the football coach or the kind of the history teacher? And, what can we learn about education by considering seriously what Plato said?

The principles of learning in childhood are rather simple really. The first and most important part of an analysis of early childhood learning is understanding where the motivation comes from. If learning starts with a goal as we have said, one question is what goals do children have and how do they happen to have them?

When people mention motivation, the word *reward* is often added into the discussion. What kinds of rewards do children receive and to what extent are these involved in learning? Bear in mind that there are three kinds of rewards, *intrinsic*, *extrinsic*, and *systemic*. If it makes me happy I need don’t need you to tell me I did well. If the activity doesn’t really matter to me (an algebra test for example), I will need some outside reward to even try. When do kids learn because of the use of external rewards? If I do well on an algebra test it might be that it gives me intrinsic happiness to know I did well at algebra. As a math-oriented kid, I did get that kind of reward. It also makes you happy when your parents are proud of you. And it makes you happy when your grades win you admission into Yale or get you something else you might want.

Which types of rewards figure into early childhood learning and what can we learn from this about learning? And, what will this tell us about teaching?

Let's start with walking and talking.

Walking and talking are intrinsically rewarding. No kid needs encouragement to do either. They do have to be discouraged from crying when a word will serve them better. *I want milk* works better than *wah*. But they learn this quite naturally without very much parental help. They learn to walk when their parents hold their hands and cheer when they succeed, but they would have learned to walk anyway.

The parent's role as the teacher of their children can be seen very clearly when we consider walking and talking. Kids can learn to do either without much help, but they do these things quicker and better with parental help. Children who are spoken to by their parents, and listened to and corrected when they make an error, learn to speak well and more clearly as adults. While everyone learns to walk, parental care prevents falls when steps and other hazards present themselves.

So, is the parent teaching the child? What does the parent actually know about how to teach walking and talking? Actually the parent knows quite a bit about teaching. We are wired to teach our children and help them. All higher level animals do this as well. It is not a particularly conscious process.

So, at what point are children better taught by professional teachers instead of their parents? This is an important and interesting question.

A professional teacher is better than a parent if and only if the teacher knows more about what is being taught than the parent does. Teachers may take education courses and that may seem to qualify them to teach, but really those courses are not so much about the art of teaching *per se*. Teachers learn to teach by teaching, like anyone else learns how to do anything. But, teachers learn to teach in the system they find themselves in, This

means that typically they learn how to manage classrooms and deal with administrators and handle various issues that are very specific to school.

Teaching outside of school does not usually entail managing multiple children nor should it entail dealing with state standards and other governmental interference (although that often happens anyway.)

So, knowledge is the real issue in teaching, not teaching skill. Or so it would seem.

Actually this idea is clearly wrong if one thinks about university teaching. Professors become professors by writing a PhD thesis, not by learning anything about teaching. They may have some teaching experience prior to becoming professors because they may have taught an introductory course or two as graduate students, but nobody teaches them how to teach. In fact, professors are not qualified to teach since they know nothing about teaching. They are hired by universities because of their research credentials and teaching doesn't matter much. There is some lip service about the subject but no one ever got hired at Yale as a professor because he was a great teacher who did no research.

I certainly knew nothing about teaching when I became a professor at Stanford many years ago. But I hated seeing students bored and miserable and started to think about what the problem was and how I could fix it. Many professors do exactly this. They want to be good at something they do regularly and their pride makes them into good teachers. Not all professors do this by any means. What does it mean to become a good teacher in that context?

Professors are rated for their teaching ability. It is clear if one looks at those ratings what the criteria are from the student's perspective. They rate the *friendliness*, *fairness*, *enthusiasm*, and even the *hotness* of their teachers. These ratings have been studied extensively and conclusions like this one are typical:

While student evaluations of faculty performance are a valid measure of student satisfaction with instruction, they are not by themselves a valid measure of teaching effectiveness. If student evaluations of faculty are included in the evaluation process of faculty members, then they should represent only one of many measures that are used.¹

Professors and universities are very concerned about the evaluations of the teaching of the faculty and these days web sites (like *ratemyprofessors.com*) make a very public show of how badly received some professors are. The professors are concerned with how they appear and whether they are liked and how all this might affect their salaries. They are not concerned with teaching effectiveness because, in a sense, that is meaningless criterion. The real question is why teaching effectiveness is a meaningless criterion.

When a child learns to walk you cannot say you were very good at teaching him to walk. He would have learned to walk without your help most likely. When you teach a child to play baseball you can more easily say that you were a good teacher, but really who knows you didn't screw him up with nonsense that it may take him years to undo? I was taught to step into the pitch in baseball and years later that learned that what I was taught was wrong.

College professors can only be evaluated on effectiveness if someone knows what that means. Does it mean how well students do on exams? We can make easier exams then. Does it mean how many of them get into PhD programs at Harvard or how many get good jobs at graduation? That likely has nothing to do with the effectiveness of the professors.

There are no measures that make sense for a very simple reason. College teaching doesn't make much sense in the first place. Lecturing and giving grades is certainly not a paradigm that any

¹ John V. Adams Student Evaluations: The Ratings Game *Inquiry*, Volume 1, Number 2, Fall 1997, 10-16

parent would use. You don't grade your child on speaking ability, you help him speak better. If it takes longer to do that then it does. Even the Motor Vehicle Bureau doesn't care about effective teaching. It doesn't give grades, just licenses. *Can you do it well* is the question they are charged with answering. But *can you do it well* isn't a meaningful question in the top universities because there is typically nothing, other than research, that anyone is really being taught to do.

This leaves us in a quandary when it comes to understanding what it means to teach well. If we are teaching something where there are no performance measures then effectiveness cannot be gauged. If the performance measurement is based on an exam, this likely would not reflect on the teacher's ability at all. Some students do well on exams and others don't, even though they all hear exactly the same lectures. And when there are performance measures, it is not always clear that it was the teacher who was in any way responsible for the success of the student (or their failure.)

So what is effective teaching?

If a teacher is better at teaching a child than a parent is, it must be because the teacher knows something the parent doesn't know or at least, doesn't know how to teach. This makes the teacher more effective than the parent but for very uninteresting reasons. You can't teach what you don't know of course.

But knowledge alone is meaningless because teaching is not about the transfer of knowledge. I realize that a great many people think that this is what teaching is about; except if that were the issue, students who wouldn't even think about rating their teachers on anything except how much do they know. And, by the way, that is about the last thing teachers are ever rated on.

Teachers are rated by students on how entertaining they are for the most part. But entertainment and teaching are really not particularly related. They are not unrelated because you can't get through to someone who has tuned you out. But you can entertain your students and get great ratings and still teach them nothing.

So, again what exactly is effective teaching? Let's look at two of the longer versions of what my former PhD students and former employees wrote to me when I asked about good teaching. These stories each need some context in order to be understood, and then I will comment:

The first story is from a PhD student of mine who then continued to work with me for 30 more years:

You were collecting key things teachers needed to know to do story curricula properly. Your contribution was "know when to lie to students." That triggered all kinds of discussion, pro and con, leading eventually to a longer more explicit statement about knowing when to oversimplify, etc.

Reflecting on it later, I realized that "know when to lie to students" was the right way to say it. The rephrased version was too reasonable. It didn't trigger any emotional reaction and reevaluation. "Know when to lie" is a lie, but that's the point.

Why is this story important? I placed it here because it reflects an important belief that I hold about teaching. At the moment to which he is referring, we were writing, as a group, a set of guidelines on how to teach Socratically using the on line curricula we were building for high schools. We were, in essence, writing an instruction manual for teachers on how to teach in a new way. When I supervise very smart people who know perfectly well how to do things I deliberately provoke them. I believe that my job is to make them think. There is no better way to make someone think than by annoying them in a way that makes them defend their point of view, especially when their point of view may not have been well thought out.

It is important, when teaching Socratically, which is my preferred methodology, to make students question their beliefs. No one is a better teacher than a teacher who makes students wonder if he has been wrong about something.

Do I think that teachers should lie to students?

I think teachers should make students think harder than they might have been capable of doing without them. I also think that teachers should not tell answers to students. Students do not learn from memorizing answers. They learn from developing questions for themselves that they then can begin to find answers to.

I believe that effective teaching makes....

students develop questions for which they then will seek answers

students look for answers from people other than the teacher

students confused and less certain than they were before

Now, I realize that these are pretty non-standard ideas. That is, of course, the point.

This next writer worked for me (after getting his PhD elsewhere) in the academic world and later in the business world:

Probably the most important lesson I learned from you was the value of overstatement and oversimplification in communicating ideas and getting people's attention. I recently retired and was roasted at my retirement party by a group of longtime employees and there were some interesting anecdotes about what I'd taught them about selling their ideas through management. Software engineers are often uncomfortable making a point without giving every possible nuance, caveat, and detail. This typically causes management's eyes to gloss over and their ideas never get a fair hearing. So, I've (apparently relentlessly) encouraged employees to make their points quickly and to use overstatement and oversimplification as rhetorical devices. I'm still wincing over the roasts that portrayed my predilection for interrupting presenters and asking "What's your point?" – I learned that one from you.

I most certainly taught the lessons this writer describes. I hated it

when students couldn't get to the point and frequently interrupted them when they were speaking. In business, I make a point of saying things that are very simple, which tends to upset people. I find this a good way to start a conversation that addresses complex issues.

Of course, I never actually say any of this. I simply do it. The real issue in teaching, by parents or by teachers or by anyone else, is the model you present to the students. That model is presented by what they see you do and how they see you act. They can choose to emulate you or not. But a good teacher makes students think about how to behave and about what works and what doesn't.

I believe that effective teaching makes....

students think about how the teacher is behaving and causes the student to wonder about whether copying this behavior would be a good idea

students think about what works and what doesn't in the adult world

This next writer is a professor at a major university. I hired him to be on the faculty at Yale, which was his first academic job.

I teach by telling stories that are meaningful to me. I let them see who I am and how I live. I let them see what is important to me and why. To be a real teacher you have to let yourself be vulnerable. The student needs to see that you are a human with feelings and fears and goals. You are saying to students: this is the way I do it; it fits with who I am; it helps me be successful; and don't let anyone tell you that you can't do something. Everyone wants to control you, but in the end, you have to be you, for better or worse. So, don't let anyone tell you that you can't do something.

I tell that story over and over and over again in different ways. About my research, about my company, about my family. I walk the talk.

And, the students have to see that there are consequences of breaking the rules; that it costs; and the costs can be high at times. But, that's part of the price of believing in yourself. Sometimes you get hurt and then you have to pick yourself up

and try it again.

This writer was writing about his teaching. I behave this way as well, and he knows it.

I believe that effective teaching makes....

students think about the stories the teacher tells

students believe that their teacher is not a phony, so they can take what is said seriously

students think about what it means to put oneself on the line for one's own beliefs

This writer worked for me as a writer for many years. Her main career was, and is, as a concert musician.

My high-school English teacher was a great teacher. He was married to the Singer sewing machine heiress but committed to teaching kids. He had us keep a writing journal, and was just excellent at helping me understand what was so personal to me that others wouldn't be able to connect (or perhaps just plain sappy romantic drive!!) and what was "strong" and pertinent to everyone. I still have the journal and wince at what I wrote but still really admire his comments in the margins.

In the future, in a world where on line learning begins to pre-empt classroom teaching, mentoring will replace lecturing. Many teachers know how to mentor but they are often not given the opportunity or don't take the time. The teacher she describes above was a personal writing mentor, which is about the only way you can teach someone to write.

I believe that effective teaching makes....

students look more carefully at the work that they themselves have produced

students believe that their teacher is their personal mentor

Here is the same woman, this time writing about how she learned music:

My mentor, Otto-Werner Mueller, was conducting the Yale Philharmonia in the 1970s -- I met him as an undergrad in Madison WI. I attended his graduate seminars in Madison, and spent a lot of time with him while he was in New Haven. He guest-conducted the Hartford Symphony (where I now work) twice in the past few years. (He is 83 now). I spent hours and hours in "lab orchestra" watching him teach his conducting students, both in Madison and at Yale. What always struck me was how students were either so self-conscious they were wooden, or how they'd try to imitate Otto (who at 6 feet 7 inches had amazing stature) physically and couldn't pull it off. Very few were able to incorporate what he was teaching and then make it their own.

I believe that effective teaching makes....

students look at what the teacher does and see how they can imitate it in a way that is consonant with whom they are

This writer was a PhD student of mine and is now a professor at a major university.

Trust your intuitions. This was something you told many of us over and over. It has had two meanings for me -- first, that the only right things to work on are those that I can imagine a solution to, second, that whether a way of attacking something is the right way or not, it will lead me to the right way, and third, go out on a limb. I can't say how I learned this except, perhaps, through trusting your advice and then noticing that it got me to success over and over again. It began to really sink in when I had my own students. Often, the most interesting things they brought to me were more intuitive than they were based on what everyone else was saying. And I have had to reassure people that their ideas are good and they should follow up on them. Of course, there are also intuitions that my students have that I don't think are good, and I don't advise them to follow up on those. So I think I now believe in trusting intuitions that someone I trust can also see value in, and for my students, trust

intuitions that someone they trust can also see value in.

I believe that effective teaching makes....

students trust their own intuitions

students trust their teacher's advice

The final two are a little different than the others. I included them because teaching is not always implicit, as the above stories indicate but sometimes explicit. The writer was student of mine who is now high up in a large corporation.

You taught me that you always start by collecting data -- so basic, but so often overlooked. I recall watching most of your papers start by collection of data. I recall watching your criticisms of work that was just abstraction on abstraction, with no data at its roots. For the work I'm currently doing, I have a log of all the types of entities (typically business or government enterprises), interactions (typically business models or sustainability models), and outcomes. I just gave five talks last week and used the method of "start by collecting data" when introducing my work and when being a critical thinker about the work of others that was being presented to me.

This point is about how to do real research does not apply to everyone. But a more general form of this advice is to start at the beginning, which is usually useful advice. Knowing where the beginning is can be complicated however.

I believe that effective teaching makes....

students understand how to begin a process

students understand what you tell if you constantly demonstrate the value of what you tell them

This writer was another of my PhD students who is now a professor at a major university.

You taught me about the important role of explicit social hierarchies in a learning environment. At Yale the hierarchy was very clear and everyone knew exactly where they stood. You pay your dues before you join the club and academia is chock full of clubs. You taught this by both example and explanation. Seeing a good clear example of a social hierarchy that works (such as the one we had in our lab at Yale) gave me one level of understanding, but I had to see what happens when the hierarchy is not so obvious to truly appreciate the importance of the whole concept. Any long-standing community will have a social hierarchy, but it's not always so obvious (especially when the community likes to pretend it doesn't exist), and that makes it really hard on newcomers. I've seen some really stellar junior faculty get into difficult tenure decisions because no one was guiding them politically (or else they just blew it off). And more recently I've been running into more and more students with "entitlement issues" who just don't seem to buy into any social hierarchies. There is a lot of social commentary on why this is happening and how the workplace needs to adjust to a whole generation of kids who always got trophies.

I believe that effective teaching makes....

students understand where they fit in the world in which they live

students understand how to get ahead in the world in which they live

students understand the roles of those around them

There is certainly a great deal more that one could say about effective teaching. Unfortunately, much has been written on effective teaching that is not particularly helpful. Mostly it is politically correct advice that is quite difficult to implement. Here are two lists that I found:

1: Interest and explanation²

2: Concern and respect for students and student learning

² Ramsden, P. (1992). Learning to Teach in Higher Education. New York: Routledge.

3: Appropriate assessment and feedback

4: Clear goals and intellectual challenge

5: Independence, control and active engagement

6: Learning from students

Principle 1: Good Practice Encourages Student-Faculty Contact³

Principle 2: Good Practice Encourages Cooperation Among Students

Principle 3: Good Practice Encourages Active Learning

Principle 4: Good Practice Gives Prompt Feedback

Principle 5: Good Practice Emphasizes Time on Task

Principle 6: Good Practice Communicates High Expectations

Principle 7: Good Practice Respects Diverse Talents and Ways of Learning

Whenever I see phrases like *diverse talents* and *ways of learning* and *active learning* or *active engagement* I am very distrustful of the advice being offered. *Active learning* should mean learning by doing, but it never does because learning by doing is very difficult to implement in the university context (which is where this advice comes from.) It is easier to do it in first grade, but after a while the class has to sit still and listen and that is not active learning no matter what the teaching guides say. *Different learning styles* is usually a way of saying, *some people are dumber than others*, which no one wants to say. What bothers me most about these

³ Chickering, A., & Gamson, Z. (1987). Seven principles of good practice in undergraduate education. *AAHE Bulletin*, 39, 3-7.

kinds of lists is that they avoid saying what really needs to be said. It is nearly impossible to measure your success as an effective teacher because the performance expectations of students are almost always about test scores and very rarely about actual production.

With this idea in mind, that effective teaching means helping students do what it is they wanted to do and not what it is that you wanted them to do, I will list the suggestions I have been scattering about this chapter. Bear in mind that this is not meant to be a complete list. I got this list the way you saw, by interpreting things written by students and former employees about their own experiences.

Effective teaching makes....

students develop questions for which they then will seek answers

students look for answers from people other than the teacher

students confused and less certain than they were before

students think about how the teacher is behaving and causes the student to wonder about whether copying this behavior would be a good idea

students think about what works and what doesn't in the adult world

students think about the stories the teacher tells

students believe that their teacher is not a phony, so they can take what is said seriously

students think about what it means to put oneself on the line for one's own beliefs

students look more carefully at the work that they themselves have produced

students believe that their teacher is their personal mentor

students look at what the teacher does and see how they can imitate it in a way that is consonant with whom they are

students trust their own intuitions

students trust their teacher's advice

students understand how to begin a process

students understand what you tell if you constantly demonstrate the value of what you tell them

students understand where they fit in the world in which they live

students understand how to get ahead in the world in which they live

students understand the roles of those around them

Now taking my own advice about starting with the data and then classifying it lets look at these rules as a group. What are they suggestions about exactly? Broadly speaking they fall into the following categories:

Helping students think:

students develop questions for which they then will seek answers

students look for answers from people other than the teacher

students confused and less certain than they were before

students think about the stories the teacher tells

Helping students observe and copy good behavior:

students think about how the teacher is behaving and causes the student to wonder about whether copying this behavior would be a good idea

students think about what works and what doesn't in the adult world

students look at what the teacher does and see how they can imitate it in a way that is consonant with whom they are

Making students respect their advisors:

students believe that their teacher is not a phony, so they can take what is said seriously

students believe that their teacher is their personal mentor

students trust their teacher's advice

students understand what you tell if you constantly demonstrate the value of what you tell them

Teaching students how and when to take action:

students think about what it means to put oneself on the line for one's own beliefs

students understand how to begin a process

Teaching students to be good critics of their own work:

students look more carefully at the work that they themselves have produced

students trust their own intuitions

Teaching students their place in the world and how to succeed in that world

students understand where they fit in the world in which they live

students understand how to get ahead in the world in which they live

students understand the roles of those around them

Effective teaching then, means teaching these things:

How to be a critic

Whom to respect and copy

How to know where you fit

How to take action

How to think

The relevant question for a teacher then is: *does your teaching*

result in students who can do the five things listed above? There are many ways to get those things to happen for students. These typically do not include however: lecturing, being entertaining, giving easy grades or easy tests, or marching students through boring exercises that teach them the truth.

Effective teaching is made much easier, of course, if what you are trying to teach is something worth learning. So, let's move on to discussing that.

Chapter 3

What Shouldn't You Teach?

When children are born they come with distinct personalities. Ask any mother of a second child. *It even behaved differently in the womb* they will say. One kid is aggressive while the other is contemplative. One kid is constantly talking while the other hardly says a word. One kid is shy while the other is aggressive.

Often, when we think about teaching and learning, we have the idea that if we want someone to do something, or know something, or behave in a certain way, all we have to do is teach it to them. So we teach kids to appreciate music, when they may have no interest in, or inclinations in, music at all, or to act in the class play, when they are simply bad at acting, or to throw a baseball when they simply can't do it and don't care. Often, but not always, we are forgiving of the

differences between people and their individual talents and we acknowledge that *he is tone deaf*, or *he will always throw like a girl* and we give up.

Small children are like sponges. They ask questions constantly and, if they have reasonable parents, get answers. The belief system that children adopt is usually quite similar to that of their parents. They don't decide to try out a different religion at age 5, they do what they have always known. They eat what they were fed and they like to go to places they have been taken. Parents influence every aspect of a child's belief system. Because of that, we have the sense that we can teach children anything, but this gets less true as they get older. The Jesuits have an expression about teaching a child before he is seven and thus producing the man he will become. There is some truth to this. If you really learn honesty when you are five, it is unlikely you will become a crook. Your subconscious wouldn't permit it.

Then, what is the role of the subconscious here? When a child is being taught at three it is not being taught consciously. It does not memorize rules for walking or talking and it does not learn anything very much by consciously trying to learn. Rather, a child absorbs by constantly practicing and then making that practice a part of who he is.

Later, when the subconscious attitudes about walking, talking, relating to others, family values, and all the rest, are well within the deep subconscious of the child we begin the attempt to teach the child consciously. We worry when we hear for example, that:¹

About a quarter of teens questioned in the broad survey weren't able to correctly identify Adolph Hitler as Germany's chancellor during World War II. About 20 percent couldn't say whom America fought in that war.

More than a quarter wrongly believed Columbus sailed to the New World after 1750. Half didn't know whom Sen. Joseph McCarthy investigated. And a third had no clue the Bill of Rights is the source of freedoms of religion and speech. Nearly a third couldn't tell you who said in a famous speech: "Ask not what your country can do for you..."

¹ From a column by Robert Jamieson Jr., Seattle PI.com, Feb. 27, 2008

Until a child enters school, he has been learning things that are useful to him. He knows where his toys are and how to play with them; he knows how to get food; he knows how to get his parents to do what he wants (perhaps); he knows how to entertain himself. In short, he has learned what he has learned because he has found his new abilities to be of value.

And the history cited above? Of what value is it to know about Joseph McCarthy? Not only is it of no value to a child, but what we know about McCarthy is slanted by whomever is writing the history and biased by whatever point they are trying to make. It is all very well to tell students the truth about what happened in the past and assume that they will learn from it, and therefore not repeat it, but we can't easily know the truth and they are not likely to learn much from the telling anyhow.

Pundits scream and yell about what children don't know. The question is: why do they need to know it? If the answer is that it makes the system happy that they know certain facts while not making the child in any way happier, we all can guess how well that is going to turn out.

The bottom line here is one of initial belief systems and fundamental personality characteristics coupled with the notion of truly held goals. You cannot teach someone something that:

1. does not help them achieve some goal they actually hold
2. is not in line with their fundamental personality characteristics
3. goes against their subconscious beliefs

You can try, but you won't succeed.

So the question of what you can't teach, which is very important when we think about teaching and learning, comes down to a question of whom the child has become because of what he learned prior to the age of seven, and what he was anyway when he exited the womb. Those two things are powerful enough even if you don't add in trying to teach something which in no way relates to any goal the child has.

This is even more true for adults of course. We can try to teach adults things that are at odds with who they are as people, but good luck with that.

Traits may come with the child, or they may have been learned by the child prior to the age of seven, but it really makes no difference when we are discussing teaching. Personality cannot be changed. Core beliefs are very hard to change. Interests are hard to change, although new ones can be found. Clinical psychologists try to make small changes in these aspects of people but they have a very difficult time doing it.

But, my point here is to address an issue in education and training that is not well understood. Simply stated it is this: **it is not possible to teach or train students to do things that are not in line with who they are as people.** This matters because much of what we try to teach in school and train for in companies is the attempt to alter behavior.

I have been building what have come to be called *e-learning systems* for about 25 years. Over the years, I have realized that there is nothing new under the sun in the subject matter that e-learning systems are asked to address. One of my least favorite subjects, one that comes up frequently, is: *Integrity and Compliance*. I have been asked to work on this subject quite often. Usually what is being asked is impossible. Most e-learning companies simply do what they are asked to do by the client without pointing out -- if they even know -- that what they are being asked to teach can't be taught. Companies that need to train their employees in such things, because of some regulation or other, ask for it, and e-learning companies willingly build it.

Unfortunately, as my mother would have attested to, were she still around, I was born with off the scale honesty. I can't build e-learning I know won't work any more than I was able to let my mother walk out of a store without paying (by mistake) without my becoming hysterical.

So, now I am hysterical about fraudulent education and fraudulent e-learning -- namely courses that claim to teach subjects that alter the

very nature of a person. Of course, such courses don't say that is what they are trying to do, but it is pretty much the basis of courses about safe driving or drugs or sexual behavior, how not to violate the law.

How is training about compliance an attempt to alter basic behavior?

Recently I was presented with an opportunity to teach Integrity and Compliance to the employees of a large company that bids on RFPs. The bidding process is part of a legal process and the company wants its employees to stay within the guidelines.

Fair enough. Makes sense.

Except, when you look at the guidelines they include an array of rules spelled out in a complex document, typically a signed legal contract for potential bidders. To know those rules, one would have to read the contract. The company wants to train people to read, and pay careful attention to, the contract, in effect. They want to do this by putting their employees in fictitious situations in which someone has not read the contract and this failure to read causes serious difficulties for the company when the employee violates a rule they didn't know about.

Much of e-learning is like this. You are the manager of a large project, which needs to finish on time, and is over budget. Do you:

- a –steal money
- b- lie about the time you have spent
- c- tell the company they can keep their damn project
- d–carefully explain to your superior the problems that exist and let him decide.

Do people learn from stuff like this? Of course not. But everyone feels better after producing it. At least I assume they do.

If this stuff makes people happy then build more of it by all means. But, if we want to address real issues we need to discuss personality and how to deal with it.

I have insisted, as long as I have been discussing education², that learning has to be experientially-based. I proposed building complex social simulators 20 years ago and this has come to be understood by the e-learning community as telling people they are in a situation that they may or may not relate to instead of actually putting them into a very realistic simulation of that situation. The reason they do it that way is money of course, but something gets lost in the translation.

What is the difference?

Suppose that I tell you that you are a baseball player in the major leagues and your team is down by one run with one out in the bottom of the ninth with the bases loaded. I then give you a set of multiple choices about what to do on the first pitch (like a- take the first pitch, b – look for a fast ball etc.) What is the problem with this? There are right answers about what to do, but they depend on many variables. (Do you know this pitcher's habits? How have you been hitting today? How fast is the guy on 3rd?) Pretending that we can abstract a situation with a simple description and then suggest there is a right answer is absurd. But more importantly if you have never actually been in that situation, if you have never played baseball, your comprehension of the unmentioned details is likely to be zero. Attempting to teach anything through short descriptions of situations followed by multiple choice answers is just dumb.

Why then do e-learning companies keep on building courses that sound like that? Usually the answer is that corporations who don't know any better asked them to.

What does this have to do with altering basic behavior? I do indeed play baseball, as I have said, and what I would do in that situation depends upon my personality in many ways. It also depends upon an accurate assessment of my own abilities. What it doesn't depend upon is deep thought. Professional athletes do not become professional athletes owing to their superior cognitive abilities. They have superior physical abilities and rely upon instinct for thinking. They do what they "know" to do. They don't think it out. Coaches try

² I didn't start writing about education until 1978. Before that it was always Artificial Intelligence that concerned me.

like crazy to get them to think it out but you can often find a 20 year professional veteran getting chewed out by his coach and being asked *what were you thinking?* Nothing. They were thinking nothing. Correct action is rarely about thought, especially when little time for thinking is available.

So then how do we teach people to do the right thing especially when the right thing is not in line with their normal behavior?

Can we teach nurturance, or aggression, or extroversion or orderliness? I hope that it is obvious that we cannot do this. People are born with these characteristics. They are not learned. The degree to which we have them defines our innate personalities. So, we need to translate this question into one we can answer.

The real issue is one of degree and not of kind. You will never teach someone who is fundamentally dishonest to be very honest or vice versa. You will never teach someone who is very aggressive to be very passive. What you can do is make people aware of the consequences of their actions and hope to change their behavior slightly, when they have the time to think about what they are about to do. You can make people aware of their behavior and their rational selves can direct what they do, if they have time to think about. But, their unconscious is likely to want them to behave differently, and it is their subconscious that is usually in charge in a pinch.

Someone who hates details is not a good candidate for being taught to read contracts in detail. Similarly, someone who loves details is not a great candidate for sales rep. (Why? Because being very people-oriented is actually a characteristic that never goes hand in hand with detail-oriented.) So, it is not uncommon for companies to be faced with the arduous task of training their salesmen to pay attention to detail. Telling them to hire differently is hopeless because people who are both very detail oriented and love engaging people socially do not exist. Accountants don't usually win personality contests. What to do?

This is indeed a job for teaching but not for teaching of the usual sort. To see what kind of job it is, we need to think for a moment about how the mind works. Specifically we need to think about how the unconscious learns to make decisions.

If you have a character trait, say honesty, you have had to come to grips over the years with its up side and its down side. People appreciate you for being honest, but not when they ask you if they look good after they have spent an hour dressing. (I speak from experience here.) People dislike dishonesty but not when it helps get a deal closed because you said you loved a restaurant that you really hated. We have mixed feelings about honesty, as we do about any personality characteristic. We like friendly people but we dislike overly friendly people. Who decides which is which is anybody's guess. Teenagers often try to be all things to all people but as adults they soon realize that they will simply have to be themselves and will try to find work and friends that suit the personalities that they happen to have.

Personality features are not conscious. We don't decide which ones to have and we may not even be aware of how others perceive us. We do what we feel comfortable doing and we push on. And then we meet integrity and compliance officers.

They tell us to read every detail of a contract to make sure we are in compliance and those who are detail-oriented and fearful of making errors and introverted and sensitive do it without question and those people who are gregarious and confident and aggressive figure they can get by without it. What is an integrity and compliance officer to do?

Here is what not to do:

1. Don't try and tell people who act naturally one way to act differently.
2. Don't make a movie of the idiot who did it wrong and say see *look how dumb that guy was and look what trouble he got into.*
3. Don't lecture on the benefits of behaving the way the company wants you to behave.
4. Don't write a manual with correct behavior that no one will read
5. Don't build an e-learning course with multiple choice answers where one of them is the right thing to do.

The mind is organized around experiences. We remember our experiences and we index our remembered experiences so that we can find them later. Individuals don't know how they do this, but cognitive science can tell something about how this process works. You can't find an experience that was indexed wrong for example.

Correct indexing involves figuring out the goal that an experience relates to and the conditions that allowed that goal to be achieved or not. We do not do this consciously. We learn by doing, that is, we learn from experience, and from thinking about those experiences. When we have understood our experiences well enough we can (unconsciously) index them so that they will come up again just in time when we need them again. (This is what we call being reminded.) It is beyond the scope of this book to explain how that process works³. The simple idea is that experiences get labeled when we think about them and not otherwise.

So the real question for an Integrity and Compliance officer is how to get people to think about Integrity and Compliance issues. This thinking needs be done over time in a complex way and voluntarily. How might we do that?

That is the real question.

One answer to this is *stories*. People really like stories. As long as there have been people, there have been stories, we have moved from epic poems and theatre to novels and movies in recent years, but, by and large, the stories are the same. How to overcome obstacles to getting what you want, is a theme that dominates much of literature for example. Movie makers say it as *boy meets girl, boy gets girl, boy lose girl, boy gets girl*. There have been many books written about the basic plots that occur again and again in stories.

Human beings understand stories because they resonate to them. Characters have dilemmas that the reader or viewer has himself had. Stories appeal to emotions rather than logic and emotions are at the heart of our pre-seven year old unconscious selves. We feel

³ I have done this in gory detail in *Dynamic Memory* and in *Dynamic Memory Revisited* as well as in *Explanation Patterns*.

something because of a well told story and that feeling can help us see something in a new way.

Why am I going on and on about stories? I believe that all of human intercourse is about the exchange of stories. (I wrote a book about this.)⁴ If you want to appeal to the pre-seven year old unconscious that resides in all of us, you need to hit emotion not logic. This means that a good story can help someone to re-consider deep down in their unconscious a feeling or attitude or seemingly immutable personality trait that they can feel is perhaps somewhat dysfunctional.

That story cannot be short and sweet. It takes a great deal of emotion and empathy to change a point of view in a belief system. Deciding to construct a 15 minute e-learning module in which one plays the salesman and learns that honesty is the best policy is so absurd am I sorry I am referring to it at all, except that is what was proposed by the *Integrity and Compliance* people to whom I was speaking.

You can move people ever so slightly by having them have emotional experiences that they can discuss with each other. Imagine a book club which deals with a book about dishonesty and causes people in the discussion group to talk about the subject. If the book presented deep dilemmas to which there were no obviously right answers, this would allow people to get to and discuss their unconscious beliefs. Simply articulating those beliefs can be quite helpful. This is what clinical psychologists are really trying to do after all. It is also what literature professors are trying to get their classes to do. Thinking about and talking about complex emotional issues makes personality traits and core beliefs something you can think about consciously.

The real issue is interests in the end. Teaching works best when you teach students who agree that they really want to learn whatever it is you have to teach. This means making sure that students are preparing to do things that they want to do and will actually do. That makes teaching much easier for all involved. The *one size fits all curriculum* doesn't work because one size doesn't fit all. Let detail-oriented people learn detailed kinds of things, Let artistic people learn artistic kinds of things. Let logical people learn logical kinds of things.

⁴ Tell Me a Story

Roger Schank

Cognitive Processes

Everyone would be much happier and all would enjoy learning a lot more if we simply let people be themselves.

Chapter 4

Sixteen Cognitive Processes that underlie learning

Not everything we would like to teach can be taught as we have seen. Similarly, not everything we would like to learn can be learned, especially if we are taking the wrong approach to learning. In the last chapter we discussed what can't be taught. Now, let's talk about discuss what can be taught.

One problem in such a discussion is that we are used to, (because we went to school) thinking about what needs to be taught and learned in terms of subjects (English, Math, Science, etc.) We think this way because school was originally organized by professors who

had specialties in these subject areas. These professors were scholars and they set up the lower schools on the basis of the specialties that they had.

When I was working in Artificial Intelligence, I began to realize that what I needed to teach the computer to do in order for it be smart was a far cry from what people thought needed to be taught. People assumed that we needed to tell the computer facts about the world of the type that children learn in school, and that this would make the machine smart. (Quite recently, I attended a meeting of AI people who were planning a project to allow computers to pass SAT tests as a way of showing that the computer was smart!)

But what computers lack is intelligent capabilities, not information. It is easy enough to fill a machine with information, but when you are done it would only be able to tell you what you told it. (If that was what a child did you would think that he was brain damaged.) Intelligence and the learning required to create useful new knowledge, are really a result of an amalgamation of cognitive processes. Intelligent computers, and intelligent people, need those processes to be working well.

What I mean by this is that there is stuff we can do mentally, and that learning just means doing that stuff and getting better at it. Learning is not any one process, but many processes depending on what you are learning.

What are the cognitive processes that make up learning? If we wish to teach people it is important to ask what cognitive capabilities we want them to have when we are done, not what we want them to know. In other words we want to understand what we have to do in order to make them better able to think.

In this chapter, we will discuss the kinds of mental processes that people can (and must) learn to do well. Later we will discuss how to best approach learning and teaching these processes.

There are sixteen types of processes outlined here. There may be more types than these, but with these we can pretty much cover the ground of what human learning looks like. I have divided them into

four groups: **Conscious processes**, **Subconscious processes**, **Analytic processes** and **Mixed processes**. Notice first that all the types are types of processes. Learning is a process. It is something we do. We need to see what that doing is like.

All these processes require practice in order to master them. You cannot learn to master a process without practicing it again and again. Feedback and coaching help one learn.

Conscious Processes

1. Prediction: Making a prediction about the outcome of actions

Experiential learning about every day behavior in its most common form - it includes learning about how to travel or eat or get a date for example. In its complex form it is how one learns to be a battlefield commander or a horse race handicapper. One learns through experience by trial and error. The cognitive issue is building up a large case base and indexing that case base according to expectation failures as I described in *Dynamic Memory*. We learn when predictions fail. When they succeed, we fail to care about them because most of the predictions we make are uninteresting (*I predict the room I just left will look the same when I return.*) Learning to predict what will happen next requires repeated practice in each domain of knowledge. There is some transfer across domains but not that much. (Learning to buy an airplane ticket is somewhat related to eating in a restaurant, but not that much. You might use a credit card in each for example and might be refused service because you are rude.)

2. Judgment: Making an objective judgment

There are two forms of this, both involving decisions based upon data. The first is deciding if you prefer Baskin Robbins or Ben and Jerry's. There is no right answer. We make judgments and then record them for use later. We find ways to express our judgments. (*Ben and Jerry's is too sweet*, for example.) We learn what we like by trying things out. A wine expert learns about wine by drinking it and recording what he thinks so he can compare his thoughts about one wine to a different wine later on.

The second form is reasoning based on evidence. A jury does this but it doesn't learn much from it. Judges however learn in this way, as do psychiatrists and business people. They collect evidence, they form a judgment and later they may get to see if their judgment is correct.

When asked they can tell you clear reasons (typically post hoc justifications) as to why they decided the way they did. The wine expert can say reasons as well, but the evidence for taste is not really all that objective. (Of course, the evidence may be found after the judgment is made. People are not always entirely rational.)

To learn to make objective judgments one needs constant feedback either from a teacher or from a colleague or from reality. One needs to think about what was decided and why. People who are good at this are good at it because they have analyzed their successes and failures and they can articulate their reasoning. Learning requires repeated practice.

3. Modeling: Building a conscious model of a process

We need to learn how things work. A citizen knows, presumably, how voting works. Someone looking for venture capital should know how fund raising works. Processes need to be learned in order or effectively participate in them and in order to propose changes in them. Building a conscious model of a process matters a great deal if you want to make the process work for you. If you want to get into college you need to understand how the process works. This cannot be learned from experience in a serious way because one may only do it once and may not be able to experience the entire process. Having the process explained to you may not work that well either because this will not bring an operational understanding of it (as opposed to a more superficial understanding of it). Designing it, modifying it, and participating in simulations of it work much better as learning methods.

4. **Experimentation:** Experimentation and re-planning based on success and failure

This is probably the most important learning process we engage in while living our lives. We make life decisions and we need to know when we need to change something. There are big decisions - like getting married or how to raise a child or whether to change jobs and little decisions such as changing your diet or your sleep habits. We make our decisions on the basis of what has worked before and what has failed to work. We tend to make life decisions without much knowledge. We don't know how our bodies work all that well and we don't really know how the world works or what it has in store for us. Thinking about these issues and learning from failure is a pressing need all through life. Learning to analyze what has worked out and what has not and why is part of living a rational life. These things can be learned by living and talking about our experiences, thus creating a database of stories that we can rely upon later on. We learn by talking with others and hearing their stories but we also learn from our own

experience as we construct our own stories. We can learn about life experiences through reading and movies as well. We like stories in all these forms precisely because they focus on real life issues. The cognitive task here is story creation, comparison, indexing and modification. Most conversation depends upon story exchange. The more emotional a story is, the more likely it is to be remembered.

5. **Describing:** Creating and using conscious descriptions of situations to identify faults to be fixed

When problems exist in any situation we need to be able to describe and analyze those problems. We need to be able to describe them in order to get help from people who may know more about the situation than we do. We need to learn to focus on the critical issues. In order to do this we need also to be able to analyze these situations to see what was supposed to happen and why it isn't happening. Consultants who try to fix failing businesses do this sort of thing all the time as do doctors when consulting on difficult cases. Learning to create a careful description of a situation is a skill which only be learned through practice. This is sometimes described as learning an elevator speech to tell someone succinctly what you are doing. This ability is a very important part of understanding and helping others understand.

6. **Managing:** Managing operations using a model of processes and handling real time issues; case based planning

There is a big difference between learning how a process works and managing that process. As we gain more responsibility we tend to have to learn to manage the processes that we are part of. We may become managers of groups we belong to or we may want to start up our own processes. Either way we need to not only know why the process worked the way it did when we arrive, we also need to know how it improve the process. This means building up a series of cases (indexed in terms of their role in the process) about faults in a process and known (or invented) solutions to rely upon when suggesting changes. The cognitive strategy here is called case-based planning.

Subconscious processes

1. **Step by Step:** Learning to execute a step-by-step subconscious process

Most of what we know how to do we practice on a daily basis. We may have consciously learned each step initially but over time we do things mindlessly. This is why we can talk and drive a car at the same time. We drive subconsciously. Driving is more difficult while talking on a cell phone because we are capable of driving without looking (even though we may not realize that we are not looking) and there is a tendency while using a cell phone to look elsewhere. When we ride a bicycle or hit a baseball we are using a subconscious process. When we understand and speak our language we are using a subconscious process. When can figure out what people are really thinking by observing their body language we are using a subconscious process. We react quickly and easily without knowing the details of what we are doing or how we are doing it. When we try to consciously modify such processes (when we tell ourselves to listen more carefully or look at the ball more intently before we swing) we often cannot change our behavior.

We learn by doing in the beginning. Once we have fixed ways of behaving we typically stop learning and behave automatically. To learn to do a subconscious process one simply does it all the time and gradually improves. Coaching can help. There is no substitute for constant practice.

2. **Artistry:** Improving an artistic (no defined rules) judgment

There are no rights and wrongs in what we like. But there is general agreement about what makes a work of art great. The factors to be considered are not necessarily conscious, although for experts they typically are. In these more subjective and subconscious areas of life, it is more a matter of trying to understand what feels right than understanding why it feels right. There is a difference between being someone who can make an artistic judgment and being an art expert. One might learn to notice things that one had failed to notice, if someone takes the time to point them out. Learning to make artistic judgments is about learning to notice, to describe, and to appreciate. One's concept of beauty changes when one's focus changes. Practice is a key idea here as is the assembling of a case base to use as a comparison set. Nevertheless the comparison set is not usually conscious. One can like something because it is pleasing without realizing (or caring about) why it is pleasing.

3. **Values:** Making a value judgment

Values are another subconscious idea. We don't necessarily know the

values we have and we haven't necessarily learned them consciously. We should value human life over property but whether we do or not we will only find out if the situation arises. It is tempting to try and teach values but this is actually done so early in life and in so many subtle ways that anybody over the age of ten is unlikely to be much affected by what people say to them about what they should value and what they shouldn't. Perhaps husbands should value helping their wives over watching football but that doesn't mean they will. In important areas of life, on the job and in child raising for example, one's values come into play. If one believes one shouldn't correct a child when he makes a mistake in speaking one will soon find that one has a child who speaks poorly. The value held by the parent may well be that self-confidence is more important being articulate. (*I don't want to criticize him.*) Perhaps it is. But, the consequences of one's values manifest themselves every time a value-based decision is made.

Nevertheless we do need to learn to make value-based judgments. Doing this requires understanding what our values are. Confronting a person with their own value system (one that they have unconsciously adopted) can help them think things out, but change is never easy.

Analytic Processes

1. Diagnosis: Making a diagnosis of a complex situation by identifying relevant factors and seeking causal explanations

Diagnosis is a very important skill and one that needs to be learned both in principle and separately for each domain of knowledge. Diagnosis of heart disease isn't a different process in principle from diagnosis of a faulty spark plug in a car engine. Nevertheless one wants a specialist to do the diagnosis in each case. Why is this? Diagnosis is both a matter of reasoning from evidence and understanding what to look for to gather evidence. Given all the evidence it is easy to make a diagnosis in an area of knowledge you don't know very well. So, the gathering of the evidence is the most important part. Crime analysts and gardeners all do diagnosis. They all reason from evidence. What separates them is knowing what constitutes important evidence and what does not. Here again this comes from experienced cases.

Analytic processes involve attention to details that enable the forming of hypotheses that can be tested by a variety of methods. These three pieces, determining evidence, forming hypotheses, and testing hypotheses is what is commonly referred to as the scientific method. When science is taught it often dwells on the facts of science rather than the process. Diagnosis is about the process. But the process is not of much use without domain knowledge. Domain knowledge is

often about causality although that knowledge of causality may be subconscious.) Experts know what causes an engine to misfire so they know where to look to find a faulty part. Experts also know that an engine is misfiring in the first place. What causes what is the real issue in the comprehension of any given domain.

We learn to diagnosis and to understand what causes what consciously. This is knowledge that can be taught to us by experts, but it needs to be taught as part of the process of diagnosis. If you have a goal (understanding what is broken or has gone awry is a very typical goal) then it is much easier to acquire information that helps in the pursuit of that goal than it is to acquire that same information without that goal. To learn diagnosis one must practice more and more complex cases in one area of knowledge.

2. Planning: Learning to plan; needs analysis; conscious and subconscious understanding of what goals are satisfied by what plans; use of conscious case based planning

People plan constantly. Often their plans aren't very complicated. *Let's have lunch* is a plan after all. Sometimes they make much more complex plans. A football coach makes plans to fool the defense. They are called plays. A general makes battlefield plans. A businessman writes business plans. An architect draws up architectural plans. All these more complex plans have a lot in common with the *let's have lunch* plan. Namely, they have been used before or something quite similar has been used before. People rarely make plans from scratch. When they do, they find the process very difficult and often make many errors.

Learning to plan therefore has two components: being able to create a plan from scratch (which almost never actually happens) and being able to modify an existing plan for new purposes. The first one is important to learn how to do, but it is the latter ability that makes one proficient at planning. Planning from first principles is actually quite difficult. Normally people just modify an old plan. *Last week we had steak this week let's try lamb chops*. This doesn't sound like rocket science and it isn't. Computer programmers write new programs by modifying old programs. Lawyers write contracts by modifying old contracts. Doctors plan procedures by thinking about past procedures. In each case, people try to improve on prior plans by remembering where these plans went wrong and they think about how to improve them. Acquiring a case base of plans is critical. One can modify plans from one domain of knowledge to use in another but this is not easy and requires a level of abstraction that is very important to learn. Most creative thinking depends on this ability to abstract plans from one field of knowledge to another. We learn to do this by practicing it. Teachers can help people see correspondences across domains.

Abstraction of this sort is what creative people do best.

3. Causation: Detecting what has caused a sequence of events to occur by relying upon a case base of previous knowledge of similar situations (case based reasoning)

All fields of knowledge study causation; biology, physics, history, economics -- they are all about what causes what. The fact that this is an object of study by academics tells us right away that it is not easy and no one knows for sure all of the causes and effects that there are in the world.

Because of this, acquiring a set of known causes and effects tends to make one an expert. A plumber knows what causes sinks to stop up and knows where to look for the culprit. A mechanic knows what causes gas lines to leak and know where to look. A detective knows what causes people to kill and knows where to start when solving a murder case. Causal knowledge is knowledge fixed to a domain of inquiry. Experts have extensive case bases. Case bases are acquired by starting on easy cases and graduating to more complex ones. It is important to discuss the cases one works on with others because this makes one better at indexing them in one's mind enabling one to find them later as needed.

Mixed processes

1. Influence: Understanding how others respond to your requests and recognizing consciously and unconsciously how to improve the process

Human interaction is one of the most important skills of all. We regularly interact with family, friends, colleagues, bosses, romantic interests, professors, service personnel and strangers. Communicating effectively is very important to any success we might want to have in any area of life. But, we do not know why we say what we say, nor do we really understand how we are being perceived by others. We just talk and listen and go on our way. Some people are loved by everyone and others are despised. It is wrong to assume that we know what image we project nor that we are easily capable of altering the way we behave so that we will be perceived differently.

How do we learn to become conscious of inherently unconscious behavior? One can learn to behave differently if one becomes consciously aware of the mistakes one is making. Watching others,

watching oneself, thinking about how to improve; all this helps one make subconscious behavior into conscious behavior.

We unintentionally return to standard ways of acting in various situations. A wallflower at a party doesn't decide to be a wallflower -- it is simply behavior they are comfortable with. If no one is harmed by these subconscious choices then there is no need to fix anything. But, often we treat others in ways in which, if we had realized what we were doing, we might have behaved differently. Getting along with people is a very big part of life. Each of us has our own distinct personalities and they often don't match with one's own ambitions and desires. To change one's behavior one needs to practice new behaviors that become as natural to us as our old behaviors. The only way to do this is to do it. People can help point out what you are doing that isn't helpful to your needs but that does not mean you can easily change. If you want to change you need to try new behaviors and practice them. This can be coached. Practicing new behaviors and being critiqued can help greatly. Written communication is handled the same way.

2. Teamwork: Learning how to achieve goals by using a team, consciously allocating roles, managing inputs from others, coordinating actors, and handling conflicts

It is the rare individual who works all alone. Most people need to work with others. Children are not naturally good at this and are taught to "share." Then they sometimes do what is called "parallel play" where they play near each other doing different things. Getting kids to cooperate to do something together is not easy. Usually one wants to dominate the other. There is nothing wrong with this *per se*. People are who they are and they need to assume roles in any team that are consonant with their personalities. One person plays quarterback and another blocks. People do not have to do the same thing in order to work together. But they do need to get along and function as team. This is no more true of sports than it is of the workplace. People learn to work in teams by working in teams and receiving helpful advice when a team is dysfunctional. Football coaches explicitly teach this. More formal learning situations (like school) often don't which is unfortunate. It really isn't possible to get along in the real world unless you can assume various roles in a team that fit with who you are.

3. Negotiation: Making a deal; negotiation/contracts

Contracts, formal and informal, are the basis of how we function. We reach agreements in business, in marriage, in friendship, in a store, and at school. Parties to those agreements have the right to complain if obligations are not met. Learning to make a contract, legal or not, is a big

part of being a rational actor. To make a contract one must negotiate it. Negotiation is often seen as something only politicians and high powered business leaders do. But, actually, we negotiate with waitresses for good service and we negotiate with our children when we give them an allowance. Learning how to negotiate can only be done by trying and learning from failures. The techniques tend to be context-independent, but, there is, of course, special knowledge about real estate and politics (for example, the relevant laws), that make one a better negotiator in each situations. Again, practice with coaching is the ideal.

4. **Goal Conflict:** Goal prioritization; managing internal conflicting goals; implicit nonconscious understanding of relative importance; learned by living

We all have goals. Which ones are more important than the others? We know subconsciously that if there is a fire we try to save the child in the house before we try to save the house. Perhaps this is taught in fire safety school, but there is no human who does not implicitly understand it. Dogs understand it. If we want to be rich but will have to lose the respect of people care about in order to be rich, we need to make a conscious determination about goal priorities. If we want to get a degree but we also want to support our family we need to think about how to manage goals that both compete for our time.

Goals conflict with each other all the time both internally and externally. Not only must we deal with goal conflicts that are caused by our pursuit of multiple goals at the same time we must also deal with external goal conflicts. Children learn about these early on when they compete for use of a toy or later for the admiration of a playmate. We compete for power, status, money, and success with others who may wish to thwart our achieving them because it prevents them achieving goals that they are pursuing. All of these are external goal conflicts. Understanding how to manage goal conflicts is extremely important.

This can be taught again by acquisition of cases and extrapolating from those cases.

Now let's see what we have. First let's list the types of learning again:

Conscious Processes

1. Prediction
2. Judgment
3. Modeling

4. Experimentation
5. Describing
6. Managing

Subconscious processes

1. Step by Step
2. Artistry
3. Values

Analytic Processes

1. Diagnosis
2. Planning
3. Causation

Mixed processes

1. Influence
2. Teamwork
3. Negotiation
4. Goal Conflict

What kind of stuff is this? I said above that these are mental processes. So let's look at them from that perspective. Let's start with the **analytic processes**.

What does it mean to say that **diagnosis** is a mental process? It means that there are steps and these steps are steps that are based in thought rather than in action. The first step may be to *gather evidence* for example. While this seems like a physical act, and often it is, it is actually a mental act. Evidence can be gathered *by asking questions, by looking carefully at a scene, or by listening to sounds, or taking blood tests*. There are many ways to gather evidence and typically the physical manifestations of evidence gathering bear no real relationship to one another. Evidence gathering is a mental act not physical one. It is a mental act that is part of a set of complex mental processes which, of course, include

reasoning about the evidence, checking the validity of the evidence, comparing known information to previous cases that are similar and so on. Diagnosis is a complex mental process. Teaching diagnosis matters because getting good at diagnosis can make you a good mother, a good teacher, a good detective, a good nearly anything you can think of. The process of diagnosis is constant in our mental lives.

Are all sixteen of the processes listed above like this? Clearly the other analytic processes are very similar. **Planning** is a mental activity that one gets better at by doing it. Whether you are planning a party or planning a career, the process involves thinking about steps and imagining consequences to those steps. The more you plan the better you get at it. We do planning every day. It matters a great deal and the better you are at it, the easier your life will go. The same is true of third mental process: **analysis of causation**. Knowing why something happened allows us to not do it again --if we didn't like the end result-- or --to try and do it again if we did, and everything in between. Determining causation is a mental process that is very similar to diagnosis of course.

So these three are all mental processes and they are ones where practicing them and getting better throughout one's life matters a great deal.

Subconscious processes occur all the time and, because they are subconscious, we are not aware of them. When we drive a car, speak our language, or watch over our children, we are employing subconscious processes. We do not think about each step. We just do it. The same is true when we produce or react to art and music, and when we feel good about something we have done because we did the right thing according to our own value system. None of this is really thought about and thinking about it doesn't necessarily make it better. One of my favorite baseball aphorisms is: *if you think long you think wrong*. This means, in sense: *just throw the ball, don't think about it*. Subconscious processes drive our physical actions as well as our emotional reactions. We do things subconsciously but still we need to be able to talk about it in order to improve. One gets better with practice and coaching helps.

The **conscious processes** listed above are all conscious mental processes of course. They are aspects of thinking. **Prediction** is one of the most important kinds of thinking we do, and we do it constantly. What will happen when I open the door? What will happen when he calls? What will happen if I continue working like this? What will happen if I continue eating like this? These are things we think about. Getting good at prediction means making one and seeing how it worked out and then making another. Discussing with others why one's predictions were right or wrong helps in the analysis. Prediction is a fundamental mental process. The same is true of **judgment**. They are both learned better if, after one has done them, one consciously analyzes what went right or wrong.

The others in the group, **modeling, experimentation, describing** and **managing others**, are not mental processes that one does all the time. In fact, many people never attempt to build a mental model of a situation nor do they attempt to run a mental experiment to learn something. And many people never manage others. Most people do describe things, but judging from the interviews with the general public that one sees on the nightly news, most are pretty bad at it. One can learn to do these processes after all, by attempting to do them and getting help when one does them badly. School is remiss in not offering these as subjects precisely because doing these well is often what differentiates successful people from people who seem not to have a clue about what is going on.

The mixed processes are more subtle. Influencing others is, of course, a mental process, in the sense that one wants to say and do the thing that has the effect you want. But you can't influence others by yourself, so it is a mental process that needs to be practiced with someone else. The same is true for negotiation. Teamwork requires a team to work with and goal conflicts don't usually happen unless someone else is around with a goal of their own that messes with your own. For this reason, these mixed process are only partly mental processes in the sense that practice in thinking will make you better at them. Teaching them requires others to work with which makes these group activities. The mental processes involved in all of them must be practiced and are a critical part of what it means to learn.

So what is a mental process? And what is learning? And what does it mean to learn a mental process?

I am going to define learning as improvement in one's mental processes. This definition is of little interest without being careful about understanding what constitutes a mental process of course. The sixteen processes are the key ones in cognition I think. Now let's look more closely at them.