**2014 Showcase of Teaching • Drexel University**

**Plenary Session:   
The Distinctiveness of a Higher Education  
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**Introduction**

Dr. Brian P. Coppola is *Arthur F. Thurnau* Professor of Chemistry and Associate Chair for Educational Development & Practice at the University of Michigan. As a faculty member in the Department of Chemistry at University of Michigan, Dr. Coppola has divided his work between different areas. One, he exemplifies discipline-centered teaching and learning in the design, implementation, documentation and evaluation of organic chemistry education. Two, preparing future faculty by broadening the concept of a research group to the idea of forming teaching groups and three, the internationalization and globalization of science education. Dr. Coppola is also acting as the Associate Director of the University of Michigan's Joint Institute with Peking University to establish strong cooperative working and collaborative relationships for the University of Michigan community with premiere research institutions in China and other parts of Asia. Dr. Coppola's contribution to the profession are exemplified by his recent receipt of the Robert Foster Cherry Award for Great Teaching in 2013, CASE/Carnegie U.S. Professor of the Year award in 2009, the CASE/Carnegie State of Michigan Professor of the Year in 2004.

**Faculty change is a difficult challenge**

To be involved in education today means that I live in a world concerned with faculty change. Let me tell you two funny stories about faculty change.

First: there are two distinctively different models that describe how faculty change takes place, namely, the miraculous way and the normal way. In the one case, the heavens open, the angels descend, the harps play and the trumpets blow…

…*and then there's the miraculous way*.

Second (my Department Chair loves to tell this joke): how many faculty members does it take to change a light bulb? [pause, then screams with incredulity] *Cha-a-a-nge?!* What do you mean: ***change!?!***

Thank you for the kind and generous introduction. It is a pleasure to be here, particularly because there's nothing so special as seeing a bunch of faculty gathering around and being excited about teaching (especially at a university).

**Asking questions about teaching and learning**

I strolled the posters this morning, and something that gives me great encouragement about the growing effort to ask questions about teaching and learning was terrific examples of having reached a point where not every hypothesis has to work out as planned. The education literature is dominated by the stories of what worked, but not the critical reflection on why something might not have worked. Finding a place for learning from error is important. It's absolutely okay to have had an idea, to gather some data, and at the end say that it didn't really work out the way I wanted it to work out. This sequence leads, one hopes, to an informed choice about what to do next.

And so rather than necessarily think about teaching development as a proselytization of “how something should work,” there’s really an opportunity there to say something that's simply intellectually honest: it didn't go the way I wanted it to the first time, what can we learn from that, and how to move forward? I see evidence for that in the room next door.

**Going online?**

Let me start with an interesting statistic. Thanks to technological advancement, there are four times as many students taking courses using distance education as there are taking on-campus courses, and universities are responding by tailoring these lessons to the individual students through innovative tutorial programs. Is that shocking? Maybe yes, maybe no… but let me tell you that those statistics are from 1920.

This was the birth of the development of the correspondence school, which followed from the technological advancement of an efficient postal system. I suppose the same thing probably happened after Gutenberg: new technologies are going to revolutionize education… again and again and again. Good teaching is intrinsically difficult, and I cannot fault folks for wanting to make it easier, but I figure that some millennium we’ll finally admit that a house cannot build itself, no matter how good the hammer is.

As far as I can tell, this fool’s errand, to finally make teaching easy, appears with all technological advancements. You can find really interesting reports from UNESCO in 1960 about how television was going to change everything. By 1930 the verdict was in about the amazing technological revolution of the postal system and the correspondence school. The only thing that it seemed to promote was “participation” rather than “education.” Confusing the goals of the correspondence school, learning what's right rather than wrong, becoming competent according to a *status quo*… confusing the goals of the correspondence school with the goals of an education: it's simply a mistake.

I see the goals of an education as ***not*** following the *status quo*, but learning how to question it; as living at the edge of what is barely known, ***not*** following the dogma (because there is none); as searching and seeking to winnow away all of the multiple answers that might work, ***not*** complying with policy on the answer that has been selected by some committee of lawyers concerned about eliminating risk from being sued by another committee of lawyers. Education is about advancing knowledge and understanding, ***not*** sticking put to what is but rather what might be, including the needs of society equally with the anticipated needs of society.

I beat up on the word competence all the time and I have not stopped yet; it is of minimal significance for the truly educated.

**A perfect storm**

Today, although we hear about technologies (books, postal systems, television, the internet, whatever) as the drivers for this change in higher education, I assure you that technology is not the driver. Money is the driver.

Higher education is facing a perfect storm in 2014 because every administrator I know, when given a chance to pause and relax tends to take on a posture that looks a bit like Edvard Munch's *The Scream*. They're worried about the rising costs, including the costs that have come from compliance, which are significant.

I will tell you: at the University of Michigan they are worried because of the guidance we get from lawyers, because of decreased external support, because of the tuition plateau and because of something that I have a very, very small responsibility for, the 1974 valley of live births in the United States.

If you look back to 1957, the year I was born, it turns out to be the mountainous, post-World War II peak of births. There has been no greater number of births in the United States than 1957. And so right around 1974 we should have been having children. We did not. In fact, a deep valley of births in the United States occurred right around 1974.

If you put that together with people having started their professional lives later, and having their children later, it means that every demographer in the world has been telling your administrators for the last few years, the echo from the 1974 valley is coming. My generation did not reproduce the way it was supposed to, and enrollments are set to be going down in the late 2010s. In fact, there is some evidence of that starting.

There is an interesting conflation of things that has happened, things that we didn't even think of when I was starting my job in academia in 1982: accountability (and its expense); this massive surge of thinking of education as a form of consumerism (which just makes me itch, and not in a good way); a kind of rebirth of the anti-intellectual skepticism in the public about academia (a criticism perhaps warranted for universities offering classes in the World Wrestling entertainment and whatever else); the growth of the culture wars (and the screaming that passes for news reporting); and, to point my fingers back at me rather than at everybody else, the poor job that we professors have done in presenting education as being more than just about the transfer of information. And if there's anybody at fault for not stepping that up it has to be the faculty, standing in dark classrooms reading PowerPoint slides.

I think of the enthusiasm that Salman Khan and Bill Gates have for underwriting mechanisms of information transfer, which probably represents the distasteful experiences that they had in the university, when the only thing they thought that they were getting – and it might have been true – was the transfer of information. That isn't their fault; it’s ours. You know, one of the things that got Bill Gates started on this whole education jag was because he spent all his time jogging listening to tape recordings of professors teaching, this method of continuing education for the elderly retired, and he said well, if I can learn that way, then everybody else can learn that way. After all, it's only about getting factual stuff moved from the professor to me.

Okay, you depressed yet? Hang in there.

**A silver lining**

Let me skip to the end of this sad story because I think there's a way out of it and I think that it's up to every single one of us, the faculty, to be the big promoter of the faculty. It's up to us to demonstrate the value of true education and to make sure we provide it. It's got to be more than rhetoric.

It will be up to us, the faculty. It's not going to be up to the Deans, it's not going to be the Provosts, it's not going to be the Presidents (and I'm sorry to bite the hand that’s paying me to say that it's not going to be the teaching centers, either).

It's going to be the faculty because it is the faculty who are in rooms with the children. We are the ones who can make the argument because, dammit all, we are the educators. Without us, the chain of education breaks.

We, the faculty, have the strength of the discipline to draw from in order to make our case with the students… and so with everyone else.

If I could do one thing, if the heavens did part and the angels descended, and I could do one thing because I was granted one wish, I think I would start an “occupy the university” movement for faculty. We the Faculty! Take back the Tower!

I think there's a real need to take back. After all, revisiting things like core mission, core purposes, and core values, is a really good thing in teaching in all of its forms. I'm not taking away from the value of research at all. At its best, we have turned academic research into an incredible form of teaching, at least when students are working “with an advisor” instead of “for the boss.” In fact I support greatly the idea that benefits derive from putting teaching and research together, because I believe in the understanding that the discipline provides for more than just the information but, in fact, how we, as intellectuals, deal with the world. It is the strength of the university education to have the people who are the practitioners in the art in the classroom, because you cannot help but bring all of your disciplinary dispositions into the classrooms. I do not have a single indication that learning about scientific skepticism is a part of any science class I have ever taught, nor do I talk about it in any paper I ever write, but it is there – all the time, at every moment – because I AM a scientist, and what I know is far more interesting and complex than a list of subject matter topics.

No one besides we, the faculty members, are responsible for bringing these understandings to the next generation. And it’s worth not screwing it up. This drives my strong personal skepticism when someone tries to sell me on easy teaching. Good teaching is not easy, and, my friends, easy teaching is not good. Don’t buy it. Get over it and then get on with it.

Among the incredible obligations we have that are overlooked, is this one: across higher education today, every single individual of their generation who is going to teach at any level, ever, is in our classrooms today, whether those are the future professors or the future school teachers.

Educating the next generation of educators is not somebody else's responsibility, it's OUR most special responsibility.

**Another unfortunate storm**

As important as research is, one of the things I people should think about is that publicly funded, big research at universities is a mere blip on the historical radar. This activity did not exist before 1915. Publicly funded research was a decision made by the United States government when three university Presidents turned into lobbyists: Vannevar Bush from MIT, James Bryant Conant from Harvard, and Isaiah Bowman from the Johns Hopkins Institute.

After the success of utilizing the scientific academic workforce on the Manhattan Project, Vannevar Bush, in particular, lobbied FDR strongly*. “See how well that worked? You should give a bunch of money to our universities to carry out basic research.”* Note: “our universities.” Vannevar Bush and this gang of three did not have egalitarian point of view about this. They knew that there were some universities that were more important than others. They did not propose the National Science Foundation. They proposed a Research Corporation, a handpicked set of 12 institutions to receive that money from the government to carry out basic research.

FDR died before this could be enacted, but it was damned close. But when Truman came in, he said no way am I giving those eggheads all that money, and this is not going to be done unless it's done in a very democratic way. And so the sense of spreading the wealth out through the current structure of things like the National Science Foundation is actually a result of Truman's insight.

My point is that this was a decision and that decision, or any part of it, can be reversed. At funding levels from NIH and NSF of less than 10 percent, it's practically, functionally reversing already. I can think of too many scenarios, because of the perfect storm, where it will be better – and perhaps even necessary – to close struggling doctoral programs than keep them going. If you have never read or heard about the Flexner Report… you should become familiar with why medical education looks the way it does today.

Shutting down research programs does not mean the end of education, or that it has to last forever, but I predict it will happen. At that point, rebooting some core values about education will be a paramount need. Turning undergraduate laboratory courses into fertile fields for carrying out some basic forms of research, which is not a new idea, could take off like a rocket. You see, I do think that research and teaching belong together… but it might not look the way it has for this less-than-100-year historical blip.

I urge you to take a look at Isaiah Bowman sometime. As President of the Johns Hopkins, he was an interesting and underappreciated character in higher education, beyond his hanging around with Bush and Conant. Let me read you a quote from just one of his very, very many interesting statements:

*"The university is a social agent as well as a creator and conservator of knowledge deemed to be fundamental. It operates in a given time with the social expectation, with the knowledge and training of a university will have useful applications. It is not operating in the millennium; it must be demonstratively useful tomorrow to the society of today as well as to the hope for the society of tomorrow."*

Isaiah Bowman wrote a terrific monograph in 1934, a quite thin one if you can find it, called “A Design for Scholarship,” in which he makes and pitches the idea of the integrated research and teaching model. Remember Flexner? He used the Johns Hopkins MD program as the model for what medical education should be like, universally. The combination of research and teaching.

Another important idea in the big picture of higher education is that we who dwell in the R-1 settings, where every future educator in higher education is educated, occupy a mere sliver of the higher education landscape.

The Carnegie Foundation for Advancement of Teaching, every X number of years, goes around and takes a survey of who's doing what in higher education. In the United States, in the 2010 Carnegie census, there were 4,634 institutions of higher education in the U.S. if one counts two-year schools all the way through research institutes, enrolling 20.7 million students.

How many of those institutions offer at least one PhD degree? We live, all of us live in an environment where that is the natural, the default. But the fact is of the 4,634 institutions of higher education in the United States, roughly 300 of them only offer at least one PhD.

In my discipline, Chemistry, there are 169 departments that offer the PhD in Chemistry. A meager 3.6 percent of schools, accounting for about 5 percent of undergraduates, are 100% of where PhDs in Chemistry are generated. And from these 169 departments, 50% of all PhD students are at only 30 of these schools. At least in science, the original Bush/Conant/Bowman model is probably a better way to think about the underlying structure.

Roughly speaking, this means that 18-19 million students in higher education are not at schools that offer research in the way we think about it. At 95 percent of schools, where if you need a PhD to teach, those individuals all come from us, 100% of them. Simply: the places where our students teach are simply unlike the places where they earn their degrees. The places where university and college educators earn their degrees is a true minority, perhaps a rounding error, in the landscape of higher education.

And never mind… just never mind… I have not even mentioned the training of the 7.2 million K-12 teachers in the United States.

**The distinctiveness of a university education**

I started this tirade on objecting to the definition of education as competency, and so it begs the question about what are my guiding principles about education. You can search around and you can find all kinds of writing, starting with Dewey if not Aristotle, but let me point you in the direction of a meta-study that was published in 2012 in *Educational Psychology Review*. The review is called “Transformational Teaching,” and the authors are Slavich and Zimbardo. They did a 40-year look at the business of reform in higher education, in particular, and they created – empirically, that is, at least using the information out there in the literature - a model for what they called transformational teaching.

The part about their transformational teaching model that got my attention turns out to be the middle layer of their model that they called the core principles. Something called “the core principles of transformational teaching” pretty much gets my attention.

Before I get to the details, let me also say that, although it is not explicitly a part of their review, I also think that Slavich and Zimbardo have placed a really interesting challenge in front of the faculty. Maybe they've even thrown a gauntlet. I'd like to think that they were thinking about it that way.

What makes an education distinct? With their core principles, I think that Slavich and Zimbardo are telling me that you cannot claim to have educated students - ***you cannot claim to have educated students*** - unless you have done these three things. Ready?

Number one, and this is the easy one, that you've demonstrated that the students have mastered the concepts of the field. That's “easy” in quotes, for sure. They did not that students have gathered and vomited back a of bunch of information and factoids, it's “master the concepts of the field,” which includes the ability to apply of those concepts to new and unfamiliar information and derive meaning.

Number two, you cannot claim to have educated unless you have also improved an individual's ability to learn.

Number three, you cannot claim to have educated unless you can also demonstrate that you have developed positive learning related attitudes, values and beliefs; things that come along with the learning that are associated.

The first two principles are relatively self-explanatory. As I emphasized a moment ago, mastering concepts is not the same thing as gathering and exchanging marbles and I think making demonstrable improvement in learning as an explicit learning goal is terrific.

The real magic is in the last principle. I just love the phrase, and I use the phrase now as a part of my lingo, “learning related attitudes, values and beliefs.”

Now do not look to the paper for what I'm about to say, because as educational psychologists Slavich and Zimbardo were emphasizing things that were important to them as the third principle: motivation, self-efficacy, and satisfaction. But I see that category as being much broader. It's the stuff that comes along with the education that does not appear on the syllabus. What are these learning related attitudes, values and beliefs? One thing that I would say is a thing called disciplinary disposition, the things that comes along with the learning of the subject matter in the discipline that is so embedded in the way you think about it, you stop thinking about it.

I have mentioned this idea earlier. As a scientist who is a science educator, I gave you the example of how scientific skepticism is inextricably joined with my understanding of the subject matter. Scientific skepticism is an example of a learning related attitude, value or belief that gets delivered… that ***should*** get delivered… during effective science education.

Arthur Camins, in a Washington Post editorial about a year and a half ago, wrote a nice piece relevant to this topic. He said that if he strips away all the window-dressing, there are only three things he cares about seeing in students who emerge from a STEM education: one, that they have comfort with ambiguity; two, that they have comfort with the search for uncertainty; and three, that they have comfort for learning from failure. These are learning related attitudes, values and beliefs because I promise you nowhere on my syllabus is there a day that says Day 16, today is skepticism day. Nowhere does it say this is the uncertainty day.

As a person versed in the state of the art, and here's the best argument you are ever going to get for the blending together of research and teaching, if I am being as intellectually honest as possible when I teach, then I can't help but be skeptical. I can't help but deal with uncertainty. I can't help but know the positive aspects of learning from failure because it's a part of my DNA as a disciplinary expert. One of my colleagues, who was curious about what I was doing in the classroom, gave me an insight that I value greatly: he said, oh, I see, you are actually just teaching the students about learning science, and not at all teaching about how to do some subset of science problems or how to take science tests.

When a scientist is in class reacting, particularly when you're reacting extemporaneously… when you're doing in class what you need to do a lot of, namely, improvisation… you then default to your own core values as a scientist. And if your core values as a disciplinarian include things like skepticism, comfort with uncertainty, and so forth, those things will come out. You cannot help yourself. It is the way you think about the subject.

I would like to think that I am displaying those things every day as I think about the way I interact with the subject matter with my class. It is our job to design and implement lessons where these things can come out.

There is a value in the challenge that Slavich and Zimbardo provide because they remind us that the more that we can reflect on these principles and make them explicit, the better off we will be as educators. Do not leave it to chance. Do not leave it to be the tacit knowledge. Understand when it's happening, step to the side and point to it and make that an explicit part of what's done.

I’ll say it again: learning related attitudes, values and beliefs. For example, to write and speak clearly and economically, to see recurring elements and common themes, lateral thinking, to know that no answer is a final answer, social responsibility, intellectual integrity, replacing confrontation when it comes up with things like cooperation and learning about conflict resolution, and the list goes on and on and on. And that is not a new-fangled 2014 list, that list is one version of many that lists the values from a liberal arts education. Promoting these values is not a quaint, nineteenth century anachronism.

I recently read an editorial where the word “artisanal” was used to describe liberal arts values. I like that: a great education is like getting a nice, hand-thrown crusty pizza with fresh mozzarella, freshly pulled from a wood-fire brick oven. It does not come out of a box, or a CPU, or a video.

Your Provost can't demonstrate these values, your President can't demonstrate these values, and the Director of your learning center can't generate this or demonstrate this. We, the faculty, have to demonstrate this.

We are the discipline. If I answer my phone and say “Hello, this is Chemistry,” I really mean it.

We are Chemistry; We are History; We are Sociology; We are the Fine Arts. If those learning related attitudes, values, and beliefs are embedded in how we understand, then we are the ones to bring them out.

It is not easy to generate the evidence for these things, trust me. And if anybody tries to sell you on the idea that you can get a 25-question, multiple choice test that will demonstrate that your students have developed skepticism, ask for the bridge instead.

People will try to sell you the idea that this stuff is easy to get. It's sometimes called institutional assessment. Pisses me off. Our job is to make sure these values are there, and sooner or later it is our job to make sure we provide the evidence for these values. We need to provide this evidence for our administrators. *We really do.* We're putting up an argument that's no different than the argument that we put up when we earn tenure. We're making an argument. We're providing the evidence for the thing that we claim, that we are educators. And you cannot claim to have educated unless you can demonstrate that students have mastered the concepts, have increased learning how to learn and have positive learning related attitudes, values and beliefs; that is a wonderful, wonderful challenge.

**A grand challenge**

The challenge I just identified is a big job. We need people, and we need to train them, the people who are going to be the faculty members for the next three generations, who might be able to make a dent in this challenge.

I have hung my entire career on future faculty development and doing it in a way that arms the faculty with a way to get work done. You have at Drexel University, right here and right now, the same thing that every research university has, namely post-docs, grad students and undergrads who want to be professors one day. Find them, reach them, and put them to work. Gather that evidence for the grand challenge the same way you do when you put them to work on your research ideas. You can get the details about this elsewhere in my writing.

**Learn from your students about how they learn**

Mining the strength of the classic liberal arts education is not easy to do but it's enormously important. There is an emerging literature out there on discipline-centered post-secondary education, and it sits alongside the decades of research from psychology and educational psychology in ways that can cross-inform and advance understanding.

We have evidence that students learn best when they do not have easy access, to authoritative answers. It only makes sense. If you have an answer key you're going to cheat. If you know the authoritative answer is out there, you are less inclined to dig deep for your own understanding. Perhaps the most interesting discovery is this, because it has such face validity: when you put students in these experimental psychological situations, not only will they cheat when they have access to an answer key but they will believe they are learning. Self-deception comes with providing people with easy access to answers. That's interesting and we ought to think about it.

It’s easy to hear this result and then react like an idiot: great, I will stop giving answer keys. Bwah-hah-hah. But reacting thoughtfully means constructing learning environments based on what to do instead, and being sure to inform students about why you are doing what you are doing… call it informed consent if you want.

I've been teaching since 1982 and I will admit to you that there is something I've never done. I've never offered office hours where I say I will be at my office during these times, so come by then and ask questions. Instead, I hold open sessions in big rooms where I say I will only answer real questions (e.g., “Can you do problem 16?” is not a real question; well, at least, it is a question that only has a yes or no answer). I do all kinds of other stuff, but promoting the idea that students need to climb the mountain to find the little guy sitting at the entrance to the cave of wisdom, as the source of authority who will repeat the given truth, I do not want to encourage that. I have never wanted to encourage that. Sources of authoritative answers can be evil.

Another emerging literature points to the value in giving high level exams that have lots of challenges and where students get things wrong. *Mother of God!* *Student can get things wrong!* And those errors can provoke further and deeper inquiry than when students take dopey exams. Evidence-based teaching is not, to me, a long string of parlor tricks, it is an understanding about learning that I need to adapt to my understanding of my discipline as I think about how to accomplish three things: conceptual mastery, improving learning how to learn, and gaining those learning-related attitudes, values and beliefs.

I told a story yesterday about how I started looking at some of the high achievers in my own class. I call them freakishly high achievers because they do better than I do on my own exams. When I write my grading keys, I rarely get 100 percent the first time around.

I had gathered some information from those high achievers about what they do when they are learning, and rather than ask them what they were doing well, I asked a different question. In fact, you might be provoked into thinking about asking your own really good students this question. I didn't ask them why they were doing well, I asked them to think and tell me why they thought their peers were not doing well. Be critical. This is anonymous, so be critical.

Why are your peers not being as successful as you? Tell me about their behaviors. Here's the three things I learned, and these are the things I learned from a group of about 40 first term first year university students. These students told me three fascinating things.

The first thing they told me was this: you know what my peers are doing wrong? They are confusing the understanding of somebody else's answer with having solved the problem. That makes an enormous amount of sense and argues for not giving those authoritative answers. These really good students know this already.

The second thing they told me was that merely the knowledge of the existence of other people's answers was a distraction to learning. Never mind the answers. They had already written those off. They did not see their peers engaging as deeply because they know that they could reach over and find answer keys somewhere, if they really wanted to. When it is too easy to cheat, some will.

And third, they told me: my peers tend to forgive themselves small errors, whereas I see the small errors that I make as something to focus on because they're like the tip of the iceberg, always a sign of something bigger under the surface.

A collection of about 40 first-term, first year students told me about their learning in a way that I could usefully turn back to the class as a whole, which I did, the next day. Nothing in the last year has made me more hopeful than what those students told me.

**Good teaching is not easy, and easy teaching is not good**

When you can, wean yourself from the script of PowerPoint. I've said this so long it's practically just something that comes in the inside of my eyelids.

How can I improve the state of higher education overnight?

One, make PowerPoint illegal.

Two, outlaw multiple-choice exams.

We have lost something. We have lost the ability to walk into the classroom with that kind of commitment to the social contract of the face-to-face interaction to say I am going to give you my all, right here and right now. I hate the idea of walking in with a script. I can't do it. It turns out I fundamentally can't do it. I need the lights up, I need to see the faces, I need to talk with the crowd to see if they are getting it, and I need to improvise, in the moment, according to how things are going down. I have a nearly unlimited number of ways to get you to walk along the pathway of understanding organic chemistry, but I have to interact to do it.

Performance is not a 4-letter word, and it is simply not the same as poo-pooing an effective performance as merely edu-tainment. Think about a script to any movie that you've seen. Think about the notes on a staff to a musical piece. Think about the directions of a dance.

I use the comparison to music all the time to make this point about performance. You want to learn to teach like me and you think you can do that by grabbing my notes? Be my guest. Why don't you also just go grab Yo-Yo Ma's notes and see if you can play like him?

It's not about the notes, it's how you play them, and how you play them comes from your experience, and what you see between the lines. And at some point, even the notes become internalized and can be reformulated on the spot. As I think I said before, I find teaching performance to be no less than the grandest form of improvisation.

Because I am interacting with my crowd, I am making turns and moves that I had no idea were coming. It is truly different every time, and somehow it ends up looking like I've known it all my life. In fact, think that an act of excellent classroom performance is the greatest level that anyone can achieve because not only do you have to deal with the writing of the script, you have to direct it, you have to produce it and you have to perform it. You have to put it on and you have to know that no matter what you planning to do, you got it wrong, and so you have to turn on a dime. I don't know how you do that with PowerPoint. I can't.

And I certainly don't know how I demonstrate deep learning on multiple-choice exams, and except for the people who are trying to sell me on them telling me that I can, I really do not see that much support for them. You might be able to learn something, but you cannot learn the same things you can learn when a student is faced with a blank sheet of paper and a provocation.

I also think about weaning faculty from the belief that classroom tricks can carry the burden of educating: easy teaching is not good. If you turn your classroom into a game show you have now made it active, but I'm not sure that you have created intellectual engagement – teaching science and not just how to solve science problems.

I love this idea from Richard Clarke, from 1983:

"Media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition."

I hear a lot of conversation about trucks. I use this truck, I use that truck, but what I don't hear about is the groceries. What's being delivered? What's being learned? I've said before nothing comes easy, it's worth underscoring that. You can call a 30 item multiple-choice exam a concept inventory, but that does not mean it actually is one. There are ways to collect real data on conceptual understanding, learning how to learn, and maybe even those attitudes, values, and beliefs - but it's hard work, and you know it, because in every single one of your fields, good research, to really know something, is hard work.

So here is my conclusion, if I have not depressed you too badly.

I have huge, positive and enthusiastic respect for the power of the faculty and the power of education. The utter joy I have from getting just those little quotes from those high achieving students tells me these are really core values that are out there, and they need to be nurtured, understood, and spread around. They provide direction for the type of education I want to provide.

I also showed that it was possible yesterday for a chemistry department in a top tier research institution to embrace holistic education as a part of its mission. Some people would say poo: you are simply the exception that proves the rule. *Au contraire!* I say. As a scientist all I need is one exception to disprove your stupid hypothesis.

The good news is that I think the future of higher education is still in our hands. We the Faculty. I don't think it's been taken away yet, and it is worth fighting for.

Let me end with one more favorite quote. It is from George Bernard Shaw. I first encountered this quote 40 years ago because it was taped above the bench that I occupied as a graduate student at UW-Madison, so it was a message to the future:

"Take care to get what you like or you'll be forced to like what you get. Where there is no ventilation, fresh air is declared unwholesome. Where there is no religion, hypocrisy becomes good taste. Where there is no knowledge, ignorance calls itself science."

And I would add to that: where there is no learning, education calls itself competence.

Thank you.

*LEADING REFERENCES:*

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