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The challenge of ensuring college readiness lies with ensuring that all of our children have great teachers. Arthur Levine, past president of Teachers College, Columbia, states, in a recent report on the preparation of teachers, "The future is in the hands of the nation's teachers. The quality of tomorrow will be no better than the quality of our teacher force."

My educational path was backward compared to that of my colleagues in education. I got my undergraduate degree in science education and then went on to get my masters and PhD in experimental nuclear physics. It wasn't quite as simple as I'm portraying but that's another story.

My first job after undergraduate school and before going back to graduate school was to teach high school physics, chemistry, and physical science in a very good, but elite, private boarding school. I didn't need to worry about these students knowing that they were heading to college. After my PhD in nuclear physics I had a joint appointment at Temple University between the physics department in the Liberal Arts College and the science-education dept in the School of Education. So I literally lived in two very different worlds. I would listen to my colleagues in physics talk about the fluffy educators and my colleagues in education talking about the irrelevant physicists. In the context of the theme of ensuring high school students have access to college, this was the time in my career when I became very familiar with the challenges with an urban environment. Later, I took another joint appointment at Montana State University... half time in physics and half time heading the Science/Math Resource Center… helping science and math teachers across the Big Sky state. Here, I learned first hand the challenges of rural science education.

My main point is to assure you that I have existed (I think successfully) in three of the four "worlds" involved with teacher preparation. (The fourth being the political, policymaking domain.)

My talk will oscillate between the specific situation in science teaching and the general state of teacher preparation. I make no claims to hold any expertise in mathematics education though I have a nagging suspicion that math and science are more alike than different.

First the state of science teaching in this country:

We tried this before during the Sputnik era … But, (and this is true)... the very same day that the Russians launched Sputnik, the USA launched, "Leave it to Beaver." That's true… and, while funny; I think it's symbolic of the changes that have occurred in our country in the past half century since October 4, 1957. Incidentally, we didn't fail in our Sputnik response… at least not as badly as many claim. In 1957 the challenge was to educate the scientific elite.

Our current challenge is to educate *all* students to live in the rapidly emerging technological world. As numerous books and reports highlight we live in a very "flat" world that has the potential to totally turn our global position in that world upside down. And the victims of this will be our children. To ensure their success we need to move beyond what I call the McDonalds (or Wendy) solutions to the problem — putting colored keys on the cash registers so young adults can make the correct change for our hamburger order. Our nation needs young adults coming into its workforce who are able to problem-solve and communicate.

I believe that there are two major challenges in science education reform: First, teachers of science in this country don't know the science they've been assigned to teach. I should quickly qualify that: With the exception of NSTA members. While funny, there's probably some truth to that: NSTA members are the "alpha group" of science teachers in this country. Work by Horizon Research, Inc. has shown that only about ¼ of elementary teachers felt qualified to teach science. At the middle level, it jumps to the still unacceptable level of half of teachers report being unqualified. That this is serious should be of little debate but it bears mentioning that the reason for taking this seriously is that in a field that is sadly lacking in research data, there *is* good data showing a positive correlation between teacher content knowledge and student achievement. (Darling-Hammond, 2000; Chaney, 1995; Druva & Anderson, 1983).

The second challenge is the scale of the problem. Again, Levine: "[Today's]

… teachers have to be prepared to educate *all* of their students to achieve *the highest learning outcomes* in history. This is a fundamentally different job than that of past generations of teachers." [Levine]. And, the number of teachers of science… two million in-service teachers … is daunting. NSTA's dirty little secret is that we're the biggest science teachers association in the world but our membership pales compared to the number of teachers of science in this country. Again, there are two million teachers of science in the USA.

But for tonight's talk I will shelve that second challenge of scale and talk about implications of the challenge in the context of teacher preparation.

For too long university administration has treated the education major as their "cash cow" to the determent of quality teachers in our nation. Administrators have realized that the physics departments could never draw the numbers that the education school could and the education school could never bring the prestige to the university that an investment in the physics department could. Thus we have insufficient resources, we tolerate low admissions standards and have low expectations in the schools of education. Sadly, those are things we have little control over maintain quality for that university.

As a teacher-producing industry, we have a divided "universe of power:" The universities hold the franchise, the states hold the license, and the communities conduct the practice." So, turning this ship around will not be a trivial task.

Something we do have SOME control over the university domain in how we prepare the future teachers: the curriculum of teacher preparation.

"The focus of schools has shifted from teaching to learning… to the skills and knowledge students must master, rather than the skills and knowledge teachers must teach." [Levine: p.12] You'll see this in the new NCATE accreditation requirements: We are heading away from counting courses (and grades) and moving toward accessing competencies — eventually, I would argue, through student achievement.

Levine highlights a question that teacher educators have wrestled with since the normal schools turned into college campuses around the 1930a: Is teaching a "profession like law or medicine, requiring a substantial amount

of education before an individual can become a practitioner [or] a craft like journalism, which is learned principally on the job"? [Levine: p. 13] Most of us would probably agree it's a combination of both: the challenge is defining the balance. I'm sure you can identify the players: most people on the profession side are university types and most people on the practitioner side are in the "alternative certification" camp. What's the answer you would get if you asked practicing teachers? But I'm reminded of my son's friend who after 5 years at a high-ranking university landed a job teaching elementary children in San Diego. She emailed me frantically saying, "Nothing I learned at … is helping me now."

But from my limited experiences I will claim that we university folks have done a poor job on the practitioner side of the equation. In our quest to be honorable on campus we shunt the young faculty who have strong practical experience. In an attempt to have education faculty teaching many courses, we have nearly totally disregard the student teaching experience.

But I would claim we also don't do such a hot job on the professional side either. In the context of my claim that science content knowledge is the biggest challenge, I would claim that our preparation of science teachers' content knowledge is dreadful (too strong?). I should add a personal note here. I have won numerous teaching awards. Please believe me when I say that my huge physics classes were widely popular… filled with future teachers as well as business majors, a few poets, and promising architects. I worked hard to make compelling demonstrations, I understood where the common misconceptions were and addressed them explicitly; I even knew most of the students first names within about a month of the class. Still, I would claim that my class did not do an acceptable job preparing the future science teacher. It did not give him, or her, the understanding that would need to be a successful science teacher. And, because of the huge chasm between the science departments and the science-methods departments there was little or no communication about *what* was needed… and, *who* would do it.

So, what to do. (after all that, I'd better have some solutions)

I believe we have to "erase the blackboard" that holds the curriculum for teacher preparation. We need to move beyond tyranny of tradition and develop a shared vision for the preparation of science and mathematics teachers.

First, we need to know that we can never do it all in four years. A famous educator, the late Ernie Boyer, told me once that universities need to give their teacher graduate an "educaid" card … much like the federal government does to guarantee basic health to its citizens. Interestingly, each state has its own spin on the Medicaid program. Many (about half?) of their graduates heading toward teaching in your state. (Some data shows that they migrate to where they grew up.) Wouldn't it change your thinking if you could say that "we're not done with you… stay connected." Of course in the Internet age, this strategy depends less on where that new teacher ends up. In any event, adopting the Boyer suggestion does two important things. First, it frees your campus (and the state regulators perhaps) from thinking that everything will be done in four years. Second, it gives you a direct connection to your customers. Having the teacher in the field connected to you gives you opportunities to collect data, seek advice, … in short, increase the practitioner side of your preparation responsibilities.

For the past four years the NSTA has been conducting an e-mentoring program for early-career science teachers. The basis of the project is relatively simple: While many schools are now addressing induction, few have the on-site resources to give discipline-specific help to the new science teachers. Through our project, we pair the new teacher up with a trained mentor (experienced teacher) who has the same teaching assignment. The mentee-mentor pair are also from the same state. The e-mentoring project is currently in 16 states. This experience has taught us a lot about what we don't do for future teachers. Watching these teachers struggle through their first three years has been an eye-opening experience. And, I'd be less than honest if I didn't tell you that one of the things they claim not to need help on is content knowledge. I disagree and have good evidence to the contrary but that's what they report. Recently we asked these beginning teachers about the dilemmas they face. The responses have been fascinating and it points to what we who prepare teachers should think about. Most deal with school-based issues but not all… and, even the school-based issues should be addressed at the college campus. Who's the most powerful person in the school? (Janitor).. who is second?

Let me return to the blackboard: As you stare at the empty blackboard, you need think about getting the whole university involved in reconstructing its curriculum content. I'm not sure how to pull this off. I believe that the current attitude of education majors is extremely short-sighted. I believe that

the teaching major is like no order major on the university's campus in its power to No major … physics, engineering, nursing… has the unique ability to supply the next generation of undergraduates. The teachers that we prepare today become the counsel for the bright students choosing colleges in the next 4-8 years. I hope this argument of the uniqueness of the teaching major might pull science departments to your empty blackboard. I know they care deeply about the quality of the incoming students Telling them that our country is in trouble hasn't done it. The reports and speeches in Washington are just creating the school-of-education bashing. Science departments reply is, "Let us teach them, we'll weed out the dumb ones."

Next, the curriculum that goes on the blackboard must be radically different from the current collection of courses. In fact, perhaps even the quarter-long, or semester-long courses need to be abandoned. I don't know. It is going to take some very creative, intelligent thinking. What I do know is that every time a stakeholder identifies a new need, we cannot react by creating a new course ... seeing it as a way to up our FTEs. Also, from the consumer's point of view, there's not enough time in the four, or five, years. This is going to be a hard pill to swallow. The whole administration — from the President to the dean of Liberal Arts and the department heads of the sciences has to give up the notion that we can get by just pushing future teachers into those large "one-size-fits-all" introductory courses.

Finally, and this will be the hardest, we need to find a way to make this new preparation be ubiquitous across the 1200 campuses that produce new teachers. I don't know how to do this without giving serious attention to data-gathering and raising the standard of research. Unlike my field of physics, we do not have a good progress model in education. There are way too many advanced degrees being granted for trivial work. As a profession we need to highlight the things we know for sure, the things we think we know (but may be wrong), and the things we've really got to know to progress.

Thank you.

Reference:
Arthur Levine, Educating School Teachers (The Education Schools Project, Washington, DC, September 2006)