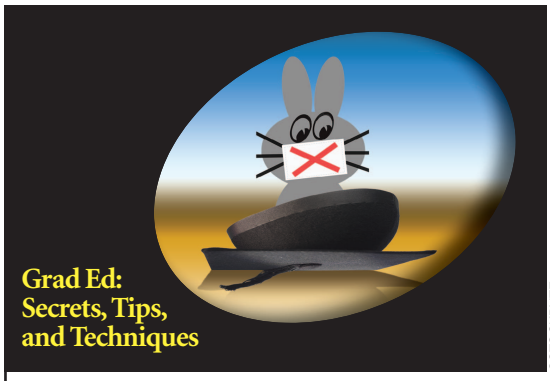

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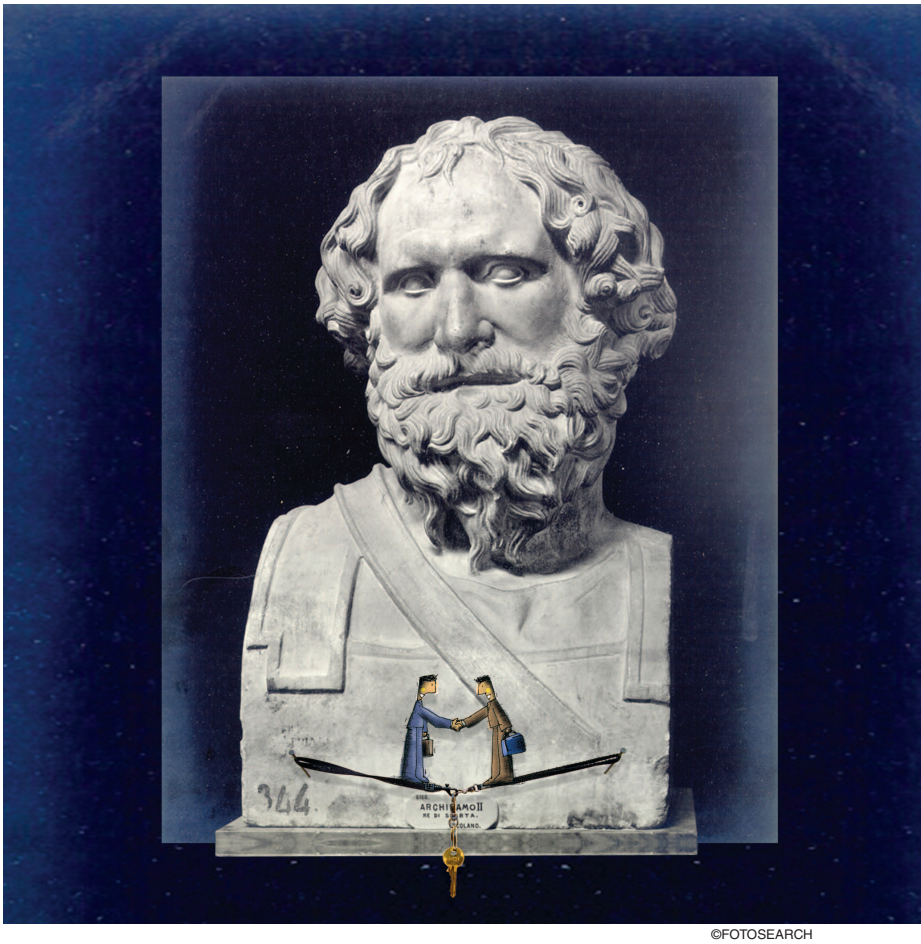

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Reflections on the gentle art of effective teaching and mentoring

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Give me a place to stand, and I will move the Earth.

—Archimedes

So here's the deal: Let's assume that you are presently a graduate student. Doesn't matter how far along you are. Maybe you are desperately holding on by the skin of your teeth to just survive that first year of grad school and you still proudly sport that deer-in-the-headlights look 24/7. No worries. Or perhaps you are nearing the glorious checkered flag, the proverbial light at the end of the tunnel, with that nice, warm feeling of "I'm-about-to-get-my-Ph.D.-and-I-know-a-heck-of-a-lot-more-than-my-professor-ever-will." Even better. Heck, maybe you're still thinking about whether going to grad school makes sense for you as a career path. Not a problem.

Let's be optimistic and also assume for simplicity that you have jumped into the grad school fray for all the right reasons. You have put serious bucks on the backburner (surely you already appreciate that there are *much* easier ways to make a living). I'm thinking instead about how you revel in the thrill of discovery, the intense pleasure you get from being a key cog in a team of really bright folks working on exceptionally challenging problems. The passion you have for the many joys of learning to bring your creativity to bear; of inventing, innovating, thinking new thoughts, and learn-

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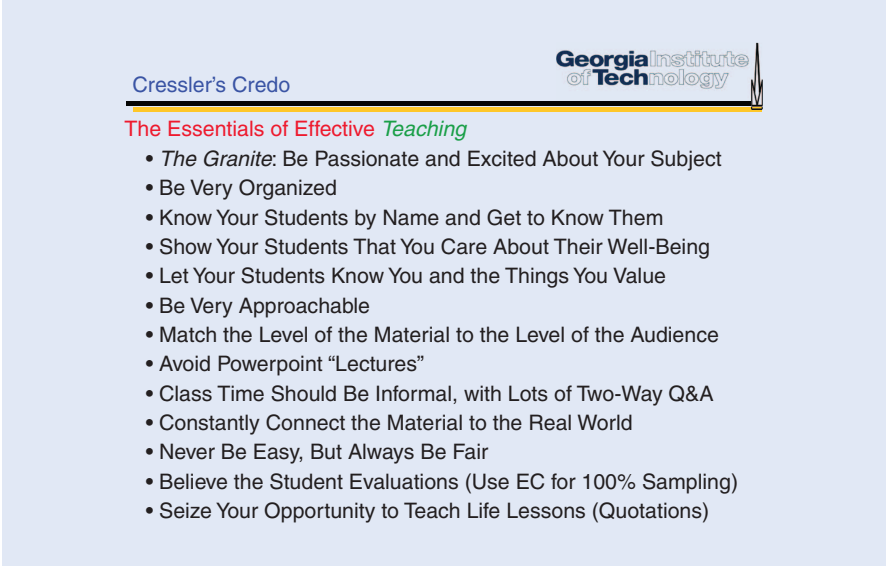

Fig. 1 The essentials of effective teaching.

ing new things. I'm thinking about the excitement you experience when you help develop new technologies that will change our planet and humankind for the better. You want to make a difference. You are in it for the love of the game. Right? Fantastic!

Assuming all this to be true, and that your graduate experience is off to a stellar start, you will still need two essential skills before you launch that illustrious career, your life-after-grad-school of which you have been dreaming. What? There is more to learn?! Oops, sorry to break the news. There is more you will need to learn regardless of whether you choose to be a professor at the end of the day to help shepherd the next generation of students or if you decide to practice what you have learned at an industrial or government R&D lab so you can rub elbows with the big boys and girls. Even if you opt to just manage folks doing R&D or if you decide on a whim to chuck it all and start your own company with a clever idea you came up with in the dead of the night. Heck, even if you decide to punt engineering and science altogether and take up professional skydiving. Or sword fighting. Or coal walking.

However it turns out at the end of the day, you will still require two essential skills for long-term career success. Skills for which, sadly, they do not have classes in grad school. Things they never tell you about. Things hidden from your view. Curious what those two essential skills are? Okay, here it goes: 1) You must be able to teach and 2) you must be able to mentor. And you will need to be able to do them both very well. Very, very well.

Skeptical? You shouldn't be. Think of teaching in its broadest possible context. Teaching is far more than just a classroom experience, an I-lecture, you-listen sort of thing. I am talking about the educational enterprise in its full glory. Helping folks learn new things. Introducing people to new worlds. Stretching minds. Changing the way people think, the way they see the world. Just who would you teach? Well, future students obviously. But if you don't opt for an academic career, there are plenty of others you will need to teach. Your colleagues, your partners in crime (so to speak), the "blue-suits" that sponsor your R&D, your underlings. Heck, even your kids when that time comes.

However it turns out at the end of the day, you will still require two essential skills for long-term career success. 1) You must be able to teach and 2) you must be able to mentor.

Same thing with mentoring. Think of mentoring in its broadest possible context. Inspiring others to do great things. Mastering the art of leadership. Showing others how to be the best they can be at what they do, no matter what that is, big or small.

Stop and consider for a moment. You will soon have a major role to play as one of the educated elite. The best and the brightest our world has to offer. As Archimedes famously said regarding his new-found lever, you have been given a place to stand—now go move the Earth! This is not optional. This is a responsibility you now own, like it or not. You must teach. You must mentor. And you must do them very well.

Come learn the black arts

Want to know how to be very, very good at teaching and very, very good at mentoring? Yeah, you do. I'll share with you my personal credo for effective teaching and mentoring. So what's a "credo"? Literally, what I believe to be true. Things that I have learned over my career that work and work well. The tools of the teaching and mentoring trades, if you will. The black arts of the field. The undiscovered country. The secrets no one ever seems to want to tell you. Think of this as a primer for teaching and mentoring success. I am a professor, so my credo is aimed at students, but you'll get the idea. The secret rules of the teaching and mentoring game are very general, useful in many contexts; academic, industrial, government lab, start-ups. Families even.

Admittedly, I am going to share my own personal beliefs on the subject. As a budding engineer or scientist, you should probably stop right now and examine my credentials, the justification for the bold claims I am about stake into your sand. Suffice it to say, you can trust me. Really! I will share what has worked well for me over the years. I'll spill the beans. I'll deliver the goods. Pay attention, this is important!

So … here goes. Drum-roll please … see Fig. 1, the essentials of effective teaching.

Go ahead, try these on for size. Read through the list slowly. Savor each one. Check their heft in your hand. Roll 'em around in your mouth a time or two. Ponder them. Extract some meaning. Disagree if you'd like. A few supplementary comments are in order. I apologize for the stream-of-consciousness riff. Well, not really. Bear with me.

Cressler says that the underlying secret to success in teaching is being excited, passionate, and animated about the material.

Cressler's Credo

Georgia Institute of Technology

The Essentials of Effective *Mentoring*

- *The Granite*: Foster an Informal, Collaborative Team Vibe
- Show Your Students That You Care About Their Well-Being
- Let Your Students Know You and the Things You Value
- Regular Contact Time Is Essential, But Don't Overdo it
- Provide Candid Appraisals, But Always Be Constructive
- Lead by Example—Work as Hard as Your Students
- Actively Encourage Your Students to Become Mentors
- Empower Your Students to Use You Only as a Sounding Board
- Always Be Patient, Upbeat, and Optimistic
- Provide a Safe Environment for Failure
- Celebrate the Accomplishments of Your Students and Team
- Give Credit Where Credit Is Due (Always Them, Never You!)
- Be Joyful and Always Remember the Golden Rule

Fig. 2 The essentials of effective mentoring.

It has always been my experience that being excited and passionate and animated about your material, whether semiconductor physics or turf farming, is the underlying secret to success in teaching. The granite. Be contagious in your enthusiasm, and it will spread like a brush-fire among your students. And if you are not enthusiastic about your subject, you likely chose the wrong field. There are remarkable facets to be found in all subjects, of all disciplines, at all levels. Drill deep, think late into the night. Read the history of the field and especially the wacky personalities that dreamed it all up.

Here is a major whiff for most teachers. You must remember that this is all about your students. Heck, they pay your salary. Sort of. Students are the be-all and the end-all of the teaching game. Inspire them. Know their names, know who they are, and what makes them tick. Show them that you care. Let them know you and what makes you tick, the things you value, your successes and failures, what you do in your spare time. Trust me, they are interested. Be friendly and approachable. Be nice, say "hi." Be informal in all that transpires in your classroom and out. But, be very organized. Controversy alert: ditch the PowerPoint "lectures." Students hate them. Stale as day-old toast. And there is a high risk that they will make your love of teaching wither on the vine. Go back to the whiteboard (grrr—I miss my blackboards!), walk around the room. Live on the edge. Worry less about how much material you cover and more about how well you cover it. Ask your students lots of questions, tons of questions. Once they see what you are all about, their questions will naturally flow and it will become a busy two-way street. Heck, students are the most curious animals on the planet. Avoid the temptation to be "easy" as a lame attempt to garner student affection. Never works. And you do them a grave disservice by insulting their ability to work hard for something of great value. No pain, no gain. Period. Still, be fair. Always.

> I can't tell you how many times I have heard professors gripe about the unfairness of their teaching evaluations. Nope. Don't believe it.

And for goodness sake, be willing, ready, and able to admit it when you make a mistake. Listen to their candid opinions of your teaching, and take it to heart. Students don't lie. Well, at least if they respect you they won't. I can't tell you how many times I have heard professors gripe about the unfairness of their teaching evaluations. Something along the lines of, "This is a tough course, so of course they trashed me." Nope. Don't believe it. I have consistently received the exact same evaluation marks (warning: no-time-for-modesty alert), which are mighty darn high, in a tough core course with an average GPA of 2.3 and in a "boutique" elective course with a GPA of 3.5. For 18 years. It can be done. Your mantra? Believe your students' opinions of your teaching. One final shocker: Your students need good role models in their lives. People that not only teach them technical material, but also offer life lessons, give advice, show they care, share their own personal stories and beliefs and life experiences. Does it take some personal vulnerability? You bet. Will they gobble it up and ask for more? Of course they will. Assuming you are a pinnacle of personal sincerity, integrity, and character. I use a collection of quotations as a segue for this classroom "sharing" process at the end of each of my lectures. But there are many creative ways to mine this untapped gold. Encourage your students to self-reflect. They will be better for it, as will you.

Rounding into shape

Ready for round two? Drum-roll please . . . see Fig. 2, The Essentials of Effective Mentoring. I am speaking here mostly about mentoring an effective research team. You know, a bunch of scruffy-looking, 20-something grad students, with a few undergrads thrown in the mix for fun. Still, I would argue that the rules of this mentoring game are quite general and widely applicable. Ye

olde granite? Well, I have always put the "team vibe" at the top of my list. Informal, collaborative. Dare I say, family-like. A place of comfort and security. It takes good "soft skills" to function seamlessly in such a team, and truth be told, I would rather have a clutch of bright team players than a single off-the-charts genius any day of the week. Hands down. Strange as it may sound, I like my students to like each other, to enjoy working together, to look forward to coming to work. Those that share the team vision.

Okay, some repetition. Students are the be-all and the end-all of the mentoring enterprise. Inspire them. Share your vision. Know who they are, what makes them tick. Show them that you care about their well-being. Let them know you and what makes you tick, the things you value, your successes and failures, what you do for fun. Trust me, they are interested. Be friendly and approachable. Be nice, say "hi." Contact time with your students is very important, but don't smother them. I hold biweekly full team meetings, and then on off-weeks I hold short one-on-one meetings to just chat and catch-up. In between, I keep my door cracked open almost all of the time so that they know I am there if needed. My students know I am busy, and I know they are busy, but I am never so busy that I can't spare a minute to act as a sounding board or help. New students need this more frequently than veterans, to be sure, since part of a grad student's job is to evolve into an efficient independent problem-solver, and like all things this must be learned.

To be successful, students must find the way to marshal the requisite forces needed to solve the task at hand, be it a complex technical problem, an experimental rat's nest, or even a personnel issue. It is just part of the grad student M.O. Your students work hard and so should you. I try to never ask a student to do a job I would not be willing to do myself. While it is a ton of work, I provide yearly (candid) appraisals of my students (more frequently if there are problems to be wrestled with). They need it, and I need it. It helps ensure we are both on the same page with respect to their performance. At the same time I have my students do an anonymous appraisal of me. A healthy exercise and gut-check for team health.

You have to be optimistic when dealing with the grad student animal, strange creature that it is. (Remember, I was one once, too.) Patience, patience, patience. And be up-beat, optimistic, especially when they are down or despairing ("It's been two years and I have no lead-authored papers! Oh my, what's to be done!"). I believe strongly in providing a safe harbor for students to fail. That is how we all learn, after all. Get knocked down, stand back up, learn what you can learn from the experience, then put it behind you and move on. I find that resisting the urge to step in and make-it-right and, instead allowing small "crash-and-burns," can be remarkably instructive, and in the end, quite life-giving for new students when they inevitably succeed. As they will. Eventually. Well, most of them. None of us are perfect after all.

Finally, celebrate. Often and much. Cheer their accomplishments, raise them up for praise. Hold them high. Brag about them. And *always* remember that you, as a prof, are only as good as the students that work for you. Period. Good mentoring can be very challenging, but in the end it is so very life-giving. Few things are as richly rewarding as seeing a novice become a master before your eyes as that person passes through your life. Be joyful in your mentoring, and remind yourself daily of that ageless wisdom known as the "golden rule." Embrace it and smile!

Few things are as richly rewarding as seeing a novice become a master before your eyes as that person passes through your life.

Whew! Well, there you have it. "The Cressler Credo of Teaching and Mentoring." Of course, as you surely appreciate, bright minds that you are, there is a huge difference between knowing the answer and being able to effectively put the answer into action. My advice? Practice, practice, practice. Embrace every opportunity that comes your way to teach and to mentor, in whatever form it may take. Look for the small chances to do your thing. Seek them out. With some solid bedrock beneath you, and some on-the-job training, you will get there in no time. Be bold. Be brave. Be optimistic. And hold on tight! Life is good. Thanks for listening.

About the author

John D. Cressler (cressler@ece.gatech.edu) received his Ph.D. from Columbia University in 1990. He was at IBM Research, Yorktown Heights, New York from 1984 to 1992, and on the faculty of Auburn University in Alabama from 1992 to 2002. Since 2002, he has been on the faculty of the Georgia Institute of Technology in Atlanta, where he is currently Ken Byers Professor of Electrical and Computer Engineering. He considers teaching and mentoring to be his primary career vocations.

His research interests center on the understanding and creative utilization of nanoscale, stain-engineered, silicon-based (SiGe/strained-Si) heterostructure technology, devices, and mixed-signal circuits, with the goal to enable new game-changing approaches to electronic system design. Cressler and his graduate students have published over 500 technical papers in this field. He is the coauthor of *Silicon-Germanium Heterojunction Bipolar Transistors* (2003), the author of *Reinventing Teenagers: the Gentle Art of Instilling Character in Our Young People* (2004), the editor of *Silicon Heterostructure Handbook: Materials, Fabrication, Devices, Circuits, and Applications of SiGe and Si Strained-Layer Epitaxy* (2006), and the author of *Silicon Earth: Introduction to the Microelectronics and Nanotechnology Revolution* (2009). He is presently working on his first novel, a love story set in 14th century Muslim Spain.

He has served as associate editor for three IEEE journals and has been active on numerous IEEE conference program committees. He serves as a distinguished lecturer for both the IEEE Electron Devices Society and the IEEE Nuclear and Plasma Sciences Society. He has received a number of awards for his teaching, his mentoring, and his research, including the 2010 Georgia Tech Class of 1940 W. Howard Ector Outstanding Teaching Award (Georgia Tech's highest teaching honor) and the 2011 IEEE Leon K. Kirchmayer Graduate Teaching Award (IEEE's top graduate teaching honor). He was elected an IEEE Fellow in 2001.