INTERLUDE. WHAT DO THEY NEED TO KNOW?

Interviewer: Good morning, Mr. Allen. I'm Angela Macher—project engineering and human resources at Consolidated Nanoproducts.

Senior: Good morning, Ms. Macher—nice to meet you.

I: So, I understand you're getting ready to graduate in May and you're looking for a position with Consolidated … and I also see you've got a 3.75 GPA coming into this semester—very impressive. What kind of position did you have in mind?

S: Well, I liked most of my engineering courses but especially the ones with lots of math and computer applications—I've gotten pretty good at Excel with Visual Basic and MATLAB with Simulink, and I also know some JAVA. I was thinking about integrated circuit design or something like that.

I: I see. Well, to be honest, we have very few openings in design and programming—we've moved most of our design and manufacturing to China and Romania and most of our programming to India. Got any foreign languages?

S: Um, a couple of years of Spanish in high school but I couldn't take any more in college—no room in the curriculum.

I: How would you feel about taking an intensive language course for a few months and moving to one of our overseas facilities? If you do well you could be on a fast track to management.

S: Uh … I was really hoping I could stay in the States. Aren't any positions left over here?

I: Sure, but not like ten years ago, and you need different skills to get them. Let me ask you a couple of questions to see if we can find a fit. First, what do you think your strengths are outside of electrical and computer engineering?

S: Well, I've always been good in physics.

I: How about social sciences and humanities?

S: I did all right in those courses but I can't say I enjoy that stuff.

I: I see … (stands up) OK, Mr. Allen—thanks. I'll forward your application to our central headquarters, and if we find any slots that might work we'll be in touch. Have a nice day.

Felder and Brent, Teaching and Learning STEM, 2016, pp. 13–15

This hypothetical interview is not all that hypothetical. The job market in technical disciplines—especially in developed countries—is changing, and future graduates will need skills beyond the ones that used to be sufficient. An implication for STEM education is that a lot of what we're teaching is the wrong material. Since the 1960s, we have concentrated almost exclusively on equipping students with analytical problem-solving skills. In recent years a significant number of business and industry spokespersons (see, for example, Prichard [2013]) argue that most jobs calling for those skills can now be done better and cheaper by either computers or skilled workers in developing countries—and if they can be, they will be. They also predict that STEM graduates with certain different skills will continue to find jobs in developed countries:

- Creative researchers, developers, and entrepreneurs who can help their companies stay ahead of the technology development curve
- Holistic, multidisciplinary thinkers who can recognize opportunities in the global economy and formulate strategies to capitalize on them
- People with strong communication, management, and teamwork skills who can establish and maintain good relationships with coworkers, clients, and potential clients
- People with the language skills and cultural awareness needed to build bridges between companies in developing nations, where many manufacturing facilities and jobs are migrating, and developed nations, where many customers and consumers will continue to be located

The question is, are we helping STEM students develop those increasingly important attributes? In relatively few cases—mostly small colleges with strong liberal arts programs that emphasize project-based learning (Prichard, 2013) and some individual STEM departments—the answer is "yes," but in an overwhelming majority of STEM programs, it is "not really." We still spend most of our time and effort teaching our students to "derive an expression relating A to B" and "given X and Y, calculate Z," but we rarely provide systematic training in the abilities that future graduates will need to get and hold jobs. Why don't we? Because people as a rule are reluctant to leave their comfort zones, and faculty members are no exception. Most of us can solve equations in our sleep and feel comfortable teaching students to do it, but we're not so sure about our ability to tackle multidisciplinary problems that require creativity and critical thinking, let alone our ability to teach anyone else to do it.

An effective first step in teaching high-level thinking and problem-solving is to formulate *learning objectives,* statements that define targeted knowledge and skills in a way that is clear to instructors and students. How to do that for basic knowledge and high-level skills is the primary subject of Chapter 2. How to then teach the students to meet those objectives is the subject of the rest of the book.