Educating to Innovate

Innovation cannot be taught like math, writing or even entrepreneurship, writes Deba Dutta. But it can be inculcated with the right skills, experiences and environments.

October 16, 2015

By

Deba Dutta

Can innovation be taught?

I first asked that question about 15 years ago, as the first wave of entrepreneurship programs at many of the nation's top research universities got underway. I was directing a program that allowed students to pursue work concurrently in engineering and business administration. It was becoming clear that scientists and engineers could, indeed, be taught to significantly accelerate the process of bringing promising new technologies to market.

But I knew that entrepreneurship and innovation are different, even if related. Both require seeing something that's not there: ideas and solutions to improve life, new markets and so on. But whereas innovators focus on creation of value, entrepreneurs focus on realization of that value. The path of the entrepreneur is more or less the traditional path of business development: conducting market research, raising capital, developing long-term marketing and business plans, and so on. And college and university courses on entrepreneurship mirror that -- covering subjects such as marketing, finance and the like. In contrast, the creativity, passion and broad vision necessary for successful innovation suggest that the very idea of a "traditional pathway" to teaching innovation may be highly unlikely.

Yet, over the years, I couldn't help wondering: Could there be an Institute for Innovation alongside the entrepreneurship programs at major research universities? Are there some discernible patterns behind successful innovation that could help educators everywhere develop innovative mind-sets in our students? As President Obama has noted more than once, innovation is the lifeblood of American global leadership, but with the rest of the world catching up to America economically and technologically, more work is needed to maintain that leadership.

I quickly discovered that the literature on innovation was sparse. Moreover, it was missing a crucial component: reflections from innovators themselves. Thus, with support from the National Science Foundation and encouragement from Charles M. Vest, then president of the National Academy of Engineering, I began what became to be the Educate to Innovate research project.

The project was conducted in three stages:

Interviews. We developed questions and conducted extensive interviews with 60 established innovators. They had experience in industry or academe, or both. Some of them are well known -- for example, Apple

CEO Tim Cook, Stanford University President John Hennessy and cellist Yo-Yo Ma. But most are recognized as innovators within narrower circles, such as Regina Dugan, senior vice president of engineering at Google's Advanced Technology and Projects group and the former director of the Defense Advanced Research Projects Agency, a federal agency known for innovation.

Workshop. More than 60 leaders from all levels of education (K-12, undergraduate and graduate), as well as industry and government participated in a two-day workshop at the National Academy of Engineering in October 2013. Those leaders discussed the data compiled from the interviews and formulated action items and recommendations.

Data analysis and publication. We carefully analyzed the data from the interviews and the workshop and the National Academies Press published it earlier this year (which is available as a free, downloadable PDF).

Broadly speaking, our research reaffirmed my intuition: innovation cannot be taught like math or writing, or even in the current framework of entrepreneurship education. But it can be inculcated by focusing on the interplay of the skills, experiences and environments of successful innovators. More specifically:

Skills. Unsurprisingly, we found that innovators tend to have creativity, curiosity, deep knowledge of a field (invariably more than one), intellectual flexibility and the ability to think outside the box of a defined discipline. But we also found that they are generally risk takers who don't fear failure (although many emphasized that they don't like failure). They also are good at selling ideas -- a crucial skill for raising funds and building a team. Innovation is, after all, teamwork.

Experiences. Again, some findings were unsurprising: innovators have strong mentors and role models as students and young employees, and they generally had a lot of unstructured time while growing up. The ones with whom we spoke emphasized gaining industrial or real-world experience that helped them focus on concrete problems and learn how to function effectively as a team member. They also emphasized the importance of interdisciplinary collaborations as ways to gain new knowledge and see people and problems from many different angles.

Environments. Environments laid the crucial foundation for the experiences and skills innovators need. The interviewees emphasized office designs that encourage informal discussion and collaboration along with explicit encouragement of innovation. Those in education -- especially at the university level -- described the importance of labs, buildings and centers structured around themes, rather than skills. What was surprising, and reassuring, was how intensely innovators perceived the value of environments -- familial to community to academic -- that place a strong emphasis on education.

The report contains much more: more insights, more stories and a slew of recommendations. But in the end, it is preliminary. We need to conduct more definitive research and take some major steps to incorporate the education of innovation into our existing curriculums. C. Daniel Mote Jr., current president of the National Academy of Engineering, put our work into perspective. "Even if it mostly confirmed our intuitive understanding of innovation, it's opened the doors to more definitive research, and that can only help our country," he said.

Now is the time for that research on such topics as how best to translate our study findings into practical and implementable solutions (something that I am keenly interested in). What are criteria and metrics for assessing their effectiveness? The research on understanding innovation itself needs to be advanced. More research is also required to understand how to leverage individual innovation capacity to enhance the innovation capacity of groups and teams; diverse teams are made of, and do well because of, individual differences.

Our interviews also suggest that some people in higher education think that our academic systems must be completely overhauled for us to be able to teach innovation. However, I believe we can, and we must, start within our current systems. We need a two-pronged approach -- one that starts by updating and modifying existing courses and infrastructure, and another top-down one that focuses on systemic changes to the institutional culture, environment and thought processes. For example, emphasizing innovation in all aspects and across all members of the institution, promoting environments and activities to discourage the fear of failure (not the same as encourage failure), and recognizing that our colleges and universities provide transformative experiences, but often outside of the classroom.

For now, we don't need to delay, wondering how or where to start, or to wait to find success stories. We can get started right away by building on activities that we already do well.

Enhancing experiential learning. Many of those whom we interviewed agreed that the craft of innovation is forged through real-world experience. Colleges and universities are already providing students with such experience through capstone projects, industry internships, global programs and other opportunities. For example, Purdue University, where I serve as provost, has developed Engineering Projects in Community Service (EPICS), an experiential learning program that places students in environments where they are challenged to innovate. The students in the program have developed custom prosthetics for injured people and helped Habitat for Humanity improve the energy efficiency of its structures. Deans and department heads must help enhance, improve and scale up this aspect of our educational programs by purposefully designing educational environments for desired outcomes, including encouraging students to take risks and learn from failures.

Modifying existing courses. Institutions can, and should, look at modifying relevant technical courses. One idea is to incorporate some history of technological innovation in specific courses so that students know about and connect to the innovator. By detailing the lives of scientists through case studies, the innovation process becomes humanized, and students begin to see innovation as possible. In interviews, innovators cautioned against focusing on successes of innovations and emphasized the need to teach stories of failures that often lay the foundation for successful innovation.

An example is the course Introduction to Solid State Chemistry, taught by Donald R. Sadoway, a professor of materials chemistry at the Massachusetts Institute of Technology. Not only does he teach the history of innovation and provide case histories of failure, he places science in its cultural and historical context. As the syllabus states, it is not "'just a chemistry class' -- it's a chemistry-centered class that integrates examples from the world around us, in the arts and humanities, the human stories behind the science, and the applications to engineering and emerging technologies."

Using guidelines for problem selection. Determining what problems to pursue and articulating compelling ideas is the key to innovation. It is important to teach students how to identify good problems and articulate ideas. That said, the innovators we interviewed reminded us that problem selection, while crucial, is not a straightforward process or an exact science. They recommended exploring at the interfaces of disciplines to identify problems worth pursuing. Most importantly, all interviewees felt that good problems are derived by building off areas that the individual deeply cares about. Thus, one approach might be to develop guidelines or checklists that faculty members, and by extension students, can use for identification of good problems.

Our report contains some guidelines that the innovators have suggested. They include:

- Spend a considerable amount of time thinking about and defining the problem.
- Identify where a need exists.
- Gather input from those the innovation is meant to help.

- Follow your instinct, intuition and passion.
- Investigate failure and ask yourself, “Is there a path that will lead to success?”
- Know when to quit or change direction.
- Target areas where there is less activity.
- Choose problems based on their impact on humanity.

Innovation has always flourished in the United States, but we must not take it for granted. Our research shows that it is important and feasible to help potential innovators discover their talents and contribute to the nation’s capacity for innovation. With an educational culture that encourages and promotes innovation, America can sustain its technological leadership for generations to come.

Bio

Deba Dutta is provost and executive vice president for academic affairs and diversity at Purdue University.