The Importance of Mindset

by

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Executive Summary. As universities race ahead to focus ever more intensely on developing the latest new scientific discovery and providing their students with ever increasing technical competence, employers have grown increasingly frustrated that college graduates continue to lack the characteristics that often matter most for success in the workplace (and many would also say in life). As important as content knowledge is, along with the skills to apply it, something else is at least as important today: the set of attitudes, behaviors and motivations that enable knowledgeable graduates to work with others productively, flourish and live a purposeful life. Too often employers have complained that university graduates—even those with high academic achievement—are unable to engage with others and succeed in the complex relationships and integrated global work environments that are required for success today. In addition, studies indicate that the complex constellation of attitudes, behaviors and motivations (mindset) that transcend any set of college courses often has more significant impact on long term success in life than academic achievement does. Recent research indicates that mindset is indeed real, definable, measureable, and teachable, and has a major impact on positive outcomes in life—across all academic disciplines and types of institutions. While shaping mindset appears to require a degree of emotional support and personal experiential learning for successful growth, mindset appears destined to become an increasingly important differentiator of life success in the 21st century, as knowledge and skills become more commoditized and easily available. This paper will make the case and provide a call to action that higher education now needs to embrace the responsibility for shaping the mindset of graduates in addition to providing knowledge and skills.

A good education changes what you know,
while a great education changes who you are.

The Need for Social and Professional Skills. In a 2013 Gallup poll of chief academic officers of universities, conducted on behalf of the Lumina Foundation, 96 percent rated their institutions "very/somewhat effective at preparing students for the world of work." While this seems to be great news, in the same case study, only 14 percent of Americans "strongly agree that college graduates in this country are well prepared for success in the workforce," and only 11 percent of business leaders "strongly agree that graduating students have the skills and competencies that their businesses need."[1] The gap is truly remarkable and represents a persistent problem with misalignment of goals and expectations between higher education, the public and business.

There is no reason not to believe the sincerity and accuracy of the reports from both academic and business leaders, from their respective vantage points. However, in reality, it appears that they are answering fundamentally different questions. It's as if the academic officers are reporting that college graduates today have never been better at solving the calculus problems. They are more advanced in their mathematical knowledge and skills and able to solve problems efficiently today that were well beyond the reach of students in previous generations. This is what they are most proud of. However, business leaders are reporting, in essence, that even more technical competence is not what is needed. Instead, a much more urgent need is substantial improvement in the graduates' competencies in ethical behavior and trustworthiness; teamwork and consensus building; effective communication and persuasion; entrepreneurial mindset; creativity and design thinking; empathy and social responsibility; interdisciplinary thinking and global awareness and perception.

[1] Busteed, B., *Higher Education's Work Preparation Paradox*, Gallup, February 2014. http://www.gallup.com/opinion/gallup/173249/higher-education-work-preparation-paradox.aspx

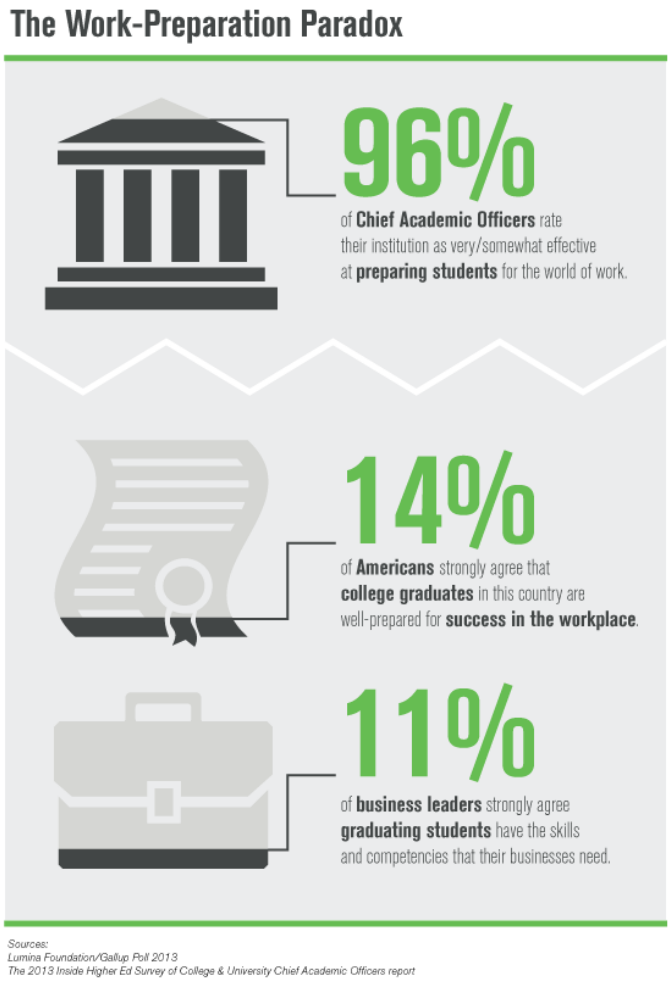

Figure 1 – The Work-Preparation Paradox, Lumina Foundation/Gallup Poll 2013
The 2013 Inside Higher Ed Survey of College and University Chief Academic Officers Report

To understand how this developed, it is important to note that the STEM curriculum widely in use today was developed more than a half century ago. In 1955, the Committee on Evaluation of Engineering Education, headed by respected educator Linton Grinter, issued a call to modernize engineering education in the United States. During World War II, scientists—not engineers—had been responsible for developing such technological advances as radar and nuclear fission. When it came to the origination of big, new ideas, it seemed to many, including Grinter's committee, that engineering was in danger of being left behind. The Grinter Report, as it has come to be known, established the need for a comprehensive shift in the undergraduate engineering curriculum: "Engineering education must contribute to the development of men who can face new and difficult engineering situations with imagination and competence."[2] Specifically, the report called for, among other things, "A strengthening of work in the basic sciences, including mathematics, chemistry and physics."[3]

[2] Grinter, L.E., et al., 1955. *Summary of the report on evaluation of engineering education*, Engineering Education 45: 25-60. Reprinted in **Journal of Engineering Education** 83(11) [January 1994]: 74-94.
[3] Ibid, p. 74.

Although some initially resisted this course change, the Russians' launch of Sputnik in 1957 turned the tide firmly in favor of those advocating a more mathematically and scientifically rigorous engineering education. A 1955 MIT course catalog foreshadowed the coming changes. According to the catalog, students in the school's newly minted mechanical engineering department would receive the following instruction: "The curriculum during the first two years provides a thorough training in the basic subjects of mathematics, chemistry, physics and materials. During the junior and senior years the student becomes familiar with the mechanics of fluids and solids, thermodynamics, properties of materials, materials processing and certain aspects of electrical engineering."[4]

The culture in engineering schools rapidly shifted toward the applied sciences, as the belief took hold that knowing more advanced science and math would contribute more to the flow of discovery. The trend has largely continued to this day. Calculus and physics are requirements for almost all engineering majors everywhere. Faculty members nearly always have PhDs and participate in original research published in archival journals. And to a great degree, the rebalancing of engineering education worked as it was supposed to. The doubling down on hard sciences and mathematics delivered real and significant results, as engineering moved from the sidelines to the frontlines, while creating some of the greatest technological achievements in the 20th century.[5]

But the world has changed in enormous ways in the last 50 years, even though the engineering curriculum has not. For example, the stock market in 1955 was dominated by the "smokestack" economy. Companies such as Armstrong Rubber, General Motors, and US Steel employed thousands of Americans. However, fast-forward to 2016 and many of those businesses no longer even exist. American smokestacks themselves now seem a rarity. Today, Apple, Google and Facebook populate lists of most-valued stocks. These companies sell devices and software platforms, of course, but they also sell much more: intangibles such as community, personal style and even emotional impact. Their success is determined by a keen understanding of human behavior and needs, not just by technological capability. To be competitive today, an engineer needs MUCH more than technical competence.

In addition, the organization of work itself has changed dramatically in the last half century. In the 1950s, it was not uncommon for workers to be organized by job function (engineering, marketing, manufacturing, testing, customer service, etc.) where those individuals performing a similar function were located together in a single building. Products were developed by passing batched problems through these departments (from Inbox to Outbox) and down the line through the organization until the finished product emerged from the last stage, as if moving down an assembly line.

But today, many organizations organize labor completely differently. Product teams, consisting of a diverse collection of people with many different job functions, are formed to conceive, design, test, assemble, market and deliver a single product. They stay with the product from conception through to delivery. This presents a very different work environment and requires workers to be comfortable and effective in collaboration on a diverse team from the start. As a result, it is not difficult to see why the demand from industry for a workforce with substantial social and professional skills, not just technical knowledge, has grown.

There are many organizations that have called for these social and professional skills in recent years. One of the early calls came from IBM (and others), for what they call the "T-shaped" individual. Their metaphor is based on this: the vertical bar of the "T" represents depth of knowledge and experience in a particular academic discipline, while the horizontal bar of the "T" represents the ability to work across disciplines with others from a different background. Their explanation of the social and professional skills needed is apparent in the figure that follows.

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[4] Massachusetts Institute of Technology (MIT) 1955. Massachusetts Institute of Technology Bulletin: Catalogue Issue for 1955-1956 Session. June. P. 56.

[5] Constable, G., and Somerville, B. 2003. A Century of Innovation: Twenty Engineering Achievements that Transformed Our Lives. Washington, DC: Joseph Henry Press.

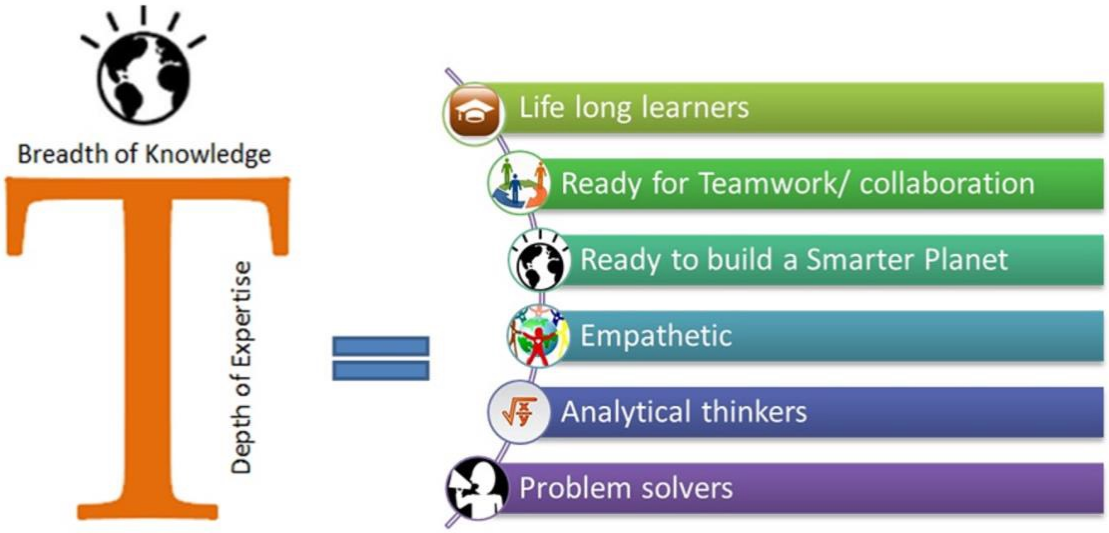

Figure 2 – The IBM Concept of the T-Shaped Individual[6]
The vertical bar represents depth in a single technical discipline, and the horizontal bar represents the ability to apply knowledge across disciplines and to work with others

Many other organizations are calling for a similar shift in emphasis of the preparation of engineering graduates, including the Council on Competitiveness and their National Engineering Forum Project. One of the goals of that project is to provide more "multidisciplinary training" for engineers and more "creative and collaborative leadership" in the workforce. Another organization is the Business-Higher Education Forum, which focuses on developing definitions of "workplace competencies" to correct "workforce misalignment." Yet another organization is the STEMconnector, consisting of more than 6,000 organizations. As described on their website: *"STEMconnector® is a consortium of companies, nonprofit associations and professional societies, STEM-related research & policy organizations, government entities, universities and academic institutions concerned with STEM education and the future of human capital in the United States…"* Of particular interest is a recent STEM Innovation Task Force (SITF) that worked for many months on the demand-side requirements of STEM professionals. Their report, STEM 2.0,[7] provides an outline of their view of the professional skills needed for the STEM workforce of the future. The graphic in Fig. 3 highlights their relevant findings.

[6] *Why Do You Need to Become a T-Shaped Person*," **Students for a Smarter Planet**, July 3, 2013.
[7] *STEM 2.0: An Imperative For Our Future Workforce*, STEMconnector Innovation Task Force, STEMconnector: Washington, DC, June 2014.

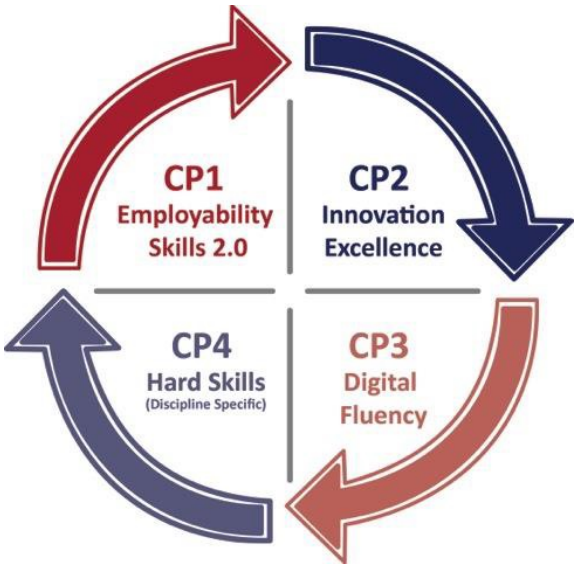

Figure 3 – STEMconnector Innovation Task Force report (STEM 2.0) on the competency platforms (CP) needed in the workplace today

As described in the report, "STEM 1.0 focused, rightly, on STEM content, whereas the next stage for our students and future workforce is to master **context**." The graph in Fig. 3 illustrates the four "competency platforms" (CP) identified by the SITF as necessary to achieve STEM 2.0. In particular, CP1 and CP2 require a quantum improvement in social and professional skills.

Employability Skills 2.0 (CP1) are identified as "the **behaviors above and beyond technical skills** that enable STEM employees to create stakeholder momentum to commercialize ideas, or in short career skills. It is the ability to **present and 'sell' their ideas to others; to function in teams; to develop business acumen; to develop leadership skills; to navigate across a complex matrix of global organizations**."

Innovation Excellence (CP2) requires developing the "process of transforming ideas into new and improved systems, services or products that enhance the value of existing resources or create new ones. Innovators **identify opportunities** and use them to **drive change**. Innovation excellence requires a **'holistic' multi/trans disciplinary skill set**."

It is clear that no amount of doubling down on even more math and natural science in the curriculum will meet these growing demands.

A recent meta-study of the evidence that social and professional skills actually matter in the labor market is available from the Brookings Institution. In particular, the study reports that (1) today's jobs demand more social and professional skills than did jobs in the past; (2) the labor market increasingly rewards social and professional skills and (3) those with fewer social and professional skills are being left behind.[8]

Social and Professional Skills are also Important for Well-Being. In 2014, the Gallup organization partnered with Purdue University to produce the largest survey of university alumni in history.[9] The resulting Gallup Purdue Index provides important insight into what really matters in higher education over a lifetime. The study includes measures of behavioral economics, focusing on a comprehensive view of

[8] Schanzenbach, D. W., Nunn, R., Bauer, L., Mumford, M., and Breitweiser, A., *Seven Facts on Noncognitive Skills from Education to the Labor Market,* The Hamilton Project, Brookings Institution, Washington, DC, October 2016.

[9] Busteed, B., *The REAL Data Revolution*, **Trusteeship Magazine**, Juy/August 2016.

"well being," while extending beyond classical metrics such as mid-career salaries or employment rates. Classic metrics in higher education include such factors as admissions selectivity and yield, test scores, retention rates, grades, and graduation rates. These are and will remain of substantial importance to all higher education institutions. But behavioral economic measures—which recently have become more widely adopted in other industries—include such factors as engagement, hope, excitement about the future and emotional support.

Gallup has been studying and measuring well-being for nearly 80 years. It began with early studies led by George Gallup that tried to "quantify a life well-lived," as he described it. And it has now expanded, both to a daily poll of 500 U.S. adults and the annual Gallup World Poll. What Gallup has learned is that there are five essential elements of well-being that are consistent across all ages, races, religions, etc. These are important measures because they are powerful predictors of a number of key outcomes. Employees who are thriving in all five elements of well-being, for example, represent one-third of the healthcare cost burden to their organizations compared to employees who are not thriving in any one element. In short, a metric for well-being is not a *nice* to have, it's a *need* to have.[10]

The five essential elements of well-being defined and tracked by Gallup include the following:

(1) **Purpose**: How you occupy your time; liking what you do each day
(2) **Social**: Relationships and love in your life
(3) **Financial**: Managing your economic life to reduce stress and increase security
(4) **Community**: Engagement and involvement in the area where you live
(5) **Physical Well-Being**: Good health and enough energy to get things done daily

When Gallup included metrics of this type in surveying university alumni, they gained some important insights into the impact of learning environments on the long-term well-being of alumni. Among the most prominent findings are that alumni who reported that their institution provided them with emotional support and experiential learning opportunities are twice as likely to be engaged in their work and thriving in their well-being later in life.

They measured emotional support by asking alumni questions like these: (1) Did you have at least one professor who made you excited about learning? (2) Did you have at least one professor who cared about you as a person? (3) Did you have a mentor in college who encouraged your goals and dreams? In addition, they measured experiential learning by asking alumni questions like these: (1) Did you have a long-term project taking a semester or more to complete? (2) Did you have an internship or a job where you applied what you were learning in school? (3) Were you extremely involved in extracurricular activities and organizations? They found that alumni who reported yes to all six of these questions had twice the level of well-being later in life compared to the average.

Gallup also found that **only three percent** of alumni in America reported yes to all six of these questions! It seems clear that providing a degree of emotional support to college students and providing an opportunity for deep experiential learning provides a substantial improvement in well-being later in life.

Although this has not yet been researched, we strongly believe that these same factors provide a fertile learning environment for the development of social and professional skills. Observing Olin graduates cross the stage at commencement for many years has led me to the conclusion that nearly all of them leave with more than knowledge and the skills to apply that knowledge. (The average Olin graduate has completed 20-25 design projects, started a new enterprise or business before graduation and has very close relationships with faculty and staff.) They also have a palpable sense of purpose, mission or calling in life. To a degree that is unusual in my experience, they are intrinsically motivated to take what they have learned and move out into the world to make a positive difference wherever they go. While some graduates at every university reach this level of intrinsic motivation, the degree to which it is true at Olin is rare, in my anecdotal opinion.

[10] Ibid, p. 7.

However, I strongly suspect that if you interview the students at most large universities who achieve this sense of self-efficacy, they are likely to tell you that they arrived at this point not because of the formal courses they took, but in spite of them. They are likely to mention two factors: (1) they had a mentor who made learning exciting for them, cared about them as a person and nurtured their dreams, and (2) they had largely extracurricular experiences that changed their lives, such as a summer trip to Costa Rica to construct a water system for the people in a rural village. The correlation in the findings in the Gallup Purdue Index are not coincidental, I believe. Instead, I suspect that they are largely causal.

Can Social and Professional Skills be Taught? Various special interest communities have been promoting the teaching of specific social and professional skills for many years. For example, The Kern Family Foundation has been promoting the teaching of an "entrepreneurial mindset" for more than a decade. Other organizations with similar goals include the Kauffman Foundation and VentureWell, both focused on promoting the development of entrepreneurial thinking and behavior in young people.

A more comprehensive program that has rapidly gained attention and adoption is the National Academy of Engineering Grand Challenge Scholars Program. Starting in 2009 with just three institutions (Duke University, Olin College of Engineering and the University of Southern California) it has rapidly grown to more than 120 institutions in the U.S. and many more abroad. This is remarkable given the difficulty in persuading colleagues at any other universities to consider making significant change to their academic program.

The Grand Challenge Scholars Program is not a curriculum, but a set of flexible goals that allows each institution to adapt their own courses and academic procedures to meet the general goals of the program. These goals broadly stated, include the development of five dimensions beyond the technical requirements for the degree, including (1) a **hands-on project** or research program related to one of the Grand Challenges; (2) an **interdisciplinary curriculum** that involves **public policy, business, law, ethics, human behavior, risk, and the arts, as well as medicine** and the sciences; (3) **entrepreneurship experience** that prepares students to develop market ventures that scale to global solutions in the public interest; (4) a **global dimension that instills awareness of global marketing, economic, ethical, cross-cultural, and/or environmental concerns**; and (5) **service learning that deepens students' social consciousness and their motivation to bring their technical expertise to bear on societal problems**.

A generalization of these five dimensions to include the social and professional skills identified by the other organizations mentioned earlier might be articulated as five different "mindsets," as follows:

- Collaborative Mindset
- Interdisciplinary Mindset
- Entrepreneurial Mindset
- Ethical/Empathetic Mindset
- Global Mindset

Here the notion of a "mindset" is borrowed from the work of Stanford psychologist Carol Dweck. For about 25 years, she has been studying the effect of beliefs students have about their abilities (and the framing of the opportunities and challenges they see around them) on their performance in school. Her work shows that mindset—which transcends the objective content knowledge from any set of courses—is not the same as a personality trait, that it can be defined, measured, shaped (or taught) and that its impact can be profound. Her work was recognized with the Atkinson Prize from the National Academy of Sciences last spring.[11]

According to Dweck, "In a fixed mindset students believe their basic abilities, their intelligence, their talents, are just fixed traits. They have a certain amount and that's that, and then their goal becomes to look smart all the time and never look dumb. In a growth mindset students understand that their talents

[11] http://www.nasonline.org/programs/awards/psychological-cognitive-sciences.html

and abilities can be developed through effort, good teaching and persistence. They don't necessarily think everyone's the same or anyone can be Einstein, but they believe everyone can get smarter if they work at it."[12] Her recent TED talk is also very informative.[13]

So, mindset is a set of beliefs about your identity and abilities that shapes your attitudes about how you can and should behave. For children, she has found that if you tell a child they did well on an exam because they are smart, it often sets them on a path of protecting their image and avoiding challenges that would risk their identity as "smart." It is as if they are saddled with a burden of having to live up to expectations that they must always be superior. On the other hand, if you tell them they did well on an exam because they worked very hard, it often sets them on a path where they feel they can continue to do well by choosing to work even harder, that nothing is out of reach if they are persistent and diligent.[13] The point here is that paying attention to how you praise students, and how you explain the reasons for their success and failure can have a major impact on their mindset. This doesn't involve including more content or spending more time on reading and testing new material. It is much more a matter of HOW you teach, not WHAT you teach.

Dweck has shown that when students are consistently put in a "growth mindset" by this type of cueing and conditioning, they consistently outperform students who have a fixed mindset. So, teaching or shaping of a mindset is not like lecturing about technical material, it is more like coaching and mentoring. The image of a basketball coach comes to mind. This is important because it signals that mindset can be shaped by consistent personal interaction, where the attitudes and motivations of the teacher are of critical importance.

While Dweck's work is well established and widely recognized, there are others also working in the same general field. For example, Angela Duckworth at the University of Pennsylvania is pioneering work in another of the key psychological characteristics of great value: "grit," or passion and perseverance.[14] Her research shows that students who have acquired "grit" in their mindset are often more likely to succeed than students with more academic ability and achievement. Her recent TED talk is also quite informative.[15]

"Motivation almost always beats raw talent."
Norm Augustine[16]

In the area of adults and behavioral economics, James Heckman's work at the University of Chicago is particularly noteworthy. Heckman won the Nobel Prize in Economics in 2000 for his investigations of the importance of noncognitive skills (social and professional skills, like perseverance and grit). He has found that grit is often a better predictor of success in life than is academic ability or achievement.[8]

"Nothing in this world can take the place of persistence. Talent will not: nothing is more common than unsuccessful men with talent. Genius will not: unrewarded genius is almost a proverb. Education will not: the world is full of educated derelicts. Persistence and determination alone are omnipotent."
Calvin Coolidge[17]

While much more research of the type done by Dweck is needed to thoroughly understand how to cue and shape the collaborative, interdisciplinary, entrepreneurial, ethical/empathetic and global mindsets, at this point it seems clear that it has more to do with how we teach than what we teach. It is also clear that it requires personal relationships to shape beliefs and mindset, so trust, transparency and mentoring are key. Experiential learning is at the heart of developing social and professional skills, so ample emphasis

[12] Dweck, C., Mindset:The New Psychology of Success. Ballantine Books. 2007.
[13] https://www.ted.com/talks/carol_dweck_the_power_of_believing_that_you_can_improve?language=en
[14] Duckworth, A., Grit: The Power of Passion and Perseverance. Scribner. 2016.
[15] https://www.ted.com/talks/angela_lee_duckworth_grit_the_power_of_passion_and_perseverance
[16] Augustine, Norm, *The next 100 years: Augustine's Latest Law*, **Aviation Week & Space Technology**, May 5, 2016.
[17] Coolidge, Calvin, quote from program at Coolidge memorial service, 1933.

on this dimension in the learning environment is essential. The potential benefits to both graduates and society are so profound that these characteristics should be embraced and brought into the mainstream of graduation requirements and not left to extracurricular experiences for those fortunate enough to stumble on them (and afford them!).

When students develop this mindset, the results are obvious. Consider the following note received from an employer of two Olin juniors in a summer internship at a biotech R&D company:

> *Rick,*
>
> *TetraGenetics hired two summer interns this year from the Olin class of 2017. I had to encourage our lab director to consider undergraduate candidates, but after he interviewed two from Olin, he told me they were both so impressive he couldn't choose one over the other. So, we hired Michael Sheets and Kelly Brennan for the summer and what a terrific experience it turned out to be. Our PhD scientists were truly blown away by the speed with which Kelly and Michael learned their way around our lab and began contributing in meaningful ways. They were smart, eager, interested and had* ***wonderful "can do" attitudes****. We were all sad to see the internships end and are hopeful to continue the relationships. These were two wonderful ambassadors for Olin. I had to share!*
>
> … Our lab director called me in Maine while he was driving home from work on the Friday afternoon that was Kelly and Michael's last day – to tell me how sad he was to see them go. On the following Monday morning, we had a lab meeting and everyone was singing their praises, and noting remorse that the internships had ended. These were people who, four months earlier, did not want an internship program because they thought it would be a burden. Michael and Kelly proved them wrong and more than won them over. Our only regret was the sadness we all felt when they had to leave. They truly became part of our team!
>
> *Warmest regards,*
>
> *Doug*
>
> *R. Douglas Kahn*
> *Chairman & CEO*
> *TetraGenetics*

While faculty members reading this message are likely to think that shaping a mindset is not their job, my response is this: then whose job is it? At this point in their life, college is the last stop on their educational train. If they don't learn it in college, where will they learn it?

Last week I had the unusual experience of serving as one of several speakers at the dedication of a portion of the Student Community Center at the University of California, Davis for a retired faculty member there, Melvin R. Ramey.[18] Professor Ramey was my undergraduate advisor, and has become a life mentor for many decades. He was honored by the university for the profound impact he had on generations of students and athletes (he is a track and field expert for US Olympic athletes). Upon review of the letters and testimonials from his many students, the best summary is probably this observation:

Hopeful faculty members spread hope among their students, and cynical faculty members spread cynicism. (Have you ever met a cynical entrepreneur? Most likely not, since that is an oxymoron!)

Professor Ramey never taught a course titled Hope 101. He didn't include any extra lectures in his courses or get paid extra for this work. He transmitted hope through the way that he interacted with you,

[18] Long term member of the President's Council at Olin College of Engineering.

and the implicit knowledge you had that he cared about you as a person and he encouraged your dreams and aspirations. Of course, his experience as an athletic coach gave his special insight and skills into building a relationship that involves suggestion and oversight and developing a growth mindset.

Every time a faculty members picks up a piece of chalk and walks into the classroom, s/he is not just teaching calculus. S/he is also transmitting a mindset. It is time we acknowledged this truth and take responsibility for deliberately preparing the faculty for this critical role beyond transmitting knowledge and skills.