The Democratization and Future Ubiquity of STEM Education

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While it is impossible to imagine the reality which humanity will face in twenty years, we can all imagine the future we *hope* to experience. The world of undergraduate STEM education has no shortage of issues, barriers to entry, and inequities. They may arise from socioeconomic disparities or even forcing students to silo themselves. If these problems are solved and treated with care, STEM education is on the cusp of unlocking an untapped abundant supply of intellect the world has never seen to date. When unlocked, this bright future will see the lines between student and teachers blurred. In 2040, the categories of *undergraduate*, *graduate*, or *K-12* STEM education will simply be nothing more than labels. In 2040, STEM education will be democratized and broadly imprinted into the roots of our society: a society which will consist of the life-time learners we must nurture and cultivate in the next two decades.

For too long and for various reasons, teaching methods and institutions have forced students to turn their back on all or part of an education. As recent as 2020, these barriers to entry could include insufficient access to financial resources or the inequal recruitment of underrepresented minority groups. A more subtle, but still detrimental, roadblock students are still facing is the lack of interdisciplinary studies available to them beyond their major. Any discouragement a student faces when seeking knowledge, even if it is outside of their major, can have long-lasting, negative effects. Reducing these barriers to education can only improve the state of all STEM fields and unlock a previously untapped supply of STEM graduates. In 2040, the news report which is all too common in 2020 ("Demand once again Exceeds Supply in STEM Fields") will nearly disappear as soon as barriers to entry and retention experienced by underrepresented groups (women, racial minorities, first-generation students) are eliminated through early, targeted recruitment in K-12 and more personalized counseling and degree planning. Placing students in an impersonal, rigid mold of their major and not allowing access to interdisciplinary coursework is an extremely shortsighted approach to STEM education. While it is clear that STEM majors have little room for non-technical electives, a standard for a multifaceted course load and personalization of degree plans must be established. Imagine the increase in a student's potential when they are encouraged to be an expert in, for example, aerospace engineering *and* a foreign language. Exactly 45 years ago, on July 15, 1975, the Apollo-Soyuz Test Project vehicles were launched from the United States and USSR. Imagine how unproductive the project would have been if, instead of learning the language and social norms of their counterparts, the astronauts and cosmonauts onboard were solely instructed on how to be the best test pilots or astronautical engineers. If diplomacy was not considered as important as the engineering during these missions, the International Space Station ultimately may not exist today. A holistic, multidisciplinary outlook must be the long-term approach to STEM education.

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While barriers to entry, retention, and interdisciplinary studies may exist today in STEM majors, the next decades hold a potential for the broad democratization of STEM education. Programs, such as open coursework or free online lectures from universities, will be commonplace in 2040. Their impact will be felt by many. Those in low-income households or even other countries will be able to access the same academic resources as those enrolled in the university and potentially earn course certifications with nothing more than an internet connection. As the internet becomes as accessible as free online lectures in 2040, student visas for international students may become a thing of the past. Open university coursework will also broaden the pipeline into undergraduate STEM institutions. Ambitious high schoolers or community college students preparing to apply to a four-year university will be able to customize their own personal curation of publicly-available lectures in order to expose and prepare themselves for the years to come. Choosing a major or succeeding in a class is much easier for a student who has been exposed to college lectures since the 11th grade.

Not only will the ubiquity of online teaching platforms grow the number of STEM students, it will also grow the availability of STEM educators, potentially blurring the borders around students and teachers. In 2040, students will find it common to learn from nontraditional STEM educators in nontraditional classrooms or settings. It is not hard to imagine students in 2040 attending a guest lecture about artificial organ growth being taught remotely by a researcher on board a commercial space station. Students could observe a live-time robotic telesurgery, while being thousands of miles away from both the physician and the patient. When teaching platforms and classrooms are no longer necessarily on a physical college campus, experts in their respective fields will become the STEM educators of the future.

As evidenced by the last few decades, it is a certainty that technology will continue to revolutionize the workforce of tomorrow. This often happens in a matter of years, not decades. Therefore, the categories of *undergraduate, graduate*, or *post-doctoral* STEM educational pursuits will soon lose meaning. STEM education will envelop all who aim to keep up with the radical advancement in new knowledge or discoveries. STEM education will encapsulate anyone from self-taught machine learning programmers without any formal education, all the way to workers, whose jobs have been automated, who are now taking advantage of the free and open course work to learn coding or information technology. STEM students will even include those with a STEM degree from decades ago, but who must now learn a new skill, such as new manufacturing processes, in order to adapt to rapidly advancing additive manufacturing techniques. In 2040, the students of the past will again be the students of the present. A lifetime of learning will be expected in order to keep up with the rapid, unimaginable advances of the future.