INNOVATING ONLINE LEARNING IN ENGINEERING FOR EXCELLENCE AND QUALITY

1. MAKE ONLINE LEARNING EFFECTIVE

Residential learning sits at the core of many higher learning institutions. Complementary to that, peer institutions, such as Stanford, MIT, Georgia Tech and Arizona State have experimented with opportunities for students seeking high-quality online learning opportunities and credentials. This is partially driven by the accelerating growth of online student population in higher education. While the overall number of post-secondary students in the United States remained at about 20 million, the share of those taking at least one online course increased by 25% from 2012 to 2016. Based on lessons learned by these peer institutions and on our unique land-grant mission, we are poised to innovate online learning by focusing on excellence, quality and effectiveness. The "pinnacle of excellence at scale" is an aspiration for what we do in online learning in engineering.

The overall strategic direction of Purdue Online, across the entire Purdue system of multiple campuses, has many pieces, one of which is the focus on post-graduate learning and credentials by the College of Engineering. This short article tries to crystallize some of the ongoing conversations as we continue to seek input from our faculty, students (on campus and online), staff, alumni and partners.

There is no shortage of challenges. How can we keep supporting our graduates' professional growth after they leave Purdue's red-brick campus? Which online learning innovations should we pursue further? What additional modalities should Purdue Engineering offer to our students? How can we ensure that distance-learning and online courses are of high quality and effective? How do we employ asynchronous education technology to enrich on-campus learning, and what would that mean for our residential education model? Such questions only scratch the surface of the online innovation field. Moreover, confusion exists about the very term and vocabulary of online education.

Fundamentally, teaching does not automatically imply learning, and this gap is particularly wide online. We often try to compensate for these uncertainties by overemphasizing technology at the expense of pedagogical efficacy. Experiential acquisition of knowledge is particularly challenging in an online environment.

In the face of these challenges, as part of a public university system, we have a special responsibility to generate and disseminate knowledge. The public has invested in Purdue so that we have the faculties to create the best programs for the state, the country and the global community. We believe in employing our resources to empower individuals to achieve their full potential. The College of Engineering in particular has been providing distance-learning solutions for 60 years now, with outstanding quality programs (ranked No. 5 in US News and World Report 2018 in Online Master's Engineering program).

As we set to write a new chapter in online learning innovation, we start by recognizing that we do not have all the answers and have yet to create some of the necessary framework. We need to keep our receivers well-tuned, our attention focused, and communication channels clear as we pivot in this new terrain of online education.

1 https://www.insidehighered.com/digital-learning/article/2018/01/05/new-us-data-show-continued-growth-college-students-studying

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2. CLARIFY A TAXONOMY OF THE SPACE

Online learning does not refer to one type of activities, but a plurality of different opportunities. At any given time, the College of Engineering maintains a focus on some of these for delivery of the highest quality.

ONLINE POST-GRADUATE CREDENTIALS (OUR CURRENT FOCUS):

The first Purdue Engineering graduate distance-learning program was approved in the late 1950s. Since then multiple efforts have led to an outstanding and affordable post-baccalaureate workforce development program that includes a variety of online degrees and certificates.

We currently offer the following tracks:

- Master's degrees in various Engineering disciplines.
- Fully online PhD degrees in a few Engineering Schools.
- Non-credit professional certificates.
- New "track:" Digital badges/certificates. There is considerable flexibility on the topics and in the number of credits required to earn these. An example is the 'Design for Security' badge jointly by Intel and Purdue; launched in Fall 2018.
- New "track:" Hybrid on-campus/online professional/specialized master's degrees. The first one was launched in Fall 2018 by the School of Electrical and Computer Engineering.
- Potential new "track:" specialized master's degrees.

Nowadays we are rapidly developing programs in the new areas. We currently focus on stackable online programs for working professionals that lead to rigorous, fast-track non-degree credentials such as digital badges. Advances in these emerging educational offerings will enhance Purdue Engineering's lead in meeting industry workforce needs and societal impact.

ONLINE SUPPLEMENT TO RESIDENTIAL LEARNING:

Online education opportunities can also substantially enhance on-campus undergraduate learning for both students and faculty. In our current plan, online offerings can effectively supplement on-campus training by enabling learners complete degree requirements while being off campus (e.g., on internships or co-ops or
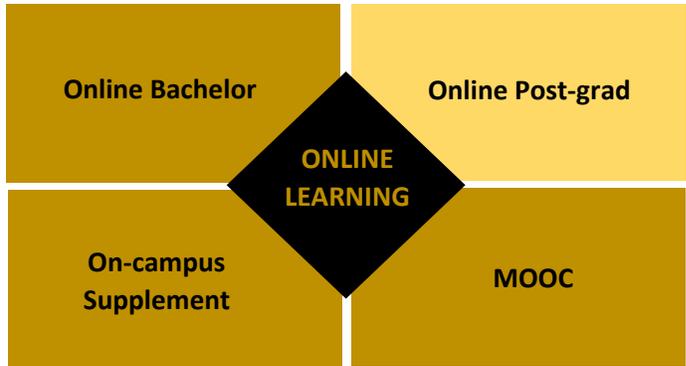
Online education taxonomy

global exchanges) and thus enhancing the efficiency of students' time-to-degree. In the future, more online content and courses can address class sizes, meet diverse learning needs and allow for a more enriched live classroom discussion.

MOOCs

Massive Open Online Courses (MOOCs) have been developed on a variety of online platforms by Purdue faculty. For instance, the Purdue-developed NanoHUB.org is the largest online platform in nanotechnology that reaches more than 1.4 million users today. Such platforms extend Purdue's mission in reaching lifelong learners as well as audiences who may not have the ability to access more traditional educational resources. Furthermore, MOOCs often lower learning barriers and encourage potential students to pursue digital badges or certificates.

ONLINE BACHELOR'S:

This is not our current focus in the College of Engineering, which remains on working professionals in the post-graduate arena as outlined above. In the future, we might look into appropriate initiatives as new opportunities emerge. For instance, university-to-university online partnership efforts may lead into new student exchange models. This could be particularly beneficial in global partnerships since it may lower the barrier for engagement and avoid costs/risks arising from the need of a brick-and-mortar international campus.

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### 3. SUSTAIN LEARNING ANYWHERE AND ANYTIME

There is more than one reason to consider online teaching and learning. For example, an institution may decide to focus its online agenda to achieve one or more of the following goals:

- Teach working professionals new mindsets, knowledge and skills.
- Reach off-campus students, including international ones.
- Disseminate knowledge to the general public for lifelong learning.
- Sharpen faculty's on-campus teaching.
- Provide supplementary resources for on-campus students (e.g. by allowing residential students to review course materials asynchronously).

There are many student groups that can benefit from accessing education opportunities. Degree-seeking undergraduate and graduate students are certainly two critical groups. At the same time, we should not ignore that both degree- and non-degree-seeking individuals can pursue career-changing paths through online learning. It is not always necessary to earn a traditional advanced degree to achieve one's career goals. Perhaps a certificate or digital badge may be a preferred choice, particularly for working professionals.

Across the world and across all industries, successful businesses depend on educated, highly-skilled workers. Constant learning and growing are key attributes for success, particularly in the fast-paced engineering world. How does one gain the necessary skills to keep up with a demanding and ever-changing job market? Online education can be a particularly effective option. Unlike traditional learning models, online learning provides the much needed flexibility in time or place, while at the same time maintaining rigor and quality.

Even with the flexibility of online learning, there are numerous challenges to part-time students who are full-time employees. How does one manage the life-work-school balance? How can you be a top performer at work and in the classroom, while at the same time balance family or other responsibilities? The biggest barriers are probably lack of time and flexibility.

19 COUNTRIES REPRESENTED

43 U.S. STATES REPRESENTED

lowest ▢▢▢▢ highest
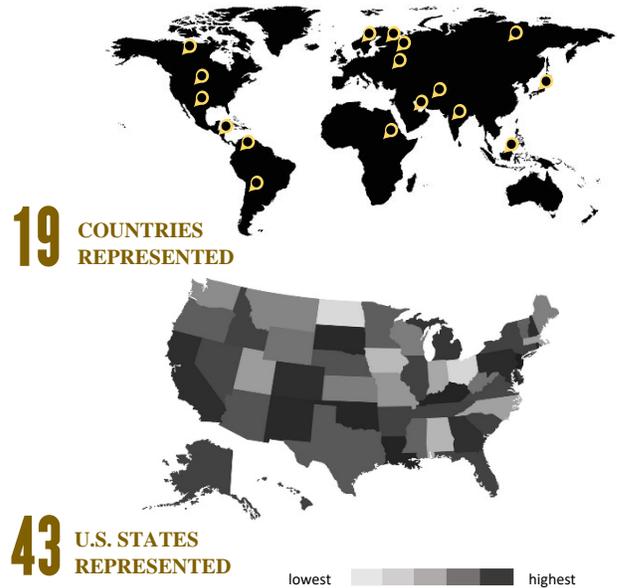
Even so, we all need to make time to learn - to own our learning process. Focusing on the benefits of pursuit of knowledge is often the best way to remain committed. For example, a promotion, new career opportunities that come from expertise in a new field and a strong sense of accomplishment and personal growth are among the most important benefits.

Besides working professionals, online learning also is a powerful tool for individuals whose early-life educational opportunities may have been limited due to economic, cultural, or other barriers. To a large extent, online education levels the playing field by providing viable additional chances in life. For example, providing learning paths for veterans as they transition from military to civilian life is a particularly important societal need that online models provide.

To achieve these benefits, online education, in parallel with industry, must be effective, efficient, and affordable. Rapid advancements in AI-driven pedagogy make personalized learning possible for the first time. Individualized student-focused content and assessment are critical for working professionals as everyone starts from a different background and has unique needs. Besides working professionals, these advancements may also benefit on-campus education quality, productivity.

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4. FACE THE CHALLENGES

Quality online education presents unique challenges for universities, teachers and students. Although each institution faces its own unique challenges, there are many common ones. While we do not have the answers to address many of them yet, spelling out and thinking through the questions is a collective first step.

Here is our top 9+1 list:

1. Can (engineering) knowledge be effectively decomposed into stackable "micro-credentials?"

2. How do we balance long-term learning objectives with near-term industry needs?

3. How do we balance residential education with online learning?

4. Will online badges or certificates prove useful for working professionals in the long run?

5. How do we effectively blend online education technology with traditional on-campus instruction?

6. How do we form and train teams of professors, teaching assistants, instructional designers, and technical personnel to deliver consistently high-quality online courses?

7. How do we update and seamlessly integrate online software tools?

8. How do we build and operate "virtual laboratories" in engineering?

9. How do operational and financial models adapt to incorporate significant numbers of online students in different tracks?

And, probably most importantly,

10. How do we measure just how well students learn online?

5. KEEP INNOVATING

Online learning is a familiar modality for today's students. Many are digital native, which makes them more receptive to online approaches. High-quality online education, just like traditional face-to-face on-campus learning, needs to yield verifiable skill improvement. To meet the rapidly evolving demands of learners, industry and society, we aspire to lead and innovate at various levels.

Operation innovation:

- Industry co-development of badges: We will provide more state-of-the-art learning opportunities for professionals who need to refine their skills but do not need/want a full master's degree. We are co-developing digital badges with industry's input. While our Schools and faculty design our curriculum, we actively integrate industry's input whenever possible. The 'Design for Security Badge' co-developed and co-branded with Intel is an example of this approach.
- "Stackable micro-credentials": We create programs based on a "small learning unit" pedagogy. This approach allows students to tackle smaller yet rigorous learning units (down to one credit hour) that can be effectively used for professional certificates, digital badges or future degrees. Flexibility is the key attribute here. It allows students to acquire skills and earn verifiable credentials in their areas of interest without committing a priority toward completing a full degree.
- Learning about teaching: We work with Purdue system-wide instructional designers and educators to ensure our faculty and TAs teaching online follow, discover and share best practices in course development and delivery.

Pedagogy/technology innovation:

- Diversity of choices: We empower faculty to consider and select from several models when developing and delivering courses, including synchronous vs. asynchronous, and blended online/face-to-face models. Without sacrificing quality, we respect individual teaching styles, preferences and pedagogical approaches. In all cases, we provide instructional design support that best suits their teaching style and pedagogy.
- Data analytics: We will explore data-based learning recommendations and adaptation, while respecting data privacy and user preference. This focus on data analytics is expected to lead to individualized learning and assessment (e.g. AI-driven personalization) for enhanced productivity and efficacy.
- Virtual labs: We are currently creating virtual labs to provide experiential learning opportunities even online. Virtual labs offer flexible access, instant feedback, utilization of creative equipment and software, all at a reasonable cost. Even though not all lab experiences can be virtualized, we can innovate to the fullest degree.

6. CONTINUE CONVERSATIONS

To innovate online learning for excellence and quality, it is critical to clarify our goals, sharpen our focus, be mindful of challenges and keep our communication channels open. With this document, we continue the dialogues. Despite the uncertainties and the rapid pace of change in the online world, we have significant potential to lead in this area and benefit our students, whether they are on campus or across the globe.