Extension School
Impact Report 2020

TU Delft | Extension School

Foreword

Educate the world and enhance the quality of campus and online education

These words clearly describe the goals of our University for online education. Following the success of its first Massive Open Online Courses, we established the TU Delft Extension School as a dedicated programme to take such goals forward and make them a reality. From its very beginning, the Extension School made the most of its pioneering character by swiftly supporting calls from lecturers willing to experiment, anticipating and adapting to learners' needs, and developing and testing innovation in education. The programme has been very successful and its impact bigger than we had initially imagined – bringing benefits to both our campus education and the world at large.

Heartfelt thanks are due to our academic staff for their adventurous spirit and hard work, and to the excellent support staff, who helped develop, market and deliver the courses. Didactics, tools and materials from online practices, bolstered by relevant research, have made a positive difference to TU Delft's campus education. As Executive Board, we wanted TU Delft to be a front-runner in the field of open and online education. Looking back, I can say that the Extension School programme definitely exceeded this aspiration.

In the space of a few short years, the Extension School's pioneering and focused efforts have positioned our University on the global stage as a thought-leader in open and online education. We helped thousands of underprivileged learners get access to quality education. We are number one in MOOC rankings, have won several prestigious awards, and our courses have attracted over two million people worldwide. The Board is very confident in the Extension School's future plans and looks forward to what more will be achieved in 2020 and beyond.

Rob Mudde
Vice President for Education, TU Delft Executive Board

Future-focused pioneering

(2013-2019)

Created with the key objective of providing open and online quality education, the TU Delft Extension School evolved from developing Massive Open Online Courses (MOOCs) for all groups of learners, to also creating professional education courses that more closely respond to the needs of those who seek to acquire new skills, keep up to date in their field, and remain relevant in a rapidly changing job market. The Extension School focused further on future needs by creating a series of short programmes consisting of stackable courses. These offer lifelong learners in-depth knowledge and the opportunity to upskill themselves in areas of expertise of great relevance to the environment and society, such as energy transition and sustainable cities.

MOOCs

In 2013, TU Delft launched its first two MOOCs. Since then, in collaboration with all faculties, it has developed over a hundred ─ on engineering, science and design. The approach has been bottom-up: any lecturer can submit a proposal to receive a financial grant and dedicated support. This includes didactics, tools and platform development, video processing, administration, and marketing and communication. As of 2020, these free courses have realised over 2.6 million enrollments worldwide.

The Solar Energy MOOC, our very first in 2013, is still one of our most popular. Now in its fifth run, it already counts over 200,000 enrollments. To reach a larger global audience, it is offered in English on the edX platform, but also in Arabic on EdRaak and in Mandarin on XuetangX.

For learners wanting to gain expert knowledge, there is a TU Delft's MicroMasters® programme in *Solar Energy Engineering* comprising five advanced level, credit-eligible MOOCs. This is accepted toward a campus degree at ours or other universities. In 2018, its first alumni not only became TU Delft campus students, but also contributed as moderators to the online programme.

Online Academic Courses

Next to MOOCs, we offer Online Academic Courses (OACs): online versions of campus master courses, with the same academic rigor, (heavy) study load, and final assessment ─ intended to bridge the knowledge gap between higher education and the workplace. Working professionals value them for deep learning and career advancement in a given field. Learners can also expedite their progress in a relevant Master's degree on campus, by converting the gained credential to regular academic credits. Presently, more than 600 learners have enrolled in these paid courses.

Professional Education

Noting that a vast number of learners in our MOOCs were skilled working professionals, and in conjunction with industry feedback, in 2015, we introduced Professional Education (ProfEd) courses. They are specifically designed to fit in these learners' busy lives, are less theory-driven, have more case studies, and a strong focus on knowledge application at work. Since their inception, over 2,500 professionals enrolled in our 50 ProfEds.

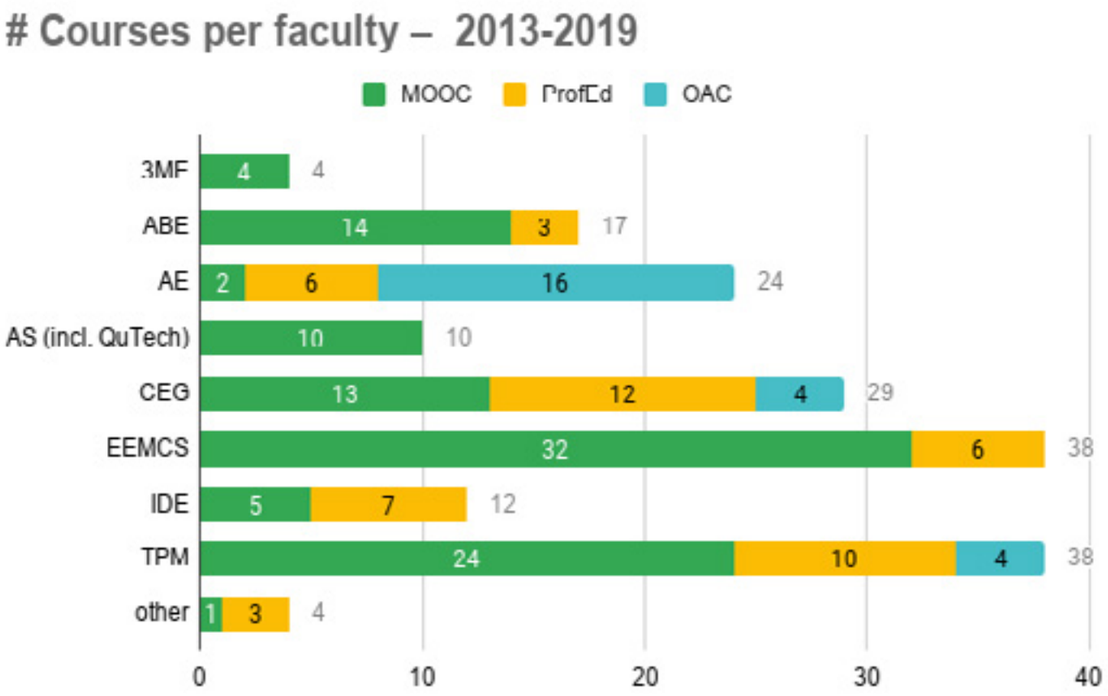
Working closely with industry is key in catering to these learners. One of our most popular ProfEds, *Advanced Credit Risk Management*, was developed in collaboration with Deloitte and has attracted over 400 professionals ─ which for this type of course is an exceptional number. They value the opportunity to expand further on topics with experts in the field and finding out how things work in practice.

Short Learning Programmes

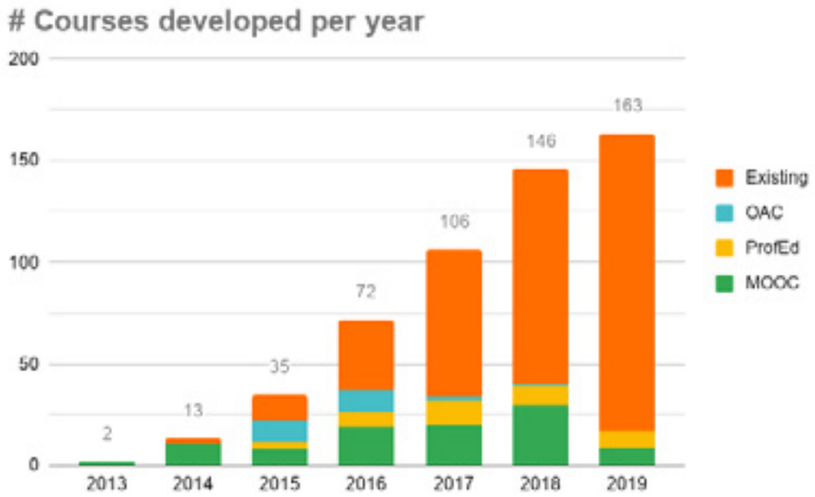
To strengthen the portfolio and offer a more comprehensive learning experience that better prepares learners for their job, we started to group courses into short learning programmes – known as Professional Certificate Programmes (PCPs). Since 2016, we launched 16 of them and issued over 1,000 programme certificates. *Electric Cars* is one of the most popular with over 100,000 enrollments. PCPs are steadily growing in popularity: learners appreciate being able to go deeper into a subject and build knowledge in discrete blocks over time.

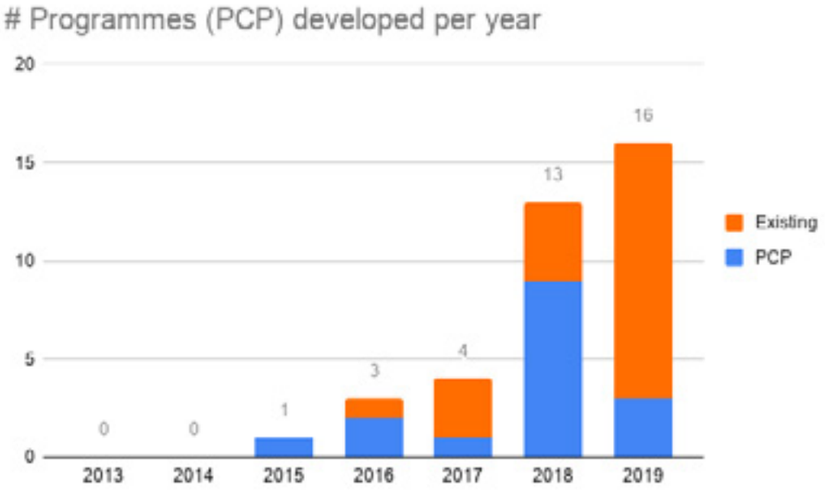
2020 and beyond

In the coming years, we intend to further focus the portfolio on modular and stackable programmes for working professionals, allowing us to better respond to their needs. At the same time, we remain true to our mission of providing quality education to people of all ages, backgrounds and nationalities, by continuing to offer our MOOCs with an open licence. This allows individuals and institutions to use materials from our courses, hereby heightening our impact in educating the world.



3ME	Mechanical, Maritime and Materials Engineering
ABE	Architecture and the Built Environment
AE	Aerospace Engineering
AS	Applied Sciences
CEG	Civil Engineering and Geosciences
EEMCS	Electrical Engineering, Mathematics and Computer Science
IDE	Industrial Design Engineering
TPM	Technology, Policy and Management





'I was looking to get both theoretical and practical knowledge on electric vehicles technology to help me increase my career prospects since the automotive industry is heading in that direction.'

Andreas Zafeiropoulos, Greece

'The railway engineering courses helped me in fulfilling the requirements of continuing education needed to maintain my chartered and registered engineer status in Australia and the UK.'

Khalid Saleem, Australia

'With the existing infrastructure and the current mobility needs in big cities, railway companies need to find innovative ways of handling disturbances and dealing with the maintenance of railway networks. This unique programme will allow rail professionals to apply an integrated railway systems approach so they can implement appropriate innovations needed to optimize maintenance time, costs and safety.'

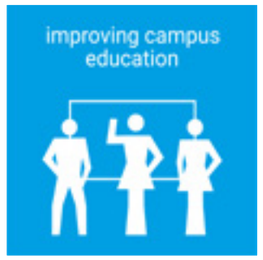
Taco Sysling - Head of Civil Engineering, Department of Asset Management, ProRail

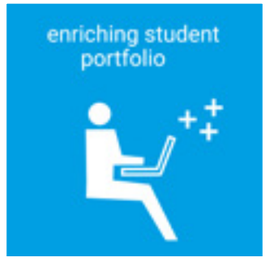
'At Trina Solar, our mission is to develop smart energy for the benefit of mankind. Skilled engineers are essential to sustain the rapid growth in the solar energy industry and drive innovation to reduce the cost of solar power. Education and training of young engineers are therefore critical in this new industry. The *Solar Energy Engineering* MicroMasters® programme is extremely relevant for anyone who would like to pursue a career in this sector.'

Pierre Verlinden, Vice President and Chief Scientist, Trina Solar

Positive impacts on…

The Extension School supports TU Delft's vision of educating the world. Through open and online education, many learners have benefited from our high-quality education. Being an early adopter and leader in this field, helps to profile TU Delft and strengthens its international standing. In recent years, our online offering centred on key topics – for example energy transition, sustainable cities and the future of transportation – that are relevant to the University's mission of contributing solutions to grand societal challenges. In addition, by facilitating instructional designers and learning developers in supporting academic staff, the Extension School exerts a strong impact on campus education and research. Online education gives academic staff new tools for research, valorisation and dissemination, as well as community building. For many lecturers, it also creates an opportunity to improve campus courses, innovate their teaching, and it adds to their professional development. It contributes to enhance networks and international recognition, in both academia and industry. Additionally, the findings from the research we conduct in online learning are applied to inform best practices in teaching, and to improve the learning experience on campus and online.





What lecturers say

'Making videos I realized that this would lead to more efficient time management. In addition, using recorded material would make it easier to step back and critically reflect on it with the students.'
Ulf Hackauf, Senior Lecturer and Researcher Environmental Technology and Design

'A MOOC is an excellent way to gain insight into the research other departments and faculties are engaged in. And the knowledge gained from research can have local but also global impact, which is essential in accelerating the transition towards a sustainable planet.'
Els Leclercq, Research Fellow Design and Construction Management

'The ProfEd Culture Sensitive Design *gives us the opportunity to exchange experiences on a global scale. Through this exchange, culture specific values and practices are elicited, which allows a deeper reflection on what culture entails and what it means for design.'*
Annemiek van Boeijen, Assistant Professor Industrial Design Engineering and Design Aesthetics

'The MOOC Decision Making Under Uncertainty: An Introduction to Structured Expert Judgment *is fully acknowledged and valued by practitioners as a TU Delft trademark. Many researchers are using and promoting the course and its materials. Personally, it has contributed to my standing in the field.'*
Tina Nane, Assistant Professor Applied Probability

'I noticed that using elements from online education in my campus courses helped those students who passed to do better. Students watching interactive components and doing virtual experiments also frees up more classroom time to address issues they are struggling with.'
Calvin Rans, Assistant Professor Aerospace Engineering

'ICT is considered a key enabler for open governments all over the world. The MOOC Open and Smart Government, *which teaches how governments can become more open and transparent, has contributed to raise my reputation by becoming the "visible face of my expertise" in- and outside academia.'*
Marijn Janssen, Professor ICT and Governance

'Creating online learning benefitted the way I teach as I could clearly assess what worked and what could be improved. By re-evaluating and incorporating feedback from online learners, I made valuable adjustments to some of the models – or even create new ones. It also helped bridge the gap between theory and real world and provided additional, relevant materials to use with campus students.'
Hans de Bruijn, Professor Public Administration, Organisation and Management

'As urban freight systems are very different around the world, it is important to share knowledge and experiences from different cities across the globe. To achieve this, we co-build a MOOC with members of the Global Centre of Excellence on Sustainable Urban Freight Systems. This was attended by a wide variety of people, from undergraduate students to seasoned city administrators. It increased our reach and helped us build relationships in areas of expertise.'
Lóránt Tavasszy, Professor Freight Transport and Logistics

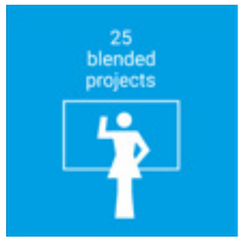
'I like the societal impact of the online course: people from all corners of the world can access knowledge that supports their efforts to provide clean drinking water in their countries and communities. I also use the online materials on campus, so that students come prepared to the lectures and learning becomes more effective.'
Luuk Rietveld, Professor Urban Water Cycle Technology

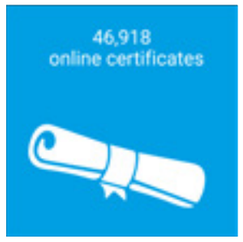
. . . Educating the world

At the start of our journey, there were relatively few MOOCs on the new online market, and they could easily reach the general public. Nowadays, the number of such offerings has grown hugely and so has the number of providers. However, despite these developments, our courses still stand out and succeed in educating a global audience. We are proud of how enabling access to world-class education has positively affected the lives of individuals and communities.

Outreach – Local use, direct impact

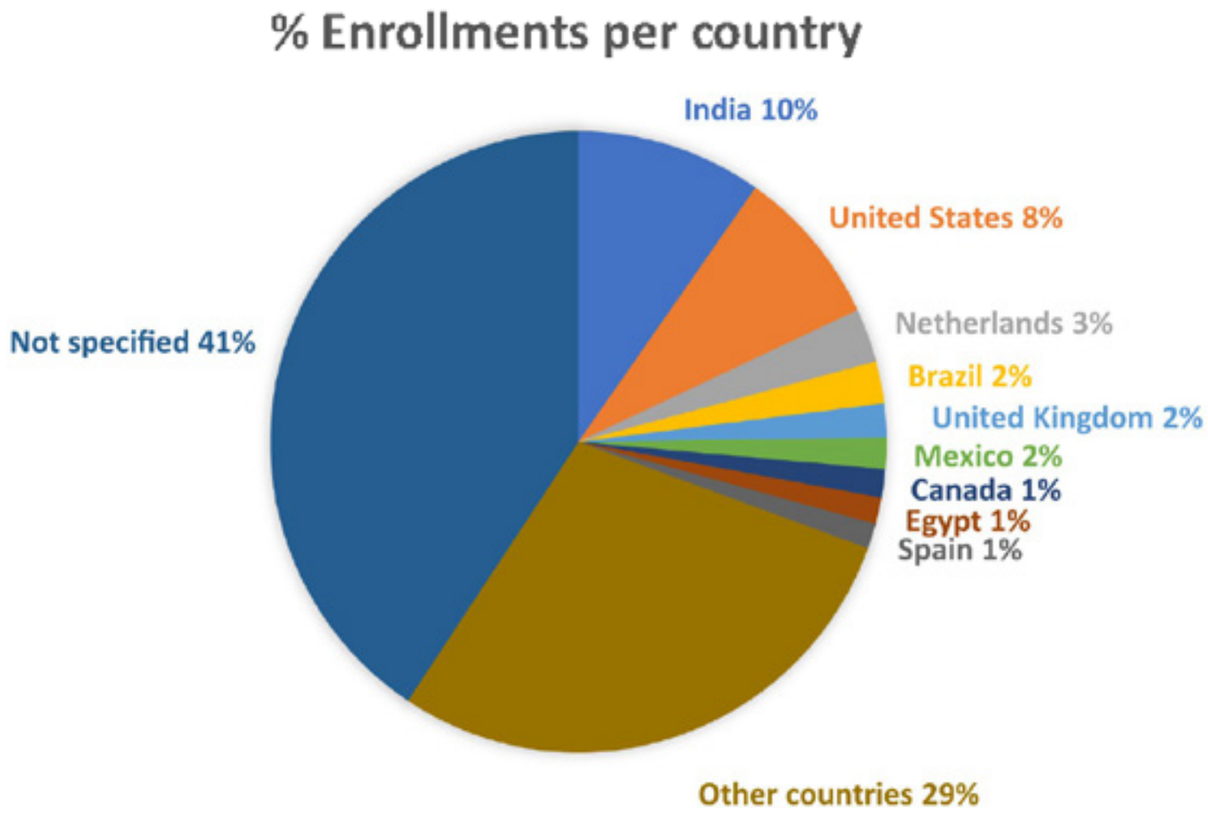
Our MOOCs are used in many institutions in the Netherlands and worldwide. In addition to MOOCs that reach English-speaking audiences, we offer several on designated platforms in Arabic, Mandarin and Spanish. The localisation of courses can be limited to a translation in another language, but it can also include a surrogate local professor, or case studies typical for the region – making it more relevant for learners. The involvement of native speakers and moderators, supports teachers in re-use and guarantees the quality of the translated materials (such as video scripts in several languages, including Hindi, German and French). For Dutch kids and school teachers we offer courses in Dutch in programming and design.





'Most graduates these days want to keep up to date with current knowledge, so it is excellent that there is this wide offer of courses.'

Vanida Salgado Ismodes, Chile



'Having that flexibility is key to provide education for people who don't have enough time to enrol in a full-time programme. And the multicultural aspect was just priceless. I had classmates from Yemen who were there to learn how to do a photo voltaic installation for their community that hasn't had reliable electricity in years, and another learner in Brazil who was developing solar modules to install on boats sailing through the Amazon'

Bertram Peterson, Mexico

. . . Enhanced reputation

Currently, TU Delft is ranked among the top five on the edX platform, amongst the top three in Europe and in the top 20 globally of MOOC producing research universities. It also stands number one in the world university rankings on MOOC provision for its outstanding performance.

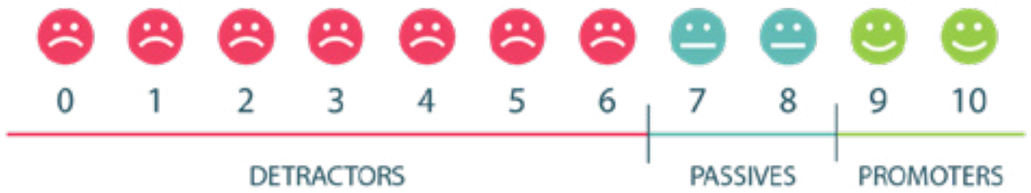
The 2018 MIT benchmark report *The Global State of the Art in Engineering Education*, praises TU Delft's expertise in online education engineering and selects it as one of only five global leaders in this field. The increasing number of institutions interested in our methodology and best practices confirms this recognition as experts.

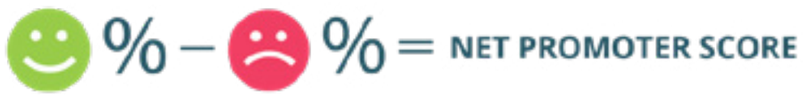
On the national and international stage, we have forged significant partnerships with several academic institutions and external partners, with whom we have collaborated in both research and the creation of online courses. To cite a few organisations: the Ellen McArthur Foundation, the Italian Association for Industrial Research, and the Joint Research Centre of the European Commission. We are working to strengthen and build further on these and new relationships, so that we can continue to bring value to learners and society.

NPS

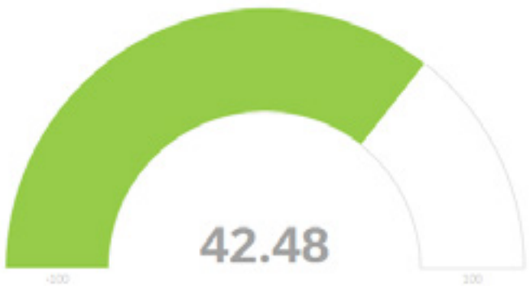
The Net Promoter Score (NPS) is an index ranging from -100 to 100 that measures the willingness of customers to recommend a company's products or services to others. It is used as a proxy for gauging the customer's overall satisfaction with a company's product or service and the customer's loyalty to the brand.

We ask the following NPS question and achieve very good scores across our portfolio.
"Based on your complete experience with TU Delft Online Learning, on a scale from 0-10, how likely are you to recommend us to a friend or colleague?"





Overall NPS score



In 2019, two TU Delft students who participated in the Hyperloop project and competed in the SpaceX Hyperloop Pod race*, went a step further. Supported by the Extension School, Bart Meeuwissen and Dirk Ulijn created the MOOC *Hyperloop: Changing the Future of Transportation* to share with the entire world their knowledge and passion for high-speed travel. For their open vision and significant, global contribution to open resources in the field, they won the Excellence in Open Education Award.

**In this competition in California (USA), student teams around the globe are challenged to design and build a half-sized Hyperloop pod, to travel through a 1.2 km low-pressure tube, in the fastest time.*

Dirk Ulijn and Bart Meeuwissen

The Virtual Exchange Programme

Started in January 2017, this pilot project exploits the positive facets of online education in a novel manner: it gives students at TU Delft and at partner institutions, access to world-class online education around the globe, with the option of gaining credits for their study programme. The convenience of flexible study, coupled with the opportunity to expand their portfolio in an international online classroom – with 65 courses on offer – has been a winning proposition for our students, of whom circa 1,200 participated in the period 2017-2020. Going forward, we note a growing interest amongst institutions in Europe and beyond, in learning from and expanding on this model for future virtual mobility.

. . . Improving campus education

Over the past five years, the Extension School expanded a learning design methodology, based on Professor Gilly Salmon's carpe diem approach, to support course teams in developing online education. In 2019, we used this in a project involving all faculties, to redesign 25 campus courses towards a blended format. Later, responding to the creation of more online programmes, we broadened the model with new templates and a new survey format, obtaining better course alignment and an improved, more coherent experience for the learner.

The blended redesign exercise applied lessons from the methodology to improve course design, structure, and didactical and content elements. It delivered on specific challenges such as: the ability to cope with large student numbers; to increase engagement and improve the quality of the learning experience, the materials and their presentation; to increase the effectiveness of education and enhance efficiency. Examples of interventions range from gamifying courses to challenge and engage students (*Algorithm Design*), to recording and integrating podcasts (*Design Theory and Methodology*), and re-using MOOCs materials and videos (*Introduction to Electricity and Magnetism*).

Considering that over 75% of online courses developed with the Extension School's methods and support are applied in various forms in campus education, the latter benefits from increased flexibility, in both time and location, variety of materials, and teaching and assessment approaches – enhancements much appreciated by lecturers and students.

Lecturers receive comprehensive support and often report becoming empowered by acquiring a range of (new) skills, and subsequently applying these to their regular campus courses.

Online teaching means rethinking the course, ensuring it addresses the learning objectives in a different format and timeframe, and adjusting it to the specific needs of a given audience. This reworking offers the lecturer valuable feedback and reflection, often translating into an improved delivery of their campus courses. Additionally, the interaction with professionals from the field provides real-life examples, points of view and insights that are then introduced to benefit our campus students.

Of the many online courses being variedly re-used on campus, the following are just a few examples. The MOOC *Industrial Biotechnology* has been used as a relevant part of the campus course in chemical biotechnology for several years, while the real-life cases developed overseas for *Engineering: Building with Nature* are being employed in the relevant campus courses. Although the MOOC *Pre-university Calculus* is aimed specifically at high-school students – to teach them mathematical concepts (functions, equations, differentiation and integration) required in many engineering and science disciplines – it is also being used on campus with first year Bachelors to bring them up to speed and as a revision tool to prepare for their university Calculus course. Looking ahead, the *Hello (Real) World with ROS – Robot Operating System* MOOC is in the process of being adopted by the Avans University of Applied Sciences in their regular campus programme.

. . . Educational innovation

Our rigorous design methodology goes hand-in-hand with research and experimentation in new ways to teach online and to improve the learner experience. Supporting lecturers across campus – be they tenured professors, first year associates, or even student Dream Teams – has resulted in a variety of educational innovations, such as new tools, animations, online labs, simulations, assessment methods, serious games and various technology applications. Moreover, we secured valuable funding from the EU and the Ministry of Education (Stimuleringsregeling Open en Online Onderwijs) to further such innovative projects, as well as for developing online courses in key areas of interest – for example the *Nuclear Energy* MOOC, developed in cooperation with the Joint Research Centre of the European Commission.

A few examples

Sketchdrive tool

This is an interactive tool to easily share and discuss visual work online, including being able to sketch directly on the images – a particularly great addition to online design courses. Following a pilot including both campus and online courses, Sketchdrive is now used across TU Delft in courses varying from design MOOCs such as *Rethink the City,* to campus ones at the faculties of Aerospace Engineering, Industrial Design, and Technology, Policy and Management.

FRP tool

The ProfEd *Fiber Reinforced Polymer (FRP) Composites* teaches Classical Laminate Theory (CLT): a framework for computing the macroscopic stiffness of a laminate. The specifically developed FRP tool uses optimisation challenges to help students practice and get a feeling for how laminate design affects stiffness, while taking away most of the CLT elaborate formulas and time consuming multiplication work.

Labs

Laboratories (labs) are a very important element of the learning experience in many engineering courses. Together with faculty and external developers, we created a number of virtual labs, such as the lab-simulator for water filtration in the MOOC *Drinking Water Treatment.* Presently, work is underway to create a number of virtual Photo Voltaic (PV) labs to function as distinct online courses. In this format, learners exercise skills and demonstrate understanding of PV panels and systems by completing dedicated lab activities and assessments.

Gaming

Interactive learning through games helps students grasp abstract concepts in a concrete way. The MOOC *Railway Engineering: An Integral Approach*, and the ProfEd *Adaptive Planning*, are two of our courses where the creation and integration of a serious game help professionals to conceptualise the challenges they face. In the ProfEd, the game is set in a port town, and the learners need to make strategic, long-term decisions to develop and protect both the town and the environment from negative environmental changes.

Simulations

A ProfEd course that skilfully integrates online simulations is *Air Safety Investigation*. Its 3D simulation lets learners walk around a digital aircraft accident scene and carefully observe it, within a limited time frame. Just like in a real investigation, immediately afterwards, learners need to answer a series of online questions using only the notes they took during the simulation.

Chatbots for assessment

These offer a more nuanced alternative to Multiple Choice Questions for automated assessment, both online and on campus. In our *Leadership for Engineers* MOOC, the chatbot tool lets participants negotiate their own learning path, based on their leadership style, and they receive points for reflecting on the shortcomings and benefits of their approach. On campus, the Labrador Team is exploring the idea of the chatbot to help students in computer science to ask questions and receive some automated feedback based on specific coding projects and automated tests.

Open source collaboration

The MOOC *The Quantum Internet and Quantum Computers: How Will They Change the World*? is rather theoretical being the associated technology still in development. To make the course more practical and give learners the chance to test concepts, a GitHub collaborative, open source environment was introduced. On this platform, past and present MOOC learners can work together to create the quantum internet, meanwhile building a global community based around this effort.

Animations

Videos, often with supporting slides or the interview of an expert on a specific topic, are widely used by lecturers in online courses to explain particular concepts. However, the MOOC *Circular Economy for a Sustainable Built Environment* introduced a series of short animations to more effectively show energy, water and waste flows in urban areas, and to walk learners through how they can be made more circular. It is rather extraordinary to note that these animations not only break the pattern in instructor-paced MOOCs – whereby the number of completed views by learners decreases as the course progresses, but they also show the highest percentage of completed views for the visual material in the whole course: 86.7%.

Virtual and Augmented Reality (VR/AR)

There have been several initiatives to develop and implement AR and VR technology in campus and online education. One such initiative is the workshop Augmented and Virtual Reality Educational Accelerator, organized in collaboration with the New Media Centre and Virtual Zone. In the hands-on session, lecturers develop and share ideas on 3D content and VR/AR learning experiences with easy-to-use and accessible software (e.g. Autodesk 123D Catch, Sketchfab and Augment) and technology (tablet, smartphone, 360º camera). One of the online courses making excellent use of AR/VR is the MOOC *Models in Architecture* where participants explore the concept of scale to relate it to context. It employs VR/AR in architectural design to bring visuals and 3D models to life in an accessible manner.

. . . Research

Our activities also include educational research. We use online student behaviour and learner analytics to gain a better understanding, and apply the derived insights to improve the quality of education and to facilitate learning in online courses. An additional benefit is the possibility of using the MOOCs themselves to gather data, linked to the topic of the course, for TU Delft's on-campus research.

Nowadays, MOOCs have also become the subject of dissertations by our academic staff, whilst research data and findings are being widely shared internationally. External researchers make use of our large datasets and run experiments within our courses to find out more about learner behaviour.

Our research and data analysis have resulted in dozens of course evaluation reports, business and marketing analyses, cross-course analyses, internal reports on student learning behaviour, and a substantial number of peer-reviewed academic papers.

The Extension School strives to innovate the design of the educational experience and to introduce new delivery strategies for quality education. The development of online education processes and research activities are thus aligned and integrated, with data collected for three key research agendas:

- course evaluation, which focuses on post-course analysis;
- research-driven innovation through short-cycled research projects;
- long-term experimental research with a specific focus on big data and learning analytics.

. . . Industry collaboration

Working closely with business partners and sector organisations permits lecturers to incorporate ideas and perspectives that supply a level of practicality and a connection to real life. These are highly valued by Bachelor and Master students, and much required by professional learners. Over the years, our collaboration with industry has matured from the contribution of case studies to the co-development of courses and programmes. We can thus deliver the latest, applicable knowledge and skills to closely serve the development needs of professionals and lifelong learners, now and in the future. As a result, several prestigious companies have chosen to offer our online courses and programmes to their employees for staff training and development, and have publicly endorsed our portfolio offering.

'Academia meets industry, a win-win situation. The ProfEd *Advanced Credit Risk Management* was created from the collaboration between TU Delft and Deloitte. TU Delft provides academic knowledge and online course development. Deloitte provides industry knowledge through its experts from the field and real-life cases. Our core objective was fully met: to have a professional course to both train and educate our employees, and to emphasize our credit risk expertise in the market.'

Koen Nicolai, Manager, Deloitte Risk Advisory and Financial Risk Management

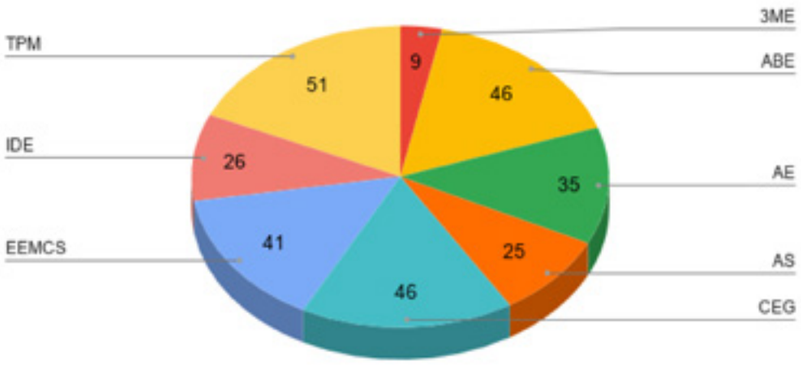
Some of the companies we collaborate with.

'Over 50 Coty employees participated in the online course *Sustainable Packaging in a Circular Economy*. This gave our teams an increased understanding of sustainability and how it can be further applied to our business. Through this course, our employees can contribute with heightened confidence to discussions on sustainable packaging.'

Vincent Delavenne, Vice President Packaging, Coty Luxury

The people who make it happen

Instructors per faculty



Over 400 Teaching Assistants.

Extension School and educational support staff
36 people (19,5 FTE)

- Business director and management: 3 people (3 FTE)
- Faculty coordinators: 7 people (1,6 FTE)
- Academic staff: 4 people (1 FTE)
- Marketing & Communication: 6 people (5,2 FTE)
- Online learning developers: 9 people (5 FTE)
- Online learner services & Administration: 3 people (1,7 FTE)
- Course evaluation & Data analysis (Quality Assurance): 3 people (1 FTE)
- Secretary: 1 person (1 FTE)

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