Five Theses on a Renaissance of Engineering Education: Skill-Driven Learning and Teaching SDLnT

Editorial

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Over the next 50 years, we, the whole mankind, will have to proof whether we will possess sufficient engineering competencies to master the great demands of sustainability and resilience, like climate change, clean water and sanitation, sustainable energies, land-use planning, population growth, ageing and nutrition, or numerous population movements, new humanitarian needs and safety.

Simultaneously, the technological progress of the digitalization offers new opportunities, like big data, driverless cars, 3D printing, quantum computer and artificial intelligence, robotics and much more.

What do all these demands, challenges and opportunities have in common? They share a very high level of complexity and are not restricted by national responsibilities, scientific subject areas and faculty or module boundaries manifested by a traditional structured syllabus.

To successfully meet these challenges and fully take advantage of the technological opportunities, we need extremely well-trained engineers (Obama engineer 2020), who master a good deal more than pure science, technology, engineering and mathematics – mankind might prosper on ARTist engineers, for STE-A-M! What should be the logical consequence of this insight? In order to secure and shape its future, humanity must invest and apply all its efforts to properly educate those new ARTist engineers.

And who has a vast body of experience in engineering education as well as the daily access to the students and thus a large and justified ambition to be in the forefront of this initiative?

Dear authors, reviewers, dear friends and esteemed colleagues: it is a pleasure and honor to have learned so much from you. And – above all else, I learnt that WE – the engineering educators, already are at this forefront. WE already lead this renaissance of engineering education and training. WE already aim at the value added that results from combining engineering education and digitalization!

In this sense, the following five theses were drafted, meant to summarize the state of the discussion on a renaissance in engineering education. I am very grateful to benefit from the extensive knowledge and experience of the engineering educators´ community: The theses have their roots in your scientific papers and your other valuable contributions, which I came to know and appreciate during my term as editor-in-chief of the International Journal of Engineering Pedagogy (iJEP).

Each of the theses comprises two parts: the keywords summarizing research-based evidence and the resulting consequences on education.

1	Zimmermann`s and Miliband`s self-regulated personalized learning SRPL: Stop pampering or incapacitating learners	Learn in small groups. Mentor students intensively. Shift from teaching to learning: A teacher should be a learning coach and not just a knowledge specialist. Transform the responsibility for learning to the learners e.g. by participating them in the development of syllabuses and courses or the distribution of educational resources, or by developing personalized learning objectives and schedules. Promote entrepreneurship by providing learning opportunities, coaching, financial support programmes, business incubators at universities, etc.
2	The Ebbinghaus Forgetting Curve - use it or lose it: Practical-oriented, project-based learning	Focus on knowledge application: build each semester around a project resulting in a real product. As a minimum: offer capstone projects. Educate in close cooperation with renowned research institutes and the industry. Increase the degree of laboratory-based education through remote labs and virtual labs. Rely on flipped classrooms by delivering IT-based learning content online, outside of the classroom. Provide a learning environment that represents the current state of technological progress, and that means above all, exploit the potential of digitalization: IT-based Learning management systems, comprising Wikis, FAQs, download of slides, video-based lectures, MOOCS, tools like spelling and plagiarism checker, IT-based literature research, serious games and gamification, etc.
3	Erich Fromm 'To Have or To Be': Instead of having successfully passed a course, an exam or having graduated, focus on learning.	Develop a positive learning attitude by replacing the 'classic' written exams on factual and conceptual knowledge by problem solving scenarios focusing on procedural and metacognitive skills: like scientific methods, academic writing, presentations or oral exams, etc.
4	Globalization: Orient syllabuses towards international standards based on solid scientific evidence.	Apply the revised Bloom's taxonomy of educational objectives to your syllabuses: Clearly structured learning paths facilitate a broad range of learning from theoretical knowledge to the development of application and metacognitive skills. Instead of repeating factual knowledge that nowadays is freely available on the Internet, encourage the creation of genuine value added: e.g. problem-solving skills, entrepreneurship, computational thinking, communication, teamwork.
5	Tear down the walls: No dead-end qualifications and close cooperation between institutions – private and public.	Ensure consistency between educational qualifications and the possibility to switch between educational institutions so that every grade opens the door to new educational opportunities. Promote dual education systems combining apprenticeships in a company and education at a school resp. university in one course. Construct education programs resp. syllabuses brick by brick from K12 through university up to in-service training thus implementing true life-long learning. This in turn needs the many possibilities that IT-based learning provides.

What is the essence of these five theses? The essence seems to be that a forward-looking approach to engineering education is driven by the successful development of skills: I call this Skill-Driven Learning and Teaching SDLnT.

Does SDLnT require appropriately designed learning spaces and (IT-) infrastructure? Yes, because our traditional classrooms and education buildings with their fixed theatre-style seating arrangement for the students, automatically lead to instructor-centered 'chalk and talk'. What about a student-centered architecture, representing limitless creativity thus supporting innovation and nonconformity, encouraging discussions and the engineering and dissemination of ideas?

May I kindly invite you – the engineering educators´ community – to rely on iJEP journal as the virtual learning space for SDLnT? You are welcome to send us your comments and hints, personal experiences and research results on the five theses. We, the Editorial Team of iJEP Journal, are well prepared to support you in disseminating your ideas from research and practice. Let´s shape the future of engineering education: yes - we can SDLnT!

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