SCIENCE AND EDUCATION IN KARAKALPAKSTAN

ҚОРАҚАЛПОҒИСТОНДА ФАН ВА ТАЪЛИМ

ҚАРАҚАЛПАҚСТАНДА ИЛИМ ҲӘМ ТӘЛИМ

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PRACTICAL-ORIENTED METHOD AS AN INTEGRAL PART OF TEACHING

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Summary: *Engineering education must be regarded as a strategic foundational element, alongside technical research, in building innovation capacity. Engineering is the social practice of conceiving, designing, implementing, producing and sustaining complex technological products, processes or systems. But many of the societal and engineering challenges are so complex and multidimensional that they cannot be unlocked with the old-fashioned key of sciences and technology alone. This high level of complexity is often caused by the emergent behaviour of system development, which changes with time and cannot be predicted from its constitutive parts.This article examines the issues of how to achieve results by teaching engineering students in accordance with the requirements of the new era and the application of a practice-oriented method in the teaching process.*

Keywords: *students, engineering education, CDIO Initiative, new technologies, the learning process, curriculum.*

Engineering education has to be engaging, compelling and motivating, and create a learning community that stimulates all students to discover their talents. The aim is to create a climate in which students are encouraged to develop ideas, both big and small, and bring to the market creative solutions to real world problems. Such a climate can be achieved by focusing on the student as the key player in the learning process (student-centred learning) and by an emphasis on experiential learning: a hands-on approach in teaching and learning of specific knowledge or skills when students feel the need for it. This is a basic premise of the CDIO Initiative , which states that hands-on experience is a vital foundation for engineering students on which to base theory and science. Exploring how one believes a system works, creates a knowledge-building relevance to the lecture or video that is then presented. Exploration, inquiry and problem solving are therefore not just “nice to have” in the classroom but an essential part of a future-proof curriculum.

Curriculum have to focus on coherence, leading to a degree and a connection between courses and (sub)disciplines. They have to connect the subject matter to the context of the students’ lives and the engineering profession, like the pressing issues of environmental awareness, social responsibility and entrepreneurial thinking (“People, Planet, Purpose”), away from the disciplinary monocultures. These issues connect with many young hearts and minds of the Millennial Generation in Western Europe. Students of this generation with birth years ranging from the early 1980s to the early 2000s, have a different set of values[1].

They demand purpose in their lives, want to know who they want to be, not what they can do. Their motivation is self-driven, and they thrive on the ideas of being connected and of co-creation. They do not respect or trust authority or institutions. They want to be involved, make a positive difference, maximise their lives and have fun: “party-cipation”). These students no longer want to be taught, but instead want to be allowed to learn their own way, knowing that somebody at the university cares about their development. Millennial Generation students have a growth mind-set and want to develop their strengths, for which feedback on progress is much more important than feedback on achievement. These characteristics are proven by the great interest, passionate exploration and commitment of the multidisciplinary D:DREAM (“Delft: Dream Realization of Extremely Advanced Machines”; http:// ddream.tudelft.nl/en/ student projects, as well as excellence programmes that offer exactly these opportunities, unfortunately for a limited few.

All engineering students have at least a touch of a maker instinct to build, test and operate things. Experiential opportunities in labs and project and makerspaces foster strengths beyond technical experiences, like leadership, ethical behaviour, deep collaboration, interdisciplinarity, and creativity. Such integrative aspects in a curriculum address real-life concerns, present opportunities for hands-on experimentation, prototyping, design thinking and problem solving. Hands-on discovery has been and will remain an important part of knowledge development. It sparks the desire to learn, promotes independent learning, and offers a more effective involvement with the engineering environment and society. It is absolutely essential that universities unite and address the engineering practice, and that they do not divide their teaching and research.

Students have to experience the real world of engineering and get a taste of genuine research by learning-by-doing and by being lectured and coached by professors, experts, researchers and engineering practitioners from the industry. Research, experimentation in labs, hands-on design projects on authentic problems, building and testing projects in project, production and makerspaces, and internships in industry and institutes enhance student engagement and teach students how to develop and monitor their own development and learning[2]. It also allows for a better application of learning outcomes in real life and the building of tacit ingenuity in the practice of engineering. Through trouble-shooting and the production of a design, students are brought face to face with the social purposes and consequences of engineering - the technologies it creates, the practice of manufacturing, the management of people, and the personal skills involved.

At a time when the classroom environment is evolving from a room-with-a-blackboard to a laptop-with-a-network connection to the cloud and an online forum, the challenge is to find ways of bringing design-oriented, project-based learning and hands-on experiences to online learning, blended with in-person, hands-on activities in real labs. The rise of new technologies of virtual and augmented reality (overlaying digital information on the real world) will make it easier to simulate in-person experiences remotely and to such a high level of detail that the human brain can no longer distinguish them from reality[3]. This technology, along with an all-pervasive content and multiple instant channels of communication, possibly supported by tactile sensing, will deliver an experience of rich interaction in a lab or a classroom, regardless of location and time.

Remote labs provide an interface through internet to remote equipment in real experimental facilities, using live video streaming of experiments with real hardware under real test conditions. Neither the virtual nor the remote labs can ever be a substitute for an in-person experience and should therefore not be simply cut-and-pasted into a curriculum. They may, however, support the achievement of certain learning outcomes. Part of the hands-on learning experience may be transformed into hands-off learning by serious game simulations of lab environments. We can make them an invaluable tool for supplementing existing laboratory work for large numbers of students. In the near future, remote labs will shift from using a specific piece of equipment to accessing a network of shared facilities between universities. As discussed above, we should avoid situations where students who use hardware simulations lose sight of the real hardware being simulated, and instead get caught up in a “computer game” attitude towards the software. Above all, it should not be forgotten that engineering students bring ideas to life and share their passion for making and testing things by means of real fabrication and experimentation in lab spaces. Hands-on learning in physical labs remains appealing for the sensing, visual, active and sequential learning styles. This generation of students does not only attend university for their engineering degree, but to develop personally as well. It is in classrooms and physical labs, where they learn by practicing and working together.

Much that they learn is not strictly academic. What sets a young engineer apart from his fellows is often not degree-related. Empirical research by the Center for Creative Leadership in North Carolina shows that experiential and social learning contributes to more than 80% of the learning gain, against 20% for formal learning. Students gain the most from one another if their classmates have different interests, experiences, talents and beliefs. This sharing makes physical labs and makerspaces an important place of community, even more so when they provide opportunities to mingle with engineering practitioners from industry and young entrepreneurs. Spaces for hands-on discovery and exploration will therefore remain essential for learning how to engineer and to accept failure, and more importantly, they are places for innovation and experimental play.

To capture student interest and respect, these ethical responsibilities should be more interwoven with subjects that are already taught instead of being condemned to the margins of the curriculum. To develop a good sense of ethical accountability and social responsibility, students need to come in closer contact with engineering professionals with whom they can identify and who they can try to emulate. Long-term strengthened relations between university teachers and the labour market that graduates are expected to enter are therefore essential.

Will we enter paperless classrooms in 2030? A major challenge for academic staff is the rapidly developing digital world. With the proliferation of the use of mobile devices, the growth of social-media connectivity has exploded, and the penetration rate of mobile devices among students has reached a record high. Young people are addicted to social media and students are lightyears ahead of academic staff. They cannot remember a world without these tools. Social media like YouTube, Instagram, LinkedIn, Facebook, and Twitter are increasingly used to bridge the gap between the lecturer and the student, and between the student and the rest of the class (social learning). There are some attractive benefits to interactivity, hyperlinking, searchability and multimedia, but they also promote cursory reading, hurried and distracted thinking, and superficial learning. Frequent interruptions scatter deep thinking and weaken memory[4]. Digital textbooks are increasingly used to share notes or passages in social-media applications. Integrating technology and pedagogy in new teaching and learning facilities allows staff to teach differently, perhaps by abandoning the linear and hierarchical world of the book and by using richer media, but it has to be taken into account that a frequent deciphering of hypertexts or studying multimedia fragments distracts students from reading and deep learning. Online tools and apps have the ability to More than just cool technologies Engineering Education in a Rapidly Changing World, 2nd Rev. Ed., TU Delft, June 2016 53 bring the world into the classroom and they enable the sharing of expertise with others on campus or thousands of kilometres away. These emerging tools make it easier for students to ask and respond to each other’s questions and for teachers to provide real-time feedback. State-of-the-art real-time response systems will allow faculty staff to better monitor student learning and to provide immediate advice during live classes (personalised learning)[5]. Although much of the senior staff in today’s education is not a digital native but more likely a digital immigrant, they can no longer afford to ignore these tools. With the revolutions taking place in the technological landscape, digital media literacy will only become an increasingly important key skill for our lecturers and professors.

Academic staff may be apprehensive of having to become fluent in these new technologies because many of them are no longer in their formative years. Since the young generation is much more digitally literate and social media savvy, reverse mentoring , whereby students coach their teachers, might be a solution[6]. A major effort is needed in the near future to ensure that staff can support students in developing and using digital literacy skills across the curriculum. The rise of data-driven learning and assessment (learning analytics), whereby data on personalised learning experiences and study results can be mined for new pedagogical insights, also poses new demands on staff abilities regarding learning analytics.

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Rezyume: *Muhandislik ta'limining innovasion salohiyatni oshirishda texnik tadqiqotlar bilan bir qatorda strategik asos sifatida qaralishi kerak. Muhandislik - bu murakkab texnologik mahsulotlar, jarayonlar yoki tizimlarni ixtiro qilish, loyihalash, amalga oshirish, ishlab chiqarish va saqlashning ijtimoiy amaliyotidir. Ammo ko'pgina ijtimoiy va muhandislik muammolari shunchalik murakkab va ko'p qirrali bo'lib, ularni fan va texnikaning eski usullari yordamida hal qilib bo'lmaydi. Ushbu yuqori darajadagi murakkablik ko'pincha vaqt o'tishi bilan o'zgarib turadigan va uning tarkibiy qismlaridan oldindan aytib bo'lmaydigan favqulodda tizim dizayni xatti-harakatlari tufayli yuzaga keladi. Ushbu maqolada muhandis-talabalarni yangi zamon talablariga mos ravishda o'qitish va amaliyotga yo'naltirilgan usulni dars jarayonlarida qo'llash orqali qanday natijalarga erishish masalalari o'rganilgan.*

Резюме: *инженерное образование следует рассматривать как стратегический фундамент, наряду с техническими исследованиями, в создании инновационного потенциала. Инжиниринг - это социальная практика придумывания, проектирования, внедрения, производства и поддержки сложных технологических продуктов, процессов или систем. Но многие социальные и инженерные проблемы настолько сложны и многогранны, что их невозможно решить с помощью старых методов науки и технологий. Этот высокий уровень сложности часто вызван эмерджентным поведением разработки системы, которое изменяется со временем и не может быть предсказано на основе его составных частей. В статье рассматриваются вопросы достижения результатов путем обучения студентов инженерных специальностей в соответствии с требованиями нового времени и применения практико-ориентированного метода в учебном процессе.*

Kalit so'zlar: *talabalar, muhandislik ta'limi, CDIO tashabbusi, yangi texnologiyalar, o'quv jarayoni, o'quv dasturi.*

Ключевые слова: *студенты, инженерное образование, инициатива CDIO, новые технологии, учебный процесс, учебная программа.*