ИНЖЕНЕРНАЯ ПЕДАГОГИКА

30 марта 2018 г. на базе МАДИ состоялся очередной (уже 23-й) ежегодный межвузовский методологический семинар по инженерной педагогике (8-я Международная конференция IGIP) на тему «Подготовка научно-педагогических кадров в технических университетах: актуальные темы». Организаторы: Международное общество по инженерной педагогике (IGIP), Московский автомобильно-дорожный государственный технический университет (МАДИ), Ассоциация инженерного образования России (АИОР), Ассоциация технических университетов, журнал «Высшее образование в России».

Своими размышлениями о сложившейся ситуации поделились известные специалисты в этой области: А. Цафошниг, В.М. Приходько, Д.А. Новиков, В.С. Сенашенко, А.А. Вербицкий, Л.С. Гребнев, З.С. Сазонова, М.Г. Минин, В.С. Шейнбаум, Г.В. Ившина, В.В. Кондратьев, Б.С. Сазонов, Т.Ю. Полякова, Г.У. Матушанский, И.Д. Белоновская, П.Ф. Кубрушко, Е.И. Муратова и др. В работе семинара приняли участие представители всех отечественных центров инженерной педагогики. Ниже публикуются статьи, подготовленные на основе докладов.

Smart Ideas for Engineers – The Impact of Emerging Technologies on Modern Engineering Education

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Abstract. *Never has the speed of development in the area of engineering been as high and accelerated as it is today when we observe the enormous and driven growth of the engineering sector worldwide. These tendencies require well-coordinated new efforts in engineering education. The importance of pedagogy in the field of engineering in both the secondary and tertiary sector is growing enormously. These changes strongly demand new didactic and pedagogic paradigms. Thus, engineering education institutions across the world need to contribute relevant concepts and pedagogical ideas that can foster the development of engineering education. At the same time, the methodological and organisational challenges in engineering education need to be tackled successfully in the nearest future because collaboration, multimedia communication and complex problem solving will play an increasingly important role. This paper discusses current experiences and examines best-practice solutions, which contribute to the development of new approaches in engineering education as a multi-disciplinary field.*

Keywords: *IGIP, engineering education, engineering pedagogy, digital transformation, interdisciplinarity, emerging technologies*

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Introduction

On 13th March, 2018, the 8th IGIP International Conference on engineering pedagogy with the title "Researchers and educators' development at technical universities: problems and prospects" took place at MADI, the Moscow Automobile and Road Construction State Technical University. In the course of the welcome address, new trends and tendencies in engineering education were discussed and the challenges of the digital transformation in education was presented as a pressing issue. The background of the conference was also to investigate scenarios and to share some thoughts with the conference participants that might have an impact on future actions in the fields of teaching, but also on research, and on how personal professional development can be organised more efficiently at various institutions.

In this respect, a new socio-political trend has become apparent in Europe across all teaching institutions. European politicians and education experts expressed their worries that the education systems can hardly guarantee equity any longer and that the inequalities between students – in terms of socio-economic implications, but also in terms of learning pre-requisites and competences – are becoming bigger and that the anxieties of the future increase. One reason for these deficits, fears and worries is the fact that the challenges of the future are more and more unpredictable and that it is difficult to prepare for them.

A possible solution to these problems is to teach all representatives of the younger generation the skills and competences needed for these challenges. Firstly, the problem of equity and quality in education must be tackled optimistically. One strategy for that could be to invest more trust in all stake-holders involved in education systems globally, to implement more flexibility and autonomy in the learning processes, and to adapt to future challenges through a better digital and media competence.

New strategies

Which pedagogical and didactic as well as organisational measures can be undertaken to help universities and teaching staff to solve the problems mentioned above and to achieve the ambitious goals listed before?

The successful mission and vision in this respect is certainly to improve the quality of teaching in engineering, to increase the efficiency of higher education, to promote creativity and innovation in engineering pedagogy, and to accredit and certify successful engineering educators. At the same time, the teaching of engineering, science, STEM

or MINT, must begin at an early age, because the future will be infinitely flexible. This means for the teaching process that not only new trends shall be embraced, but control over the learning and teaching processes must be kept. Teaching institutions must provide the necessary skills and competences, but shall also apply the freedom to choose the appropriate individual and collective measures to achieve adaptive and experiential learning through the right measure of autonomy.

Science, research and development are the drivers of our technological future – today more than ever. This fast development will bring about dramatic changes in the fields of work, economy and academic studies.

Emerging technologies

If we look at the most important recent developments, we shall see that technology is one of the most reliable, persistent and underestimated drivers of the future change. This means that the engineering education community must also deal with the potential technological advances in the following key areas.

1. Digital and communication technologies. In this respect, all developments focus on electronics, networking and interfaces – but in detail this means that we have to deal with context-aware computing, immersive multi-user virtual reality environments and digital currencies, memristors and other innovations.

2. Energy technologies. Here, the storage of electricity, smart grids, and electricity generation must be dealt with, whereby solar panels (with tandem solar cells made of silicon and perovskite) or bio fuels, micro-nuclear reactors, and distributed energy generation, will play an important role.

3. Nano technology and materials science. The next-generation materials will be much more functional, self-assembling and self-healing than any other materials before, which means that we have to look at the properties of these new and smart materials.

4. Neuro technology and cognitive technologies. This vastly undiscovered area of neural network computing, extended cognition or neural interfaces will have to be looked at in more detail and new technologies like neural biofeedback or high resolution magnetic resonance imaging systems will have to be explored more.

5. Health technologies. In this field, augmentation, new treatments and new diagnostic systems will play an important part and enhanced organs, biologically extended senses and organ printing will also have to be looked at.

6. Agricultural technologies. In this area, a higher resilience of plants and crops will be aimed at; soil, air and water will be monitored with sophisticated sensors, and new food animals and plants will be subject of extended research.

Possible solutions

One possible solution to help students and engineering teachers to improve the teaching and learning quality of students, as well as to raise their attainment levels, and to build the capacity of faculty staff, is probably the fostering and promoting of new sets of competences in inevitable for good teaching.

For that purpose participation in international engineering education conferences, in international collaborative learning initiatives, or in extended networking, can be mentioned.

In any case, inspirations cannot only come from individual presenters and speakers at such conferences, but should also be nourished by groups and networks like scientific advisory boards consisting of international engineering education experts, or by relying on the vast body of research studies and academic papers that have been published in the field of engineering pedagogy.

Furthermore, the results of many modern practical and academic endeavours can be retrieved from various archives (e.g. of IGIP, its member institutions or individual members), if further information and support on different topics are needed.

New findings are, however, also regularly published in the many international online journals, like the International Journal of Engineering Pedagogy of IGIP. But all other publication platforms are also well worth looking at and serve as support tools for our young colleagues in engineering education.

Personal and professional development

The most important issue, in connection with qualifying well for a teaching job in engineering education is, however, the possibility for each individual lecturer to be able to give evidence that they are qualified to meet the requirements of the teaching professing.

This means that the teaching staff, no matter whether they are newcomers or experienced specialists, must prove to their employers, the technical universities, universities for applied science or technical colleges, that they have completed a kind of pedagogical professionalisation program that enables them to deliver the engineering content brilliantly to their students.

In this field, IGIP is the only organisation that accredits or certifies individual engineering educators, not just universities or study programs, as so-called "Ing. Paed. IGIP", derived from the German word "Ingenieurpдdagoge", with its international Engineering Educator Certification Program.

In this program, the curriculum with its 20 ECTS provides a formal, internationally recognised qualification in teaching and learning methodologies for engineering and related disciplines (science, math, physics, IT, etc.) for faculty, graduate students and other interested parties worldwide. Those who complete it can add a world-recognised qualification to their title: e.g. Dr. Juan Pйrez, PhD, PE, Ing. Paed. IGIP.

In this connection, it is also important to point out that every engineering lecturer with an academic engineering qualification and at least one year of teaching practice can apply for the title after completing an Ing. Paed. IGIP training program at an accredited IGIP Training centre near them. The detailed locations and the curriculum can be found on the IGIP website. In any case, such a program shall enable applicants to understand and apply the individual fundamental and theoretical specialist engineering knowledge, the didactics and the methodology, as well as the best practices of engineering education that are required to become effective teachers and mentors.

Some of the key elements of the modular curriculum of the international engineering educator certification program are workshop and laboratory didactics, sociological and psychological lectures, or electives that can focus on the strengths and key competences of the candidates based on regional or local requirements.

Working groups

It shall be in the interest of the engineering education community also to deal with new developments and with new demands by getting together in working groups and tackling special problems and challenges jointly. Engineering experts from various fields who think that they can motivate and lead like-minded people to achieve best results in research and teaching, shall get together and form such a group.

IGIP currently offers working groups in the fields of "Games in Engineering and Education", "Teaching Best Practice" and "Entrepreneurship in Engineering Education".

Outlook into the future

Industry 4.0, the internet of everything, digitalisation, robotisation, virtual realities, augmented realities, building information modelling (BIM) and other modern technological keywords show us the direction into which science, engineering and the industry are going to go in the near future. We can see that the digital transformation plays an important role and if we do not adapt rapidly enough our business models will become obsolete. In industrial processes, digitalisation will have an even stronger impact through increased automation, communication and software dominance. It is therefore the foremost responsibility of excellent engineering education institutions and staff to provide excellent training for those who have to solve these engineering problems in the future. It is also a task to lead the way towards a magnificent engineering education across the globe and it shall be an ethical guideline that important sustainable development goals, such as quality education, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry innovation and infrastructure, responsible consumption and production, and many more are observed.

It is for the reasons stated, that a clear commitment shall be developed to improve the quality of engineering education worldwide, to shape the future of teaching and learning with new approaches and new methods, and to open up new perspectives for the next generation of prospective engineers. The challenges are becoming bigger, but with united forces, with innovation and creativity in the world of engineering education, they can be mastered.

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Вызовы инженерного образования: новые технологии и подходы

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Аннотация. В развитии инженерного образования не было периода, сопоставимого с текущими изменениями по темпам и качеству, что особенно заметно на фоне стремительного роста инженерного сектора в мировой экономике. Эти тенденции предъявляют к инженерному образованию повышенные требования с точки зрения эффективного педагогического взаимодействия как в сфере среднего специального, так и высшего образования и разработки новых дидактических и педагогических парадигм. Вследствие этого учреждения инженерного образования во всем мире нуждаются в создании единого банка педагогических идей, благодаря которым инженерное образование сможет получить импульс к дальнейшему развитию. В то же время внимания требуют методологические и организационные проблемы инженерного образования, поскольку сотрудничество, мультимедийная коммуникация и совместное решение сложных проблем будут играть всё более важную роль в ближайшем будущем. В статье представлен опыт текущих исследований и обсуждаются лучшие педагогические практики и решения, которые могут использоваться в разработке новых подходов в инженерном образовании на мультидисциплинарной основе.

Ключевые слова: IGIP, инженерное образование, инженерная педагогика, цифровые трансформации, междисциплинарность, новые технологии

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