IEE 2025 CONFERENCE

Innovation in Engineering Education

Book of Abstracts

February 7–8, 2025

Organised by the

Department of Basic Technical Studies
Faculty of Engineering
University of Debrecen

Institute of Mathematics
Faculty of Mechanical Engineering and Informatics
University of Miskolc

Edited by Boglárka Burján-Mosoni
ISBN 978-963-490-714-5
www.mat.unideb.hu

Scientific and Program committee:

Mihály BESENYEI PhD, University of Miskolc, Hungary

Lehel CSATÓ PhD, Babes-Bolyai University Cluj-Napoca, Romania

Marie DEMLOVÁ PhD, Czech Technical University in Prague, Czechia

Imre HORVÁTH PhD, Delft Technical University, The Netherlands

Géza HUSI PhD, University of Debrecen, Hungary

Péter KÖRTESI PhD, University of Miskolc, Hungary

Zoltán SIMÉNFALVI PhD, University of Miskolc, Hungary

Judit T.KISS PhD, University of Debrecen, Hungary

Gabriella VADÁSZNÉ BOGNÁR PhD, University of Miskolc, Hungary

Organizing committee:

Szilvia ÁRVAI-HOMOLYA PhD, University of Miskolc, Hungary

Boglárka BURJÁN-MOSONI PhD, University of Debrecen, Hungary

Imre KOCSIS PhD, University of Debrecen, Hungary

Erika SZILVÁSINÉ ROZGONYI PhD, University of Miskolc, Hungary

Content

Self-explaining (?) artificial intelligence -- Teaching the teaching assistant --

Lehel CSATÓ[1]
[1]Babeş-Bolyai University of Cluj-Napoca, Faculty of Mathematics and Computer Science, Department of Mathematics and Computer Science
lehel.csato@ubbcluj.ro

The meaning of artificial intelligence in recent days embodies everything from "conversational agent" or LLM-based artificial intelligence on one extreme, to the "adaptive" image classification that sorts vegetables, all the way to the wearable smart-watch that measures the temperature. The range is so wide, one can say that every "automated decision" can be attributed to the "artificially intelligent" - AI - agent.

This overarching simplification and umbrella blinds the possibility of systemic view to the rapidly evolving field. In our presentation we argue that the classification of AI agents according to their action domains, as it is done by the "AI Act" put forward by the European Union is beneficial in separating concerns related to the vast domain list of agent-based decision making. We highlight that systems with non-minimal risks need to address the possible justifiability in a cause-effect explanatory way and present an image classification system that is "grounded" in the sense that there is a possibility to justify the system decision by presenting patches from the image that have "interpretable" parts.

In the final part of the presentation, we list concerns related to systems based on the large language-models: starting from the sheer size of its parameters to the mechanisms underlying the predictions these systems make, we argue that these systems are the very definitions of black boxes. We present impediments to applying these systems as "reasoning" agents and press the importance of presenting these latter findings to the general audience.

Do we need to assess Math, why and how?

Marie Demlová[1]
[1]CTU in Prague, Faculty of Electrical Engineering, Department of Mathematics
demlova@fel.cvut.cz

Universities and teachers face significant challenges due to recent changes in technology and society. This is particularly true in the education of future engineers. Over the past 50 years, the technology available to both teachers and students has evolved dramatically-starting with hand calculators in the 1970s, through computers, notebooks, and mobile phones equipped with computer algebra software, and now culminating in the advent of AI. This shift has raised several important questions: Has the knowledge students need to acquire changed, and to what extent? How can we best prepare students for their future careers? And, more specifically, with the availability of computer algebra systems and AI tools like ChatGPT, is there still a need to teach mathematics? This talk will explore these questions and demonstrate that, even in this transformed environment, teaching mathematics to future engineers remains valuable and beneficial.

One of the reasons why mathematics education is crucial is that, in recent years, one of key goals of education has become the development and cultivation of critical thinking in future engineers. By critical thinking, we primarily refer to:

the process of analysing available facts, evidence, observations, and arguments to make sound conclusions or informed choices. It involves recognizing underlying assumptions, providing justifications for ideas and actions, evaluating these justifications through comparisons with varying perspectives, and assessing their rationality and potential consequences. The goal of critical thinking is to form a judgment through the application of rational, sceptical, and unbiased analyses and evaluation.
And with this Mathematics could and should help.
Another issue closely related to education is that, for any objective we set for students, we must assess their achievement. However, before assessing students, we must ensure they are given sufficient opportunities to learn the competencies we expect them to acquire. This raises several important questions:

1. How can we teach mathematics in a way that enhances critical thinking?

2. How can we assess the development of critical thinking?

By assessment, we refer to a range of both formal and informal procedures used by teachers throughout the learning process to achieve teaching objectives.
In recent years, new assessment methods have been developed and are now widely used, such as multiple-choice tests, projects with defense presentations, and combined written tests (which integrate multiple-choice questions with open-ended ones), among others. Additionally, various methods are employed for self-assessment and for the final exam, which constitutes a significant portion of the final grade. For assessments throughout the semester, such as midterm tests or homework assignments, providing students with immediate feedback is crucial. Computer-based multiple-choice tests are particularly convenient for this purpose. However, they have one major drawback—they do not significantly promote the development of critical thinking. On the other hand, homework can be designed so that students not only provide the solution to a problem but also explain why the chosen method is correct. However, the main disadvantage here is that providing immediate feedback is time-consuming, and without such feedback, homework does not effectively help students develop the ability to justify their solutions logically. This talk will explore potential solutions to overcome this issue, and concrete examples of student work will be shared.

We pretend to have some solutions … but do we understand the problematics as a whole?

Imre HORVÁTH[1]
[1]Delft University of Technology, Faculty of Industrial Design Engineering, Department of Sustainable Design Engineering
dr_imre_horvath@hotmail.com

Engineering education is an evergreen challenge. It is supposed to follow the scientific progression, aggregation of knowledge, development of technologies, industrial demands, social trends, personal interests, affordances of computerization, evolution of educational practices, and so forth. It must renew itself to comply with the changing situations, growing complexities, and quality expectations holistically and perpetually. Therefore, this keynote presentation regards innovative engineering education as a large-scale, domain-dependent, multi-faceted, and complicated problematics that has been jointly induced by technological, industrial, social, and demographic trends and factors, and that concurrently concerns research, development, and deployment issues. The talk is structured according to five fundamental

questions: (i) Why is innovation in engineering education a challenging problematics (again)?; (ii) What are the currently typical forms of engineering education?; (iii) What can we regard as an enabler for a next-generation engineering education?; (iv) What can we expect from the offerings of generative artificial intelligence tools?; and (v) What is the new mindset strongly needed for next-generation engineering education? The computerization and informatization targeted by Industry 4.0/Society 4.0, and the intelligentization and autonomization sought by Industry 5.0/Society 5.0 place the trinity of engineering education into a radically new context. Hardly any retrospectively or intuitively formulated concept can offer a complete solution for the triplet of objective (why to learn), content (what to learn), and approach (how to learn). Individually or in combination, the historically evolved forms of education, such as instructional, explorative/experimental, project-based, competence-driven, team/collective-oriented, practice-placed, design-centered, virtual reality aided, on-line/communicative, or search/prompting guided approaches can fulfil the fabric of dynamically emerging requirements and objectives only partially. To complement these, the idea of experience-oriented education has popped up recently. The widely studied but much less practiced blended learning, autonomous learning, and life-long learning approaches are often questioned due to their deinstitutionalizing, responsibility transfer, methodologically under-defined, and uncertain quality management and accreditation nature. On the other hand, they seem to have a lot of unexploited potential – a fact that begs for further intense research and practical experimentation, as well as changes in the mental models of academic educators and practical coaches. In this regard, the statement of the famous Hungarian composer, Zoltán Kodály, stands: "The (musical) instruction of children must commence with that of the parents/mentors". In the hope of efficiency, methodological innovations should be complemented with epistemological innovations. For instance, the traditional bottom-up (reductionist) knowledge transfer strategy can be combined with, or even replaced by, the progressive (top-down) holistic strategy. This strategy seems to be advantageous in the education of complex systems, such as intellectualized cyber-physical-social-human systems, which embed the knowledge of and require competencies for cross-disciplinary hardware, software, cyberware, and brainware development and their synergistic integration. However, this strategy, culminating in the third phase (university-level) education, assumes supporting first-level general and second-level professional education, which triggers organizational complexity and difficulty. A pedagogical strategy whose main objective is to delegate responsibility over the contents and processes of learning to the learners is proliferating. It intends to support the efforts of the learners by building learner-composable individual learning trajectories, course contents composed from thematic modules, learning objects-based editable courses, peer review techniques, self-evaluation frameworks, online-shared awareness spaces, and social media chatboxes. Though getting more attention and impetus, the roles of generative artificial narrow intelligence tools in next-generation engineering education are difficult to predict since, at this moment, there are positivist, realist, pessimistic, and sceptic positions taken. While it can extend human motor, perceptive, cognitive, and behavioral capabilities, it goes together with legal, ethical, motivational, and many more unsolved issues. These latter imply that there is a new mindset strongly needed for next-generation engineering education. However, instead of pretending to have some partial solutions, first, we must develop a proper understanding of the problematics of the whole.

Integrating Sustainable and Ethical AI with Data Science in Engineering Education

Masuk ABDULLAH[1]
[1]University of Debrecen, Faculty of Engineering, Department of Vehicle Engineering and Mechatronics
masuk@eng.unideb.hu

The study explores the integration of sustainable and ethical AI (artificial intelligence) with data science in engineering education. The rapid advancements in technology require the amendment of traditional engineering curricula to produce future engineers with both technical proficiency and ethical liability. The discussion highlights the importance of balancing theoretical knowledge with practical applications, incorporating ethical considerations, and fostering interdisciplinary collaboration with industry and engineering institutions. Based on personal experiences as a mechatronics engineer, a case study on cyber-physical systems (CPSs) applications shares real-world insights on how AI is changing engineering education, improving problem-solving, and boosting innovation. Findings from the case study explore successful sustainable AI implementations and the key takeaways for advanced AI tool uses for better engineering solutions. Key findings of this study emphasize the importance of continuous curricula evolution for advanced real-life learning and the development of critical thinking skills for graduate engineers and instructors. Continuous advancement of AI technology with data science is crucial for preparing future engineers to undertake complex global challenges responsibly and creatively.

Data-Driven Insight: Transforming Education Through Modern Analytics

Éva ÁDÁMKÓ[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
adamko.eva@eng.unideb.hu

In the past, data had a limited impact on education, as it was primarily gathered through static assessments that offered little actionable insight. In recent years, however, advancements in data processing tools, the exponential growth of computational power, and the rise of artificial intelligence have dramatically transformed our understanding of data-driven education. Today, student performance, behaviour, and progress can be tracked in real time, enabling more effective and personalized learning experiences. This presentation explores the evolving field of data-driven education, focusing on cutting-edge methods and practical applications of Learning Analytics. Key areas include Adaptive Learning Systems, which tailor content to individual needs; Multimodal Analytics, integrating diverse data types like video and emotion tracking; IoT-Enabled Smart Classrooms, which enhance learning environments; and tools utilizing Natural Language Processing, such as automated feedback systems. Innovative approaches like Gamification and Micro-Learning Analytics will also be examined, alongside advancements in Deep Learning Models and Real-Time Analytics, all of which are shaping the future of education.

Characterization of Challenge-Based Pedagogy – Brain Maintenance for Efficient Cyber-Physical Systems Education

István BALAJTI[1], Imre KOCSIS[2], Boglárka BURJÁN-MOSONI[2]
[1]University of Debrecen, Faculty of Engineering, Department of Electrical Engineering and Mechatronics
balajti.istvan55@gmail.com
[2]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
kocsisi@eng.unideb.hu; burjan-mosoni.boglarka@eng.unideb.hu

"There are two types of people living on Earth, the Engineers and Everyone else. We Engineers like Everyone else types of people but they are not Engineers." The importance of Cyber-Physical Systems (CPS) frequently called Industry 4.0 (I4.0), or Internet of Things (IoT), grows permanently. Artificial intelligence (AI) supported CPS is spreading rapidly in our world and it is called Smart Cyber-Physical Systems (S-CPS). The Extended Cyber-Physical Systems (E-CPS) or Next Generation Cyber-Physical Systems (NG-CPS) are expanding to address more complex problems such as the impact of intellectualization on human roles and the social embedding of heterogeneous systems.
The industrial metaverse for smart manufacturing and its novel characteristics require new types of advanced engineering education at the university level, while the addition of new skills requires rigorous preparatory work. The development and validation of effective knowledge transfer methods that meet the I4.0 educational needs is frequently called Education 4.0 (E4.0). The characteristics of Challenge-Based Pedagogy (CBP)-Brain Maintenance awarded by Nobel Beer developed in the Faculty of Engineering indicate promising performances. It focused on engineering thinking reinforcement What? Why? and How? while challenging weekly tasks are shaking the students by using their minds efficiently. The key question here is this: "How should challenges be connected, and their results enlarge each other efficiency?" Why make the report and solutions of received weekly tasks from the BOSS motivate students to become The BOSS in the near future after graduation?

Innovative Teaching Methods in Energy Engineering at University of Oradea

Codruța BENDEA[1], Vasile MOLDOVAN[1]
[1]University of Oradea, Faculty of Energy Engineering and Industrial Management, Department Energy Engineering
cbendea@uoradea.ro; moldovan@uoradea.ro

The field of energy engineering is at the forefront of addressing global challenges such as climate change, energy security, and sustainable development. To prepare students to excel in this dynamic field, it is imperative to adopt innovative teaching methods that foster active learning, critical thinking, creativity, and global collaboration. This paper explores how cutting-edge educational strategies, including active learning, blended learning, virtual and augmented reality, digital tools, gamification, and international collaboration, can transform energy engineering education at the University of Oradea. It is just recently that our Department of Energy Engineering started to implement these strategies. We focus on how to increase our students interest and motivation by using game designed elements like optimizing the energy mix for a city or region (Power Grid, GigaWatt, Pampero, and Keep Cool board games were bought by the end of 2024 are about to be used starting from the Spring semester 2025) or

simulating energy market dynamics and energy transition – online simulations - Energy market game (offered by Stanford University), Transition mission (offered by Siemens Energy), Renewable Energy Communities RECxploration, Energy manager, or ELECTRIFYtoday. Another important direction to be developed within our department is integrating sustainability into the curricula of the three bachelor study programs (Power Systems Engineering, Energy Engineering and Information Technologies, and Renewable Energy) and the two Master's programs that our department is offering. Our students learn how to sustainably produce energy and, of course, use it sustainably, addressing environmental impacts and resources management, so SDG7 Affordable and Clean Energy is addressed very often, but the rest of the SDGs are less or not at all addressed. Therefore, the main challenge for us is to make our students aware of all 17 SDGs. Topics such as life-cycle analysis, carbon footprint reduction, and circular economy principles can be integrated into existing subjects. Besides the theoretical approach, we are going to use several board games: SDG Architect, The Sustainability Lens, Global Goal Compendium, and CO2 Second Chance. Our department made some small steps towards using virtual and augmented reality. Starting from January 2025 we have two pairs of glasses that will allow our students to get an immersive learning experience by walking inside a nuclear reactor, a power plant or a hydraulic turbine. As a conclusion, the Energy Engineering Department just started this magnificent journey but specialized staff training activities for these innovative teaching techniques are still needed.

Automatic Task Evaluation System for Operating System Configuration Tasks

Piroska BIRÓ[1], Tamás KÁDEK[2]
[1]University of Debrecen, Faculty of Informatics, Department of Information Technology
biro.piroska@inf.unideb.hu
[2]University of Debrecen, Faculty of Informatics, Department of Computer Science
kadek.tamas@inf.unideb.hu

The University of Debrecen's Faculty of Informatics has a long experience of self-developed automatic task evaluation systems. In 2011, we started developing ProgCont software, which was specifically designed to automatically evaluate solutions to programming problems based on the experience of several previous experimental software projects.
Initially, the software supported the organization of programming competitions, providing an objective, automatic, and almost immediate evaluation of submitted source code. It soon became evident that the solution used in the competitions could also be used in everyday teaching, either for practice exercises or for the assessment of exam questions. That is why we have added several features to the system over the last decade. The challenges of the last half-decade, primarily the pandemic, have significantly increased the importance of software such as ProgCont.
Using our experience in this field, we have also taken advantage of the benefits of automatic online evaluation software in another area of IT. Five years ago, in the rush to respond to the pandemic, a rudimentary solution for checking virtual machine configuration was born and deployed to check IT Security and Operating Systems in practice. Because the method worked in this case, it has stayed with us until today, after the pandemic. Almost five years on, the disadvantages/drawbacks of this new software have become clear, and several new needs have arisen to extend its usability.
In this article, we would like to present a redesigned second-generation software based on the experience gained, which can be used to control and practice a wide range of virtual machine

configuration tasks in several subjects of the IT faculty. We believe that the system design developed can serve as a model for other areas and can be effectively applied in the field of engineering education.

A Framework for the Development of the Engineering Soft Skills in Undergraduate Education

Boglárka BURJÁN-MOSONI[1], István BALAJTI[2], Imre KOCSIS[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
burjan-mosoni.boglarka@eng.unideb.hu; kocsisi@eng.unideb.hu
[2]University of Debrecen, Faculty of Engineering, Department of Electrical Engineering and Mechatronics
balajti.istvan55@gmail.com

The authors developed and applied a method to improve the engineering soft skills of senior undergraduate students in the context of advanced engineering topics such as Cyber-Physical Systems, Cyber Security, Measurement Data Collection, Measurement Technology, Mechatronic Devices. The results, based on individual and group interviews, show that the gap between the existing and required soft skills of senior engineering students is quite large, and the participants expressed the need for intensive development of these skills not only in the final stage of the training. A main conclusion drawn from the interviews introduced in this paper is that the efficiency of personality development concentrated in the last semesters of education is not effective enough due to the lack of experience of students in this field. To improve the method, the timeframe was extended to the earlier stages of education, and some basic skills were identified and a method for their development was established. A case study presents the elements of the new methodology in basic subjects such as engineering mathematics.

Detecting the Eight Wastes in Digital Text Management

Mária CSERNOCH[1], Piroska BIRÓ[2], Domicián MÁTÉ[3]
[1]University of Debrecen, Faculty of Informatics, Department of Computer Science
csernoch.maria@inf.unideb.hu
[2]University of Debrecen, Faculty of Informatics, Department of Information Technology
biro.piroska@inf.unideb.hu
[3]University of Debrecen, Faculty of Engineering, Department of Engineering Management and Enterprise
mate.domician@eng.unideb.hu

According to Wings (2006), computational thinking (CT) skills, should be essential alongside Reading, wRiting, and aRithmetic (3Rs), are to build students' knowledge effectively in informatics and engineering. Are these skills sufficient to develop their algorithmic and application abilities and connect different scientific fields? Are teachers prepared to help develop CT skills of their primary and secondary students in general? Which specific CT skills do incoming students often lack? How can teachers be better prepared to improve their

students' CT skills? What strategies can teachers use to develop their level of CT skills? These questions highlight additional challenges in education.
To answer these questions, we conducted a series of tests. In the testing process four atomic text modification tasks were carried out and the participants' activities were logged in a text and a video file. In this paper, we present a case study that looks at how effectively a teacher can modify both incorrect and correct digital texts based on the eight types of waste in lean methodology. We compare this case to one (sample) where only Value Added (VA) and Requested Non-Value Added (RNVA) processes were used. Most RNVA activities came from errors in the chosen digital document that could have been avoided with proper editing.
The comparison showed that for the first task, the selected case took seven times longer to complete than the sample. Notably, the sample task was completed without any errors, while the assessed case often struggled to do the same, showing significant defects, without completing the task. Overall, we found that the eight wastes of lean were present in the first task. The process also indicated that learning from mistakes reduces the number of non-value-added activities, and the time needed.
We also found that well-edited texts are easier to work with and less likely to have errors. Our case study indicates that not all teachers have the necessary level of computational thinking skills to develop their students' CT skills effectively. As a result, students may start college in informatics and engineering without the required CT skills, which should be considered and taken into account when producing their curricula.

Advancing Engineering Education Through Competency-Based Learning: Insights, Challenges, and Future Directions

Raul Florentin DRENŢA[1]
[1]Tehnical University of Cluj Napoca, North University Center of Baia Mare, Department of Engineering and Technology Management
raul.drenta@imtech.utcluj.ro

This comprehensive study offers an in-depth synthesis of the latest research on competency-based education (CBE) in engineering, exploring its transformative potential for reshaping both academic and professional landscapes. By critically examining a wide spectrum of methodologies and outcomes, the article underscores how CBE addresses the growing need for workforce-ready engineers equipped with practical skills and industry alignment. The analysis integrates insights from over two decades of global studies, highlighting significant benefits such as enhanced problem-solving abilities, collaborative skills, and adaptability to rapidly changing technological environments. Moreover, the findings reveal how CBE fosters innovation and lifelong learning, positioning it as a pivotal framework for tackling the challenges posed by Industry 4.0 and the transition to sustainable practices.
This article also identifies key challenges, including resource allocation, faculty preparedness, and resistance to curriculum changes, offering actionable strategies to overcome these barriers. The synthesis emphasizes the critical role of partnerships between academia and industry in closing the skill gap and advancing educational outcomes. Additionally, it explores emerging trends, such as the integration of digital technologies and personalized learning pathways as accelerators for effective CBE implementation.
Through its comprehensive approach, this research not only provides a roadmap for institutions seeking to adopt or enhance CBE frameworks but also sets the stage for future scholarly inquiry into scalable and innovative models. The findings contribute to global efforts aimed at creating

an adaptable and competent engineering workforce ready to address the complex challenges of the 21st century.

Removing the Burden of Syntax: Developing Computational Thinking and Algorithmic Skills of STEM Students

Ádám GULÁCSI[1]
[1]University of Debrecen, Faculty of Informatics
gulacsi.adam@inf.unideb.hu

In higher education, solving programming exercises with a high-level programming language is a commonly used approach for developing computational thinking and algorithmic skills. However, this method has its limitations: learning the syntax of a high-level programming language puts an extra cognitive load on students, preventing them from focusing on problem-solving. Furthermore, computational thinking is not limited to programming: STEM students can benefit much more from solving problems within their own discipline, in different environments. This practical article proposes a collection of unplugged, semi-unplugged and plugged-in alternatives which can be used to develop the computational thinking and algorithmic skills of students.

Artificial Intelligence and CAD Systems in Mechanical Engineering Education

György HEGEDŰS[1]
[1]University of Miskolc, Institute of Machine Tools and Mechatronics, Department of Machine Tools
gyorgy.hegedus@uni-miskolc.hu

Artificial Intelligence and CAD systems are completely revolutionizing how mechanical engineering students learn, develop, and innovate. Automated algorithms support from AI-powered CAD tools improves the process, allowing students to create complex designs more accurately and in less time. This intelligent support helps AI-powered CAD tools simplify the design process and produce complex designs much more accurately for students.
Enabling generative design, real-time error detection, and automated optimization to encourage creativity and problem-solving skills helps students better internalize engineering concepts. Ultimately, this integration will allow students to learn more complex subjects, such as adaptive modeling and machine learning-based design analysis, by connecting theory and practical implementation.
The article presents the results experienced in recent years in the education of CAD systems supported by artificial intelligence, which is becoming increasingly powerful. It also outlooks on the opportunities expected in the future and the kind of paradigm shift that is needed for educators to accept and apply artificial intelligence.

Engineers of the Future and AI: How Does Today's Mathematics Education Prepare Them

Szilvia HOMOLYA[1]
[1]University of Miskolc, Institute of Mathematics, Department of Analysis
szilvia.homolya@uni-miskolc.hu

The rise of artificial intelligence (AI) in modern technology raises pressing questions about the structure of university-level engineering education. It is particularly important to examine to what extent the mathematical training of engineering students provides the knowledge essential for implementing AI and handling data processing tasks necessary for AI training, such as data cleaning, filtering, and encoding. This study analyses the intersection of mathematical curricula and artificial intelligence, with a focus on areas such as linear algebra, probability, statistics, numerical methods, and other fields crucial for data processing and modeling. The research aims to determine whether current educational practices meet industry expectations and to identify potential gaps and opportunities for improvement. The findings of this analysis could contribute to the development of a more effective and goal-oriented engineering education system.

Applications of Mathematics in Engineering Education

Csaba KÉZI[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
kezicsaba@eng.unideb.hu

Mathematics education plays an important role in engineering education. To learn engineering subjects, it is important to acquire the right basic mathematical knowledge. However, it is also important to give real-life examples that have already been used in the teaching of basic mathematics.

Elements of the Distributed Knowledge Transfer in Engineering Mathematics Education

Imre KOCSIS[1], Dóra SIPOS[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
kocsisi@eng.unideb.hu; dorasipos@eng.unideb.hu

According to our experience, the efficiency of knowledge transfer in engineering education is significantly increased if certain higher-level topics (concepts, methods) are presented in the professional environment in which they are used. Possible forms of this include presenting new mathematical knowledge in the context of technical subjects; reviewing and challenging what was previously learned in mathematical subjects in the form of tasks formulated with professional text; and summarizing knowledge related to technical subjects in short, specific mathematical notes. Problem-based mathematics education is a tool and not a goal; if implemented well, it does not violate the integrity of mathematical knowledge; on the contrary, greater motivation contributes to the absorption and deepening of knowledge. In the

presentation, we present a case study on the application of the distributed knowledge transfer method.

The Loss and Development of Creativity in the Digital Age

Balázs KULCSÁR[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
kulcsarb@eng.unideb.hu

Twenty years of experience in higher education shows that digital technology, which is increasingly serving and helping people, is spoiling them to the limit. Ready-made solutions that are instantly available do not stimulate thinking and creativity in overcoming problems. This generational social phenomenon is further exacerbated by a liberal, protectionist, protectionist approach to parenting and education.
The result is a lack of empirical knowledge, a decrease in (engineering) creativity, a drastic narrowing of comfort zones.
This paper seeks ways to reverse these negative trends. The solutions include both classic forgotten techniques and the tools offered by digitalization.
"The Hungarian engineer was in demand and appreciated worldwide in the second half of the 20th century because he was socialized in the scarcity economy, where necessity often called for great and simple solutions."

Innovation in the Teaching of the Structure Generating Matrix (SGM) in Higher Education

Edit LÁZÁR[1]
[1]Budapest Business University, Faculty of Finance and Accountancy, Department of Applied Quantitative Methodology
lazar.edit@uni-bge.hu

In everyday life, you use databases more and more often on the Internet. The most of them is based on a kind of relational database management program.
University students must be prepared to use them. It would be expected to have a certain systems approach of them. They must also understand how it works, along with a little of its theoretical background, for example the data model. This is also important for them because if they get to know the model in a small environment, they will understand how large-scale corporates work as management and decision-making systems, and even data warehouses and part of Big Data, work. Why is it important that data is stored in a database and not in a spreadsheet program and used from there? The best way to do this for students to create a smaller data model themselves. At Budapest Business University (BBU) Faculty of Finance and Accountancy (FFA), we also teach, among other things, the synthetic branch of data modeling, through the Structure Generating Matrix (SGM) method. We focus on the basics of this method in education.
In this article, I would like to share the newly introduced web-based initial platform in education, its use and experiences. Supporting it with data on how the students received it, how useful it proved to be, supporting all this in statistics through scores and grades.

I included data from more than 500 students in the analysis, including a breakdown by country in the case of foreigners. I was curious about how the input status of the students, such as whether or not they had a high school diploma in mathematics and/or computer science, is reflected and what background connection there may be between their understanding of the SGM model. In the article, I also compare Hungarian and foreign students. I examine whether there is a connection between gender and SGM scores.
At the end of the article, I present what opportunities there are for innovation, for example in what directions it would be worth developing, and what other factors could have influenced the obtained results.

Reducing Dropout Risk Through the Application of Retrieval Practice

Anna MUZSNAY[1]
[1] University of Debrecen, Institute of Mathematics, Department of Algebra and Number Theory
muzsnay.anna@science.unideb.hu

The transition from high school to university mathematics and the low success rate in the first year of university mathematics is a problem worldwide. One of the most reported factors correlated with academic success is cognitive prerequisites, such as prior knowledge. Students entering university with higher entry scores and a stronger foundation in mathematics tend to perform better in exams and exhibit lower dropout rates. Conversely, those with weaker prior knowledge are at a substantially higher risk of failure and dropout. Aiming to reduce the dropout risk in first-year mathematics courses, we applied retrieval practice in their lessons. The positive effects of retrieval practice – the strategic use of retrieval to enhance memory – have been shown in several cases. Still, the extent to which it can help students learn higher mathematics at different input levels has been a question. In this research, we investigated first-year pre-service mathematics teachers' performance in two mathematics courses. Within the two courses, we divided the students into two groups. At the end of the practice sessions, the experimental group took a 5–10-minute test on the material learned on the given day. They had to solve two problems individually without external help. In the control group, the teacher presented the solutions to these problems. Students' input level was assessed at the beginning of their studies, and their topic-related problem-solving skills were measured twice during the semester and a few months after finishing the course. We utilized linear regression analysis to examine their test and post-test results across the two courses, considering their initial input levels. Our findings suggest that the applied retrieval practice can effectively reduce the dropout risk and help students with lower prior knowledge to catch up in learning higher mathematics.

Spatial Skills Development for Engineering Students

Rita NAGYNÉ KONDOR[1], Erika ROZGONYI[2]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
rita@eng.unideb.hu
[2]University of Miskolc, Institute of Mathematics, Department of Descriptive Geometry
erika.szilvasine.rozgonyi@uni-miskolc.hu

According to previous studies there are correlations between spatial intelligence and performance of Science, Technology, Engineering and Mathematics (STEM). Visual–spatial ability can predict academic achievement and have a high importance in engineering education, computer graphics and architecture.
The goal of this report is to compare the freshman mechanical engineering students' spatial skills between University of Miskolc and University of Debrecen with regard to many spatial tests to understand whether the students of two universities have significant differences between their spatial abilities, and to investigate their spatial problem-solving methods so that we can develop this skills.

Application of Design Thinking in Engineering Education

Ildikó PAPP[1]
[1]University of Debrecen, Faculty of Informatics, Department of Data Science and Visualization
papp.ildiko@inf.unideb.hu

Design thinking is a human-centered approach in business that helps to understand users, their needs, frustrations and motivations. This design and problem-solving method focus on customer-centricity and creativity, redefining problems and aiming to create innovative and effective solutions to problems and situations that arise. The roots of the methodology date back to the 1950s, but since the 2000s it has been used significantly more frequently to develop better and more successful solutions, new products and services than competitors.
Design thinking is a non-linear, iterative process that combines different stages of the design process in corporate practice, including empathy, problem-solving, prototyping, and testing. Certain elements of the methodology can be transferred to different areas and levels of education and the environment should be nurturing the change and innovative way of thinking, taking into consideration inclusivity. Inclusive design thinking is an extended version of the original methodology to solving problems of disadvantaged or underrepresented groups in our society. We have dealt this topic in the framework of some previous Erasmus projects, but the actual project called eduIDT is definitely dedicated to application of these methods into higher education. We also prepared a practical guide (book, templates and tutorial videos) to provide a tool to European university teachers of technically oriented subjects.
In this talk, I will present a short overview of Design thinking and Inclusive design thinking methods and how we can take steps to achieve an inclusive society by integrating the above methods into engineering and technical education.

The Impact of Vehicle Development Projects on the Development of the Practical Side of Education

Attila SZÁNTÓ[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
szanto.attila@eng.unideb.hu

In engineering education, in addition to theoretical knowledge, the practical approach to technical tasks and problems plays a very important role. Consider, for example, industry, the automotive industry, and motorsports, where engineers are most often faced with a real-world problem, which they then solve using their theoretical knowledge and existing practical experience. Solving the tasks would be very difficult or impossible without practical experience. Therefore, practical education plays a significant role in education and higher education, during which engineering students can encounter real engineering problems and challenges, for example through project tasks or in other ways, for which they must find solutions. The Faculty of Engineering of the University of Debrecen has been conducting various vehicle development and construction projects for a long time, as well as student car racing and motorsport teams, which greatly contribute to the practical development of the students participating in them. These projects are based on a real-world engineering problem, and their solution requires knowledge gained in theoretical classes. Thus, while solving these, students, on the one hand, get an idea of the practical application of theoretical knowledge, which often helps in understanding it, and on the other hand, while solving the task, they also gain real practical (engineering) experience, which can be useful in their later work. In this publication, we present the projects underway at the Faculty of Engineering, the vehicle development teams, from which engineering tasks and projects waiting to be solved are usually born. We also analyze the effects of such practical education based on real projects on students. We also present the modern laboratories belonging to the Faculty of Engineering, which are essential for the implementation of projects. Finally, we will briefly describe our further plans and vehicle development projects, which will also contribute to the development of the practical side of education.

Project Tasks Supported by Mathematical Software for Teaching the Subject of Electromagnetizm in Mechatronics Engineering Education

Gusztáv Áron SZIKI[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
szikig@eng.unideb.hu

The subject Electromagnetism is included in the first year Mechatronics Engineering BsC program at the Faculty of Engineering of the University of Debrecen. The aim of the subject is to give theoretical knowledge in the field of electromagnetics, which is essential for students to understand the later professional and professional foundation subjects.
In addition to imparting theoretical knowledge, it is important that students apply the laws, relationships and calculation procedures, included in the subject, to solve, as a first step basic, then more difficult problems, finally complex project tasks that approximate real-world applications. The project task can be for example the calculation and visualization of complex electric and magnetic fields, or the simulation of electromagnetic systems.
To solve the above-mentioned project tasks the use of a highly developed mathematical software, like MATLAB, is inevitable. The above software facilitates these activities, offering a robust platform for modeling and computation, thus bridging the gap between abstract theory and engineering applications.
The application of mathematical software significantly improves students' understanding and engagement, fostering deeper comprehension and equipping students with practical skills essential for their future careers. The presentation will detail the structure of the above project tasks, the role of MATLAB in their execution, and the positive outcomes observed in student performance and feedback.

MöGamT in Higher Mathematics Education

Anna Mária TAKÁCS[1], Anna TAKÁCS[1], György BUDAHÁZY[1]
Budapest University of Economics and Business, Department of Applied Quantitative Methodology
takacs.anna@uni-bge.hu; takacs.anna2@uni-bge.hu; budahazy.gyorgy@uni-bge.hu

Teachers in higher education institutions are using more and more didactic tools in their lessons to prepare students. Experiential learning is becoming more prominent in both the assessment and the teaching-learning process. The traditional lecture+exercise approach is difficult for our students to follow, which is why we need to use innovative tools and software in our mathematics education. Students who are accepted and enrolled in university are born into Generation Z, which is characterized by scattered attention and short attention spans. Our experience is that sometimes they easily "give up" on the first semester of the subjects Economic Mathematics, Mathematics Fundamentals 1, one of the triggers of which may be the development of incomplete skills or even a stagnation in the steps to abstraction. This is often coupled with the development of a fear of learning mathematics or a lack of success.
We have to pay attention to maintaining motivation in lectures, seminars and independent learning. Gamification is a possible way to make the practice more colorful and to increase motivation, in order to achieve a monotonous but instrumental mastery of the knowledge. Some elements of this will be presented in our presentation.
Möbius is a web-based test and exam system, but it can also be used to create digital learning materials. It is based on the Maple math software engine, which ensures that the equivalence of mathematical expressions is checked when entering solutions. Within the Möbius framework used at our university, we mainly use point accumulation as a complementary didactic method for continuous learning. Students are given a series of weekly exercises, which can be rewarded with points if they are solved at the right level. In Möbius, it is sufficient to enter the type exercises, but we have to pay attention to the parameter assignment, so that thousands of exercises of one type can be produced. In the lecture we use smartphone apps, which are also a tool for immediate feedback on the concepts learned. The tools for this are Kahoot and Mentimeter. Initially, when entering the Kahoot quizzes, we had to be careful to use linear writing, only asking questions on problems that matched this. This has been simplified now that the equation editing interface is available in the app.
In our presentation, we will detail our methodology and show the impact of the scorers on the marks achieved through statistical analysis.

Education 4.0 Assisted by AI-driven Tools

Inti TOALOMBO[1]
[1]University of Debrecen, Faculty of Engineering
intitoalombo@mailbox.unideb.hu

Thanks to the wide availability of online learning resources, traditional learning methods are changing. Nowadays, people tend to learn from online academic platforms, video platforms, forums, and, recently, AI-Driven learning assistants. In Engineering Education, AI have also significantly impacted teaching en learning of future engineers since these tools have the potential to boost the learning experience.

This presentation explores how AI tools, digital technologies, and e-learning platforms, and the Challenge-Base Method (CMB) enhance the learning experience allowing to engineering students to gain a deeper understanding of engineering subjects. Personal findings into utilizing these resources are shared. We talk about the traditional learning path such as classroom lectures, textbooks, and static content, and compare with modern approaches that leverage AI-driven assistants and interactive platforms. The study explores, how modern Chatbots, such as GitHub Copilot and ChatGPT mimic a personalized tutor along with CBM, presenting a good opportunity to facilitate a profound learning of complex engineering subjects in the field of Cyber-Physical Systems (CPS). Additionally, we highlight how E-learning Platforms in Education 4.0 (E4.0) are valuable for learning AI-related topics from recognized experts for enhancing professional profiles for employability.
We will present the concept of realization of CMB in E4.0 by presenting a project with real-world application based on my experiences. Afterwards, a personal finding will be shared, detailing E4.0's efficiency and consequences in learning engineering subjects. How AI-driven tools helped the enhancement of the engineering community will be highlighted. Finally, the pros, cons and challenges of using these tools in engineering education will be discussed.

On Short Tests Measuring Competencies as Predictors of Dropout Among Mechatronics Engineering Students

Adrienn VÁMOSINÉ VARGA[1], Boglárka BURJÁN-MOSONI[1]
[1]University of Debrecen, Faculty of Engineering, Department of Basic Technical Studies
vargaa@eng.unideb.hu; burjan-mosoni.boglarka@eng.unideb.hu

While we are experiencing an IT revolution due to the development of artificial intelligence and robots, student drop-out is a serious problem in technical higher education worldwide. One of the reasons of that is a significant number of students cannot meet the requirements of the basic subjects. By drop-out the sustainability of an educational institution can be significantly reduced, as students are a direct source of income. The primary task of the instructors of students entering the bachelor's program is to recognize as soon as possible those students who are at risk of dropping out due to the lack of basic skills. The ability to manipulate with symbols and the ability to diagrammatic reasoning is essential for a mechatronics engineer. We examined the afore-mentioned abilities of 41 international and 32 Hungarian mechatronics engineering students and found a positive correlation between learning the basics of programming and their symbolic manipulation abilities by two tests. The results can be used to predict the dropout rate of programming courses.

Case Study on Using Inclusive Design Thinking in 3D Modeling

Marianna ZICHAR[1]
[1]University of Debrecen, Faculty of Informatics, Department of Data Science and Visualization
zichar.marianna@inf.unideb.hu

Inclusive Design Thinking (IDT) is an enhanced methodology derived from design thinking. It was developed by a collaboration of seven European universities, a non-profit organization, and a company as part of a 32-month-long ERASMUS+ project called eduIDT. The main aim

of this project was to incorporate the IDT methodology into technology-oriented higher education, focusing on problem-solving for underrepresented groups. This approach seeks to create inclusive and innovative solutions for society.

Inclusion, as a new aspect of design thinking, emphasizes understanding and respecting everyone, not just focusing on the development of products, services, processes, and culture. It ensures that even those who have been historically excluded can effectively use the new products and services designed by engineers.

By the mid-point of the project, a practical guide on IDT was developed, and several professors from the partner universities became acquainted with its principles. The consortium implemented the method through a workshop where the already trained educators collaborated with a group of students from partner universities over the course of a week to apply the methodology.

IDT is a complex process consisting of five phases, with various tools available for use in each phase to facilitate progression to the next. If time constraints prevent the application of the entire methodology, the Mini Sprint Exercise serves as an excellent introduction to the fundamentals of the method. I followed this idea when teaching students 3D modeling; thus, I made the first attempt to embed this exercise into the course schedule. According to my experience, the students were open to learning about IDT and completed the Mini Sprint Exercise with enthusiasm.