TUPMFEE Syllabus

Donbas
State Engineering Academy

Mechanical Engineering Faculty

Control Engineering Department
{Manufacturing Processes and Automation Engineering Department}

"TECHNICAL UNIVERSITY PEDAGOGIC AND METHODOLOGICAL FOUNDATIONS OF ENGINEERING EDUCATION"

"TUPMFEE"-COURSE

for graduate (MSc.-level) students majoring in the branch of knowledge

15 Automation and Instrumentation,
{0714 Electronics and automation}

with a degree-level study program in

151 (127) Automation and computer-integrated technologies
{0714 Electronics and automation}

Kramatorsk, Donbass State Engineering Academy,
Akademichna Str, 72 (2nd floor of DSEA)

Semester: [2], Year: [2021-2022]

Instructor Information

Name	**Ph.D. (Cand. Tech. Sci.), Assoc. Prof. (Docent)**
	Alexander V. Perig (Oleksandr Viktorovych Perih)
ContactInfo	**olexander.perig@gmail.com**
Office location	Donbas State Engineering Academy, 2nd floor, room 2212
Office hours	Monday - Friday, from 9.00 to 15.00

The TUPMFEE Course Description

The ongoing didactic efforts of the contemporary STEM community of engineers and instructors resulted in the appearance of numerous comprehensive international textbooks [2-4, 13, 16, 18, 21-22, 24, 26-27, 30, 35-36, 40-42, 57, 59, 62, 69, 74, 78], tutorials [1, 28, 32-34, 43-45, 48-56, 68], didactic studies [5-9, 11-12, 15, 17, 19, 29, 31, 37-39, 46-47, 58, 60-61, 63-64, 67, 70-72, 77, 79-80] and medical papers [10, 14, 20, 23, 25, 65-66, 73, 75-76], focused on technical curriculum development for better education of scientific and technical disciplines [1-80].

However, the engineering and computational topics, directly associated with teaching methodology for instruction of technical disciplines for control and computer engineering curriculum, are much better developed than for social-scientific and socio-technical issues.

Moreover, social science related questions of prospective instructor training have not been properly addressed in numerous available engineering references.

The overwhelming majority of existing approaches on curriculum development for the spheres of general engineering and engineering education are mainly focused on educational reflection of numerous instructional viewpoints on the process of engineering curriculum mapping without detailed specification of computer subject-specific engineering pedagogic content.

Additionally, Covid-, post-Covid-, climate-, ecology-, war-, and cybercrime-induced burdens and sources of social instabilities have achieved global outreach and must be addressed in engineering and engineering educational curricula.

Disturbing effects on academic wellbeing, induced by sources of external social pressure, require adequate and constructive educational reflection in social and socio-technical courses, mapped within the control- and computer engineering curriculum.

TUPMFEE Background: Graduate students of technical universities, majoring in software, computer and control engineering, have numerous practical difficulties with learning, understanding, acquisition and successful instructional implementation of the fundamentals of engineering didactics.

TUPMFEE Objective: The course is focused on the formulation of student-centered and thought-provoking curriculum for the original course of “Technical University Pedagogic and Methodological Foundations of Engineering Education” (TUPMFEE) for graduate and Ph.D.-students, majoring in computer sciences, control engineering and industrial automation.

TUPMFEE Methods: The course uses the following approaches and techniques of student-friendly curriculum design: intervention theory, first-person research, mathematical and social constructivism, didactic transposition and socio-physical similarity.

TUPMFEE Results: The author-proposed TUPMFEE-curriculum acquaints graduate students with the fundamentals of the following concepts: ▪higher education system structure; ▪instructor’s “hard” and “soft” skills development; ▪higher education quality assessment; ▪education integrity maintenance; ▪“normal” dynamics of sustainable learning; ▪instructional methods of classical and contemporary engineering didactics; ▪practical implementation of modern engineering education standards into construction of individual lessons, syllabuses and educational programs; ▪“disturbed” dynamics of the “problematic” educational process; and ▪freeware-enhanced computational modeling of instructor-guided didactical processes.

TUPMFEE Conclusions: It was practically found that the author-proposed TUPMFEE course structure successfully triggers graduate students’ interest in both social and computer sciences.

TUPMFEE Course Keywords: engineering pedagogy curriculum development; technical instructor training; control engineering education; networks education; academy community well-being; student mental health

TUPMFEE Course Language: English

Learning Objectives for the TUPMFEE Course

The graduate course of "Technical University Pedagogic and Methodological Foundations of Engineering Education" (TUPMFEE) for students, majoring in computer networks and automation, is the educational discipline, which is focused on a detailed description of the interdisciplinary questions of theory and practice of student-centered training of future technical instructors who are satisfactorily qualified for specialized teaching in high school.

The forthcoming instructor should be well acquainted with the following modern social-and-engineering methods, approaches and techniques of such pedagogical, psychological, technical, philosophical and medical sciences as:

(I) Engineering didactic for teaching of information-and-communication technologies, computer integrated technologies, educational approaches to teaching of computer engineering, computer networking and network science, automation, control-and-systems engineering, fundamentals of instrument-making engineering, and engineering instrumentation;

(II) International standards for engineering education quality; compliance verification and control of education quality maintenance; as well as acquaintance with interdisciplinary problems of academic, educational and research integrity;

(III) Educational psychology of "hard skills" and "soft skills" formation, and creative development of the art of teaching;

(IV) Students acquaintance with computer-assisted nonlinear {mathematical, cyber-physical and socio-physical} modeling of didactic, socio-educational and psychological processes in teaching complex socio-dynamic control systems and guided socio-technical networks.

The author-proposed TUPMFEE course is conceptually focused on the formation of cognitive, affective and motorial competences, as well as "soft" and "hard" skills of future instructors, majoring in computer engineering, network (Internet) engineering and automatic control in the multidisciplinary socio-technical sphere of engineering pedagogic; domain of didactic-enhanced engineering instructional description of scientific disciplines, and educational psychology. The author-proposed TUPMFEE course should acquaint prospective instructors with fundamental concepts, socio-technical approaches and international standards for teaching and quality assurance of engineering education, STEM/STEAM-education, cybernetic pedagogic, applied educational psychology, subjective wellbeing, sociology, conflictology and social psychiatry fundamentals.

Author-Proposed Themes of the TUPMFEE Classes

I.1. Lecture Topic 1. The structure, organization, general trends, social-and-philosophical dimension, politics, ethics and non-linear social dynamics of the functioning and development of modern systems of higher education in EU, USA, China, Far East, Latin America and Africa Countries.

I.2. Practical Training 1. Zoom-based face-to-face discussion and collaboration with group students upon completion of the first large comparative table "**PrTable1**" for multi-level comparison of structure and principles of operation for higher education systems in a student-selected list of prosperous, developing and poor countries. The first training session is based on preliminary individual home preparation of a detailed and comprehensive student-narrated written contribution concerning distinctive characteristics of a particular higher education system in one of the student-selected world countries. The compulsory home preparation is required for every course-enrolled group student.

II.1. Lecture Topic 2. Methods (ways) of emergence and development of the following professional characteristics, "hard" skills and "soft" skills of the future technical instructor: {▪professional competence; ▪sustainable lifelong learning and self-education; ▪speech-craft (oratory, flights of eloquence); ▪communicability (sociability); ▪empathy; ▪tolerance; ▪charisma (personality-charism); ▪charm (fascination); ▪teaching skills (art of teaching); ▪acting technique (dramatic arts)}. The complex of above mentioned teacher strengths jointly determine the socially-professional communicational-and-instructional effectiveness of prospective university (college) educators.

II.2. Practical Training 2. Joint instructor/student fulfillment of the second comparative table "**PrTable2**" for the multi-level collation of different alternative classifications of "hard skills" and "soft skills" for the following socio-technical professions and occupations: ▪technical instructor – university teacher; ▪engineer – technical specialist – R&D-developer; ▪manager – administrator – team leader, and ▪businessman – employer. Student preliminary preparation for the second practical lesson assumes home completion of an individually-written report concerning one of the possible, textbook-available or paper-retrieved, current versions of the classification of "hard skills" and "soft skills", required by all range of employers for better graduate employability.

III.1. Lecture Topic 3. Modern principles of higher education quality. Approaches, concepts, strategies and politics of G20 (The Group of Twenty) countries concerning the determination of effective socio-educational integral criteria for the complex and objective assessment and estimation of higher education quality. National implementation of international educational monitoring experience in the context of creation, launching and functioning of National Agencies for Higher Education Quality Assurance NAQA (NAHEQA).

III.2. Practical Training 3. Student-collaborative fulfillment of the third comparative table "**PrTable3**" for a multi-criteria comparison of existing alternative approaches and modern concepts for assessment and estimation of higher education quality within the framework of countrywide community experience of different G20 countries. As usually students are encouraged to prepare for the third practical training and to complete a detailed home-written report concerning specific features, individual peculiarities and country-dependent criteria of local socio-educational approaches to nationally-standardized and/or regionally-unified estimations of higher education quality for a specific student-selected country of analysis.

IV.1. Lecture Topic 4. Explanation of the elements of applied ethical questions of {▪educational, ▪academic, ▪institutional, ▪research} integrity and consistency, as well as the importance of having no conflicts of interest for all members of the scientific and educational process: ▪students, ▪Ph.D.-students, ▪Post-doctoral researchers, ▪instructors, ▪engineers and ▪university management at all educationally-organizational, institutional and management levels, positions and occupations.

IV.2. Practical Training 4. It is highly recommended for all students to prepare a detailed home-written report to the 4th practical class on one of the possible (internationally recognizable) ways to classify the existing characteristics of educational integrity and consistency using legal (regulatory-normative), educational and engineering references available in textbooks and periodic literature. It is assumed that after home preparation all students take part in the completion of the 4th comparative table "**PrTable4**" for a maximally-comprehensive comparison of existing alternative approaches and modern concepts for assessment of applied ethical questions of integrity and consistency for an integral assessment of educational activity for all active and passive members of the university community.

V.1. Lecture Topic 5. Scientific and social-scientific approaches to a socio-technical description of (distinctive characteristics of) "normal" dynamics and sustainable development of the educational process in (the case of) the absence of any serious disturbances, irregularities, and interruptions in the educationally-psychological processes of learning and instruction.

▪An explanation of the stable social dynamics of a satisfactorily-controlled educational process resulting in (successful and mutually respecting) triggering a student's learning motivation and the instructor's teaching interest, achieving communicational interaction, constructive interpersonal dialog, and a fundamental mutual understanding of all principle decisions (in student-friendly communication between instructor and his/her students).

▪Educationally-psychological definitions and technical analogies for a student-friendly illustration of the concepts for sustainability of educational development and wellbeing of the university community.

▪Practical formation of a favorable educational and psychological conditions for successful (and sustainable) formation of empathy, "hard skills" (associated with individual progress in engineering and professional development) and "soft skills" (associated with individual progress in the formation of social and communicational skills) in university students.

V.2. Practical Training 5. The instructor encourages (his/her) students to prepare (their) individual home-written assignments concerning one possible way to develop an internationally-acceptable structural classification for existing characteristics of sustainability and wellbeing from (actual) legal, instructional and periodic literature references. {Virtual} practical session 5 assumes completion of the "**PrTable5**" for comparison of existing {and retrievable} approaches and concepts for socio-educational estimation of existing international metrics and characteristics for socio-engineering description of the "sustainability" and "wellbeing" concepts.

VI.1. Lecture Topic 6. Basic concepts of classical didactic methods of engineering teaching: {▪educational constructivism; ▪didactic transposition, and ▪educational reconstruction}.

Fundamentals of modern non-classical educational concepts, approaches, methods and technologies: {▪blended learning; ▪flipped classroom; ▪project-based learning (PBL); ▪STEM (Science, Technology, Engineering, and Mathematics) multidisciplinary education; ▪STEAM (Science, Technology, Engineering, Arts, and Mathematics) multidisciplinary education; ▪CEELLL (Continuing Engineering Education and Life Long Learning); ▪Education 4.0}.

Didactics for teaching of scientific and technical disciplines in the fields of automation, control engineering, guided system dynamics, computer engineering, networks, and information-and-communicational technologies.

VI.2. Practical Training 6.

Every enrolled student is encouraged to prepare a detailed individual home-written report concerning educational possibilities of a student-chosen instructional method of classical or modern engineering didactics. The following classroom activity assumes joint student-instructor completion of the sixth comprehensive table "**PrTable6**" with a multi-level comparison of learning/instructional advantages and disadvantages for different educational methods of engineering pedagogic.

VII.1. Lecture Topic 7.

▪Didactic principles, main assumptions, educational peculiarities, practical restrictions and economic charges, associated with the adaptation, use and practical instructional implementation of the following International, USA and European standards for engineering education and certification:

((□CDIO (Conceiving – Designing – Implementing – Operating);

□EUR-ACE (EURopean-ACcredited Engineer) Framework Standards EAFSG;

□ECQA (European Certification and Qualification Association) Certification Programs {֍ ECQA Certified Control Systems Engineer (CSE)};

□NCEES (National Council of Examiners for Engineering and Surveying) {֍ NCEES PE Control Systems Engineer (CSE) Exam};

□ISA (International Society of Automation) Certification Programs {֍ Certified Automation Professional (CAP); ֍ ISA Certified Control Systems Technician (CCST)};

□IEC (International Electrotechnical Commission) Certification Programs {֍ ISA/IEC 62443 Cybersecurity Certificate Programs};

□Cisco Certification (CC) Programs {֍ Entry (E) [CCE Network Technician (CCENT)]; ֍ Associate (A) [CC Network A (CCNA) / CC Design A (CCDA)]; ֍ Professional (P) [CC Network P (CCNP) / CC Design P (CCDP)]; etc.}⟫

▪Approaches to practical development of original undergraduate/graduate syllabuses for automation, control engineering, computer engineering and computer networks curricula with wide use of the above-mentioned engineering educational standards and practices, i.e. the fundamentals of "lower level" curriculum development.

▪Approaches to practical design of original master's and bachelor's degree-level educational programs with wide use of Bloom's Taxonomy and Dublin Descriptors for description of program-determined learning outcomes, i.e. the fundamentals of "upper level" curriculum development.

▪Approaches to practical development of {֍ a competency matrix; and ֍ a compliance (correspondence) matrix for consistency of learning outcomes with components of the educational program; and ֍ a matrix for supplying of learning outcomes with correspondent components of the educational program}.

VII.2. Practical Training 7.

Preliminary student preparation of home-written individual lecture notes (leaflets) for step-by-step planning and further running of the student's trainee-narrated his/her own lesson on one of the student-selected topics of control engineering and/or computer networks with mandatory practical use of the international concepts of current engineering educational standards.

The seventh practical class assumes a detailed Zoom-based discussion of all home-prepared individual approaches to effective teaching of a specific student-chosen course topic from the engineering domains of automation or network sciences with wide use of the concepts and standards of the CDIO-based approach to engineering education.

VIII.1. Lecture Topic 8. ▪Elements of extremal pedagogic, psychology, conflictology (conflict resolution techniques), clinical psychology, psychotherapy (mental therapeutic counseling), psychological rehabilitation (rehabilitology, recreation therapy for mental healing) and social psychiatry for healthy lifestyle promotion.

▪Scientific and social scientific approaches to pedagogical, psychological and socio-engineering levels of phenomenological, socio-physical, and narrative-reflective descriptions of specific "learning"-and-"instructional" characteristics of "problematic" educational processes.

▪Disturbed (perturbative) social dynamics of "problematic" and unsatisfactorily-controlled low-quality educational processes with joint negative impact of the following disturbing factors, resulting in badly-guided learning progress and unpredictable learning outcomes:

֍ absence of learning interest;

֍ disruptions and breakdowns in communication (communicational interaction);

֍ absence of mutually-respective interpersonal communications and dialogs;

֍ communication gaps and lack of understanding between instructor and students;

֍ negative external environmental impact of large-scale well-being disturbing sources of severe social pressure, repressively and overwhelmingly acting on the academic community:

□ war (military conflict) of local, regional or global level with death, people killing and infrastructure destruction in a war zone;

□ foreign military occupation with a full scale robbery, looting, pillaging, racketeering, shakedown and extortion in the occupied territories;

□ bad ecology, induced by uncontrolled environmental contamination and pollution of the surrounding land, water and air;

□ epidemic or pandemic distribution of infectious diseases;

□ illness-induced bad health of instructors and/or students;

□ regular individual conflicts at personal, family and/or workplace levels;

□ permanent overloading of hard-working student during intensive school or university education;

□ high level of educational ambitions of younger undergraduate students, desperately competing for a strictly-limited number of available academic scholarships.

▪Student psychotherapy-focused, corrective and remedial functions of university instructors, which are mandatorily required to practically realize educational attempts at successful establishment of "awakening" communications with persistent triggering of individual learning interest among some of course-enrolled "problematic" students.

VIII.2. Practical Training 8.

Students are preliminary encouraged to prepare for the eighth practical session and complete a detailed home-written report concerning one possible and practically-acceptable educationally-psychotherapeutic approach to the construction of effective, student-centered and wellbeing-focused dialogs between instructors, excellent and "problematic" students, employers, and other stakeholders of the educational process. It is assumed that students will ground their home-written practical recommendations on effective "problematic" communication with wide use of existing social theories and approaches, available in contemporary educational, psychological, technical, legal and medical papers and international textbooks.

Eighth practical Zoom-session is focused on joint instructor/student fulfillment of the corresponding comprehensive table "**PrTable8**" for a multi-criterial comparison of existing cross-disciplinary approaches to a socio-technical description and the educational-and-psychological implications of practically alarming learning and instruction situations, severely disturbed with "problematic" student-induced violations of educational and academic integrity.

Eighth Discussion participating students are encouraged to argue (argument) their statements with wide use of well-established definitions, concepts, methods and techniques of technical pedagogy, engineering didactics, psychology, psychotherapy, social and statistical physics, computer network sciences, control and systems engineering, dynamics and automation.

IX.1. Lecture Topic 9.

Acquaintance of prospective technical instructors with existing approaches to engineering curriculum enhancement with wide use of computational possibilities of available desktop and cloud freeware as information/communication technologies and learning tools (Figures 1 – 3).

Description of actual computational approaches, mathematical techniques and socio-educational implications of system, network and control engineering as well as application of interdisciplinary transport phenomena, statistical mechanics and network dynamics to computer-based modeling of guided didactical learning and instruction processes.

Student acquaintance with cybernetic, cyber-physical, networks-based, socio-physical, multi-agent and holistic approaches to contemporary learning theories and socio-educational sciences.

Explanation of modern socio-engineering and socio-physical approaches, associated with joint use of learning theory, information theory, methods of control and systems engineering as well as the concepts of irreversible thermodynamics to a thought-provoking description of normal and disturbed modes of educational dynamics.

IX.2. Practical Training 9.

All course-enrolled students are encouraged to prepare for the ninth practical classroom session with preliminary completion of a detailed home-written report concerning educational implementation of computational possibilities of one student-selected and freeware-implemented computer modeling method for a socio-computational description of practically acceptable modes of engineering education with successful achievement of curriculum-expected learning outcomes.

The student-chosen specific computer simulation approach should provide socio-engineering interpretation and computational visualization of the socio-educational effects, associated with the proper establishment of constructive, effective, collaborative and creative communications between university students, classmates, instructors, prospective employers and other stakeholders in a sustainable higher educational process.

The technical instructor notes that possible student-proposed and computer visualization-supported additional illustration of "problematic" learning dynamics is highly welcomed as well.

Zoom-based classroom session assumes joint instructor/class students fulfillment of the large comparative table "**PrTable9**" for multi-level comparison of existing socio-technical and socio-physical computational approaches to computer-enhanced socio-engineering description and educational-psychological implications of "normally"-sustainable and "problematic"-disturbed learning dynamics with wide use of student-prepared preliminary home assignments.

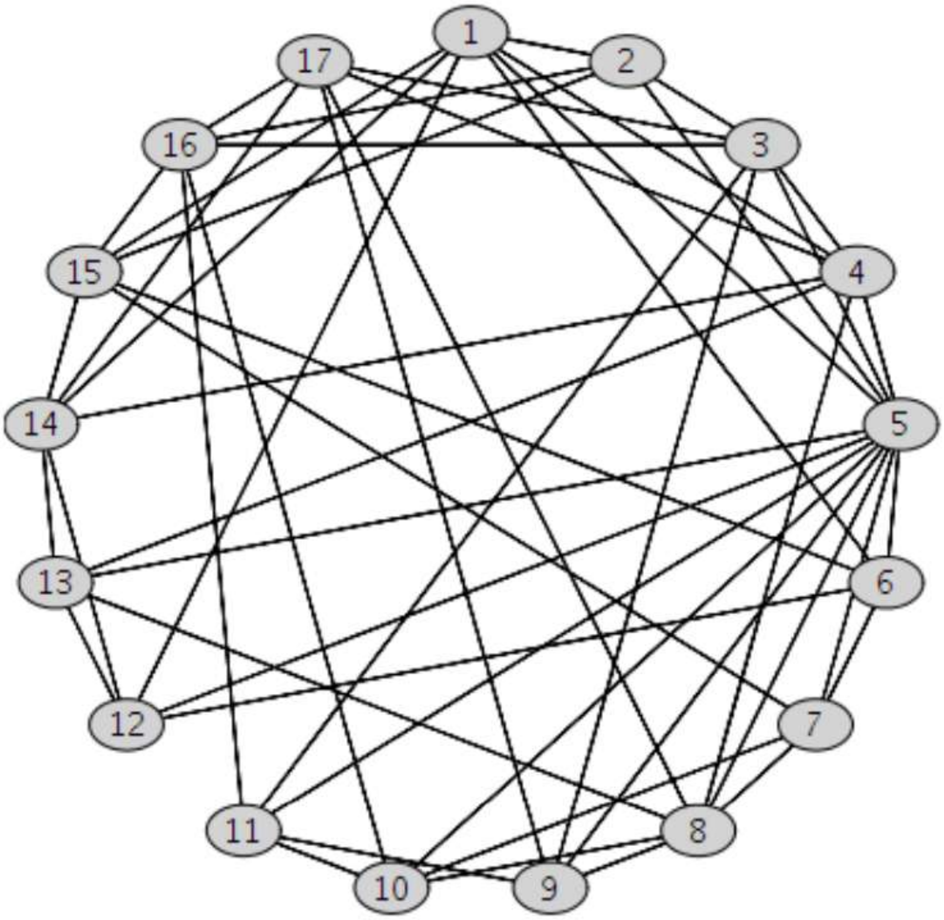

Figure 1. Instructor-proposed computational example of the first possible student home assignment for Lecture Topic 9 of the TUPMFEE course with computer-assisted 2D mapping of an undirected, unweighted graph $\{\mathbf{G}\}$ of a socio-communication network with 17 vertices for schematic visualization of 17 one-group students and 52 edges for general representation of 52 social communications between 17 group students-vertices.

Learning Outcomes and Social Implications for the TUPMFEE Course

It was assumed that the author-mapped TUPMFEE course will ensure the practical achievement of the following range of curriculum-designed learning outcomes.

C. Instructor-estimated learning outcomes for the TUPMFEE course in the cognitive domain:

C.1. Detailed and profound understanding, common awareness and qualified practical use of applied methods of engineering didactics in contemporary STEM/STEAM education for the original lecturer's development of student-friendly and student-centered courses for training of prospective technical instructors, qualified for individual teaching of scientific and technical disciplines from the fields of control and computer engineering.

C.2. Achievement of a confident level of skills formation, required for adequate, relevant, consistent, creative and successful practical application of contemporary educational methods and approaches like didactic transposition, educational reconstruction, mathematical constructivism, blended learning, flipped classroom and project-based learning together with instructional implementation of International and European standards of higher engineering education.

C.3. Formation of persistent individual ability for student-centered pedagogical and psychological thinking, constructive vision of educationally-didactic conceptions, understanding of an instructionally-admissible level of methodological generalization, comprehension of and successful multi-iterative rethinking of student-acquired new social knowledge in direct and indirect forms. Graduate students are expected to demonstrate sustainable abilities for critical but constructive and benevolent analysis of objective advantages and known shortcomings of existing didactic approaches as well as educational and psychologic models/concepts of national and international levels. Engineering students should also be able to creatively assess and rethink their existing instructional experience, individually synthesize and construct new student-proposed socio-technical ideas, analogies and educational techniques, and develop reasonable socio-educational proposals and models.

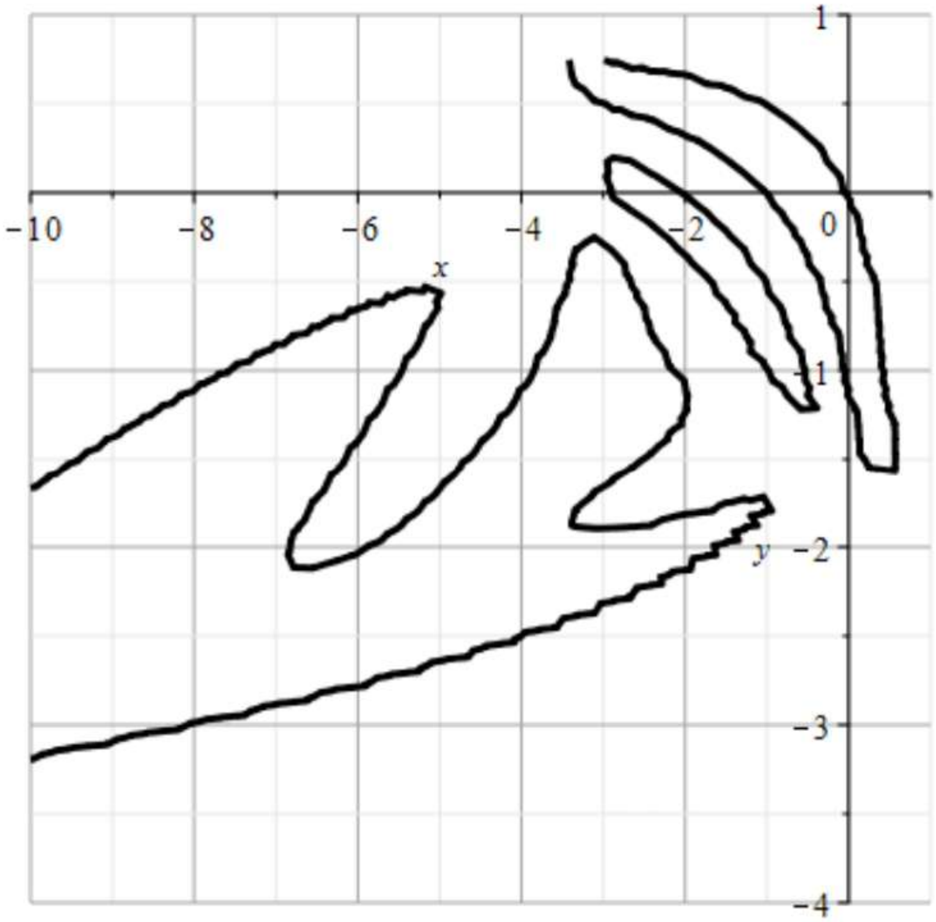

Figure 2. Instructor-proposed computational example of the second possible student home assignment for Lecture Topic 9 of the TUPMFEE course with computer-assisted 2D visualization of Tutte polynomial {T_G} with dichromate {**x, y**}-portrait for undirected graph {**G**} of the socio-communication network, shown in Figure 1, where {T_G} is a 36th (thirty-sixth) order polynomial expression.

C.4. The prospective technical instructors should develop qualified abilities to successfully ensure student-centered compliance with the operation principles of educational, academic, institutional, and research integrity. Multilevel organizational-and-pedagogical peculiarities of integrity-related socio-educational processes determine both "normal" and "disturbed" modes of learning-and-instructional dynamics in the practical implementation of continuous and long-term educational processes of lifelong learning with the purpose of simultaneous achievement of sustainability and wellbeing criteria within the student/instructor community.

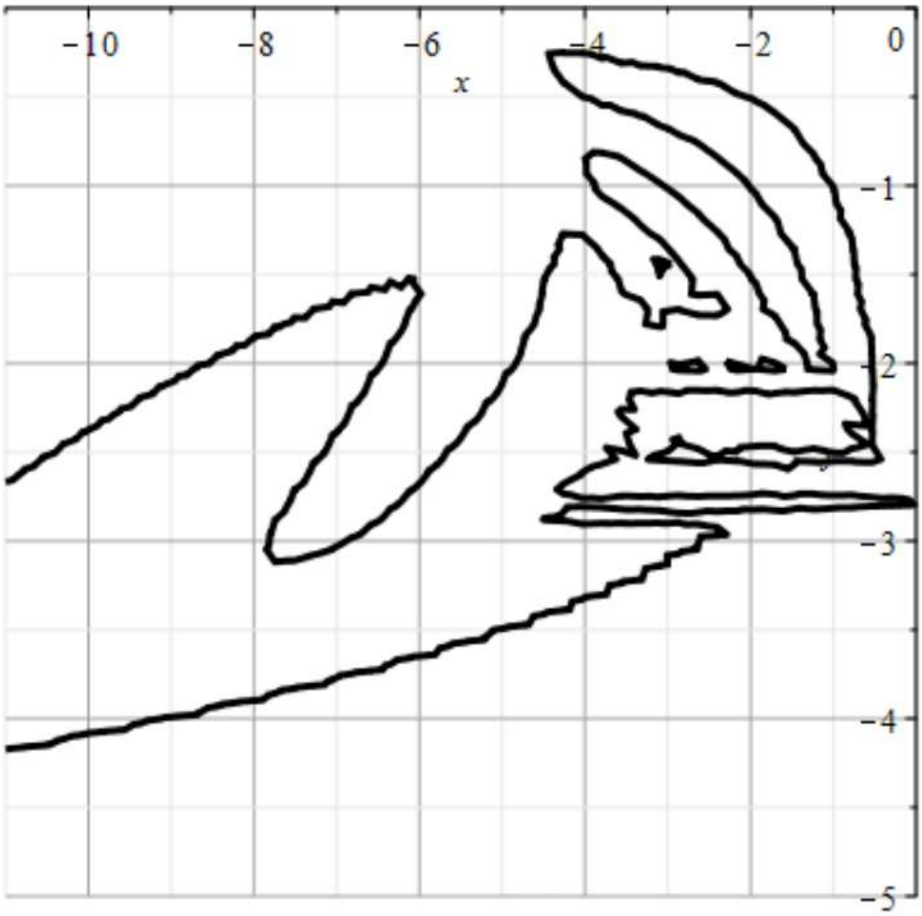

Figure 3. Instructor-proposed computational example of the third possible student home assignment for Lecture Topic 9 of the TUPMFEE course with computer-assisted 2D visualization of Whitney's rank polynomial {$\mathbf{W_G}$} with bivariate {$\mathbf{x, y}$}-portrait for undirected graph {$\mathbf{G}$} of the socio-communication network, shown in Figure 1, where {$\mathbf{W_G}$} is a 36th (thirty-sixth) order polynomial expression.

The TUPMFEE Course Analysis

Contemporary educational practice raises numerous and never-ending bureaucratic questions about who is in position to explain the mandatory graduate course of engineering pedagogy in a modern technical university: professional engineer (specialist in technical sciences) or professional educator (specialist in social sciences).

There are several general requirements for a prospective TUPMFEE instructor regardless of the lecturer's graduation and/or Ph.D. specialty:

R.1. An engineering education instructor should be personally interested in practical application of mathematical, computer and cyber-physical modeling to the socio-physical and socio-technical spheres of multidisciplinary social sciences and, in particular, to the field of education in scientific and technical disciplines.

R.2. An engineering pedagogic lecturer should be prepared to continuous self-study of contemporary theories, methods and techniques of social, educational, psychological, medical, data, network, cybernetic and control sciences.

R.3. An engineering didactics instructor should refrain from retranslation to his/her students the permanent hate speech, disdain, hostility and bullshit of many computationally-qualified but slightly arrogant and rather voluntarily narrow-minded engineers, mathematicians and physicists toward the "principally-unpredicted" spheres of social sciences, education, psychology, psychotherapy and social psychiatry.

R.4. An engineering education instructor should not allow himself/herself to retranslate to his/her students the dismissive and moderately-disgusted attitude of creative specialists in social sciences, arts and humanities toward engineers, mathematicians and other STEM professionals.

Persistent, "never-ending" and lifelong curriculum development activity is a mandatory obligation, heavy burden, bureaucratic routine, integral part of lifestyle, the way of thinking and the only practically available outlet for professional creativity for every successful technical instructor who is officially employed in a teaching, pedagogical or scientific-and-educational position in university, college or any educational institution.

Every curriculum constructor always works under a severe "descending" administrative pressure and an "ascending" student pressure when all course-involved actors from the academic community are permanently dissatisfied with the "low rate" of instructor's mapping of the mandatorily original curriculum, "insufficient depth" of deadline-limited instructional course-narration, "insufficient complexity" and "insufficient relevance" of instructor-proposed original computational assignments.

Students also complain of the principal "instructor's incompetence" to astonish everyone with the unprecedented author-proposed course, which could be easily studied without home preparation.

Quite often TUPMFEE course attendees have very complex practical questions concerning the formulation of original socio-technical analogies for engineering education. The first question students often ask themselves and the instructor is: "Where do these socio-technical/socio-physical ideas come from?" After students read a socio-technical paper, another student question arises: "Why didn't the author-proposed socio-physical idea come to them, for instance?" It is necessary to confess that both student questions are really complex issues to answer. The TUPMFEE course instructor could briefly answer these questions and note that the gradual engineering transition (switching) from technical to social sciences is really a very individual mental process. The lecturer could also add that prospective technical instructors could be quite convincing with their endeavors if they base original socio-technical analogies on numerous physical and/or computational experiments, previously provided by them and/or their teams.

The author-constructed TUPMFEE-course has found successful didactical implementation in the graduate and Ph.D.-level curriculum in the control-engineering department of Donbass State Engineering Academy, Kramatorsk, Ukraine.

All TUPMFEE-course enrolled students independently confirmed the principal originality, thought-provoking nature, and friendliness for graduate engineering students, attractiveness and the "enchantment" of the author-mapped curriculum for the TUPMFEE-course.

Learning Resources for the TUPMFEE Course – References

[1] Aberšek B, Borstner B, Bregant J. The Virtual Science Teacher as a Hybrid System: Cognitive Science Hand in Hand with Cybernetic Pedagogy. J Balt Sci Educ. 2014;13(1):75–90. Available from: http://www.scientiasocialis.lt/jbse/?q=node/345

[2] Abdulwahed M, Bouras A, Veillard L, editors. Industry Integrated Engineering and Computing Education: Advances, Cases, Frameworks, and Toolkits for Implementation. 1st ed. Cham: Springer International Publishing; 2019. doi:10.1007/978-3-030-19139-9. Available from: https://doi.org/10.1007/978-3-030-19139-9

[3] Auer ME, Azad AKM, Edwards A, de Jong T, editors. Cyber-Physical Laboratories in Engineering and Science Education. 1st ed. Cham: Springer International Publishing; 2018. doi:10.1007/978-3-319-76935-6. Available from: https://doi.org/10.1007/978-3-319-76935-6

[4] Babaci-Wilhite Z, editor. Promoting Language and STEAM as Human Rights in Education: Science, Technology, Engineering, Arts and Mathematics. 1st ed. Singapore: Springer Nature Singapore; 2019. doi:10.1007/978-981-13-2880-0. Available from: https://doi.org/10.1007/978-981-13-2880-0

[5] Balavivekanandhan A, Arulchelvan S. A Study on Students Acquisition of IT Knowledge and Its Implication on M-Learning. ScientificWorldJournal. 2015;2015:248760. doi:10.1155/2015/248760. Epub 2015 Oct 21. Available from: https://doi.org/10.1155/2015/248760

[6] Barquero B, Bosch M, Romo A. Mathematical modelling in teacher education: dealing with institutional constraints. ZDM-Math Educ. 2018 Apr;50(1–2):31–43. doi:10.1007/s11858-017-0907-z. Available from: https://doi.org/10.1007/s11858-017-0907-z

[7] Berland M, Wilensky U. Comparing Virtual and Physical Robotics Environments for Supporting Complex Systems and Computational Thinking. J Sci Educ Technol. 2015 Oct;24(5):628–47. doi:10.1007/s10956-015-9552-x. Available from: https://doi.org/10.1007/s10956-015-9552-x

[8] Bosch M, Gascon J, Trigueros M. Dialogue between theories interpreted as research praxeologies: the case of APOS and the ATD. Educ Stud Math. 2017 May;95(1):39–52. doi:10.1007/s10649-016-9734-3. Available from: https://doi.org/10.1007/s10649-016-9734-3

[9] Brady C, Orton K, Weintrop D, Anton G, Rodriguez S, Wilensky U. All Roads Lead to Computing: Making, Participatory Simulations, and Social Computing as Pathways to Computer Science. IEEE Trans Educ. 2017 Feb;60(1):59–66. doi:10.1109/TE.2016.2622680. Available from: https://doi.org/10.1109/TE.2016.2622680

[10] Chang S-S, Chou T. A Dynamical Bifurcation Model of Bipolar Disorder Based on Learned Expectation and Asymmetry in Mood Sensitivity. Computational Psychiatry. 2018;2:205–22. doi:10.1162/CPSY_a_00021. Available from: http://doi.org/10.1162/CPSY_a_00021

[11] Chevallard Y. Readjusting Didactics to a Changing Epistemology. Eur Educ Res J. 2007 Jun 1;6(2):131–4. doi:10.2304/eerj.2007.6.2.131. Available from: https://doi.org/10.2304/eerj.2007.6.2.131

[12] Chevallard Y, Ladage C. E-learning as a touchstone for didactic theory, and conversely. Journal of E-Learning and Knowledge Society. 2008;4(2):163–71. doi:10.20368/1971-8829/274. Available from: https://doi.org/10.20368/1971-8829/274

[13] Crawley EF, Malmqvist J, Östlund S, Brodeur DR, editors. Rethinking Engineering Education: The CDIO Approach. 1st ed. Boston, MA: Springer US; 2007. doi:10.1007/978-0-387-38290-6. Available from: https://doi.org/10.1007/978-0-387-38290-6

[14] Cvetkovski S, Jorm AF, Mackinnon AJ. Student psychological distress and degree dropout or completion: a discrete-time, competing risks survival analysis. High Educ Res Dev. 2018;37(3):484–98. doi:10.1080/07294360.2017.1404557. Available from: https://doi.org/10.1080/07294360.2017.1404557

[15] Di C, Zhou Q, Shen J, Li L, Zhou R, Lin J. Innovation event model for STEM education: A constructivism perspective. STEM Educ. 2021 Feb;1(1):60–74. doi:10.3934/steme.2021005. Available from: https://doi.org/10.3934/steme.2021005

[16] Felder RM, Brent R. Teaching and Learning STEM: A Practical Guide. 1st ed. San Francisco, CA, US: Jossey-Bass; 2016.

[17] Felder RM. STEM education: A tale of two paradigms. J Food Sci Educ. 2021 Jan;20(1):8–15. doi:10.1111/1541-4329.12219. Available: https://doi.org/10.1111/1541-4329.12219

[18] Flumerfelt S, Kahlen F-J, Alves A, Siriban-Manalang A. Lean Engineering Education: Driving Content and Competency Mastery. 1st ed. New York, NY, USA: ASME Press; 2015. doi:10.1115/1.860502. Available from: https://doi.org/10.1115/1.860502

[19] Fox EJ. Constructing a Pragmatic Science of Learning and Instruction with Functional Contextualism. Educ Technol Res Dev. 2006 Feb;54(1):5–36. doi:10.1007/s11423-006-6491-5. Available from: https://doi.org/10.1007/s11423-006-6491-5

[20] Foxall GR. Metacognitive Control of Categorial Neurobehavioral Decision Systems. Front Psychol. 2016 Feb 19;7:170. doi:10.3389/fpsyg.2016.00170. Available from: https://doi.org/10.3389/fpsyg.2016.00170

[21] Frerich S, Meisen T, Richert A, Petermann M, Jeschke S, Wilkesmann U, Tekkaya AE, editors. Engineering Education 4.0: Excellent Teaching and Learning in Engineering Sciences. 1st ed. Cham: Springer International Publishing; 2016. doi:10.1007/978-3-319-46916-4. Available from: https://doi.org/10.1007/978-3-319-46916-4

[22] Gant W. Surviving the Whiteboard Interview: A Developer's Guide to Using Soft Skills to Get Hired. 1st ed. Berkeley, CA: Apress; 2019. doi:10.1007/978-1-4842-5007-5. Retrieved from https://doi.org/10.1007/978-1-4842-5007-5

[23] Granic I, Morita H, Scholten H. Beyond Screen Time: Identity Development in the Digital Age. Psychol Inq. 2020 Jul 2;31(3):195–223. doi:10.1080/1047840X.2020.1820214. Retrieved from https://doi.org/10.1080/1047840X.2020.1820214

[24] Guerra A, Ulseth R, Kolmos A, editors. PBL in Engineering Education: International Perspectives on Curriculum Change. Rotterdam: SensePublishers; 2017. doi:10.1007/978-94-6300-905-8. Available from: https://doi.org/10.1007/978-94-6300-905-8

[25] Gulliver A, Farrer L, Bennett K, Ali K, Hellsing A, Katruss N, Griffiths KM. University staff experiences of students with mental health problems and their perceptions of staff training needs. J Ment Health. 2018 Jun;27(3):247–56. doi:10.1080/09638237.2018.1466042. Epub 2018 May 3. Available from: https://doi.org/10.1080/09638237.2018.1466042

[26] Heywood J. The Assessment of Learning in Engineering Education: Practice and Policy. 1st ed. Hoboken, New Jersey: IEEE Press – John Wiley & Sons; 2016. doi:10.1002/9781119175575. Available from: https://doi.org/10.1002/9781119175575

[27] Iarovici D. Mental Health Issues and the University Student. Baltimore, MD: Johns Hopkins University Press; 2014. 1st ed. Available from: https://jhupbooks.press.jhu.edu/title/mental-health-issues-and-university-student

[28] Johnston K. A dynamical systems description of privilege, power and leadership in academia. Nature Astronomy. 2019 Dec;3(12):1060–6. doi:10.1038/s41550-019-0961-2. Available from: https://doi.org/10.1038/s41550-019-0961-2

[29] Kalimullin AM, Zhigalova MP, Ibrasheva AK, Kobylyanskaya LI, Lodatko YA, Nurlanov YB. Post-soviet identity and teacher education: Past, present, future. Education and Self Development. 2020;15(3):145–63. doi:10.26907/esd15.3.13. Available from: https://doi.org/10.26907/esd15.3.13

[30] Kalman CS. Successful Science and Engineering Teaching: Theoretical and Learning Perspectives. 1st ed. Cham: Springer International Publishing; 2018. doi:10.1007/978-3-319-66140-7. Available from: https://doi.org/10.1007/978-3-319-66140-7

[31] Kang J, Liu M. Investigating Navigational Behavior Patterns of Students Across At-Risk Categories Within an Open-Ended Serious Game. Tech Know Learn. 2020 July. Epub 2020 July 28. doi:10.1007/s10758-020-09462-6. Available from: https://doi.org/10.1007/s10758-020-09462-6

[32] Keitel C, Kilpatrick J. Mathematics Education and Common Sense. In: Kilpatrick J, Hoyles C, Skovsmose O, Valero P, editors. Meaning in Mathematics Education. Mathematics Education Library, vol 37. New York, NY: Springer US; 2005. p. 105–28. doi:10.1007/0-387-24040-3_8. Available from: https://doi.org/10.1007/0-387-24040-3_8

[33] Klisinska A. The fundamental theorem of calculus: a case study into the didactic transposition of proof [PhD dissertation]. Luleå: Luleå University of Technology; 2009. Available from: http://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-17879

[34] Kostikov AA, Perig AV, Lozun RR. Simulation-assisted teaching of graduate students in transport: A case study of the application of acausal freeware JModelica.org to solution of Sakawa's open-loop optimal control problem for payload motion during crane boom rotation. International Journal of Mechanical Engineering Education. 2017;45(1):3–27. doi:10.1177/0306419016669033. Available from: https://doi.org/10.1177/0306419016669033

[35] Leshner AI, Scherer LA, editors. Mental Health, Substance Use, and Wellbeing in Higher Education: Supporting the Whole Student. 1st ed. Washington, DC, US: The National Academies Press; 2021 Jan 13. doi:10.17226/26015. Available from: https://doi.org/10.17226/26015 and from https://www.ncbi.nlm.nih.gov/books/NBK567365/

[36] Leydens JA, Lucena JC. Engineering Justice: Transforming Engineering Education and Practice. 1st ed. Hoboken, New Jersey: IEEE Press – John Wiley & Sons; 2018. doi:10.1002/9781118757369. Available from: https://doi.org/10.1002/9781118757369

[37] Liuta AV, Perig AV, Afanasieva MA, Skyrtach VM. Didactic games as student-friendly tools for learning hydraulics in a technical university's undergraduate curriculum. Industry and Higher Education. 2019 Jun;33(3):198–213. doi:10.1177/0950422218824507. Available from: https://doi.org/10.1177/0950422218824507

[38] Luniachek V, Brovdii A, Kulakovskyi O, Varenko T. Academic Integrity in Higher Education of Ukraine: Current State and Call for Action. Educ Res Int. 2020;2020:8856251. doi:10.1155/2020/8856251. Available from: https://doi.org/10.1155/2020/8856251

[39] Lutsenko G. Case study of a problem-based learning course of project management for senior engineering students. European Journal of Engineering Education. 2018;43(6):895–910. Epub 2018 Mar 22. doi:10.1080/03043797.2018.1454892. Available from: https://doi.org/10.1080/03043797.2018.1454892

[40] Martin MW. From Morality to Mental Health: Virtue and Vice in a Therapeutic Culture (Practical and Professional Ethics Series). 1st ed. New York: Oxford University Press; 2006. doi:10.1093/0195304713.001.0001. Available from: https://doi.org/10.1093/0195304713.001.0001

[41] Mathebula M. Engineering Education for Sustainable Development: A Capabilities Approach. 1st ed. London: Routledge; 2018. doi:10.4324/9781315177045. Available from: https://doi.org/10.4324/9781315177045

[42] Mayer RE. Multimedia Learning. 2nd ed. Cambridge: Cambridge University Press; 2009. doi:10.1017/CBO9780511811678. Available from: https://doi.org/10.1017/CBO9780511811678

[43] Mayer RV. Computer-Assisted Simulation Methods of Learning Process. European Journal of Contemporary Education. 2015;13(3):198–212. doi:10.13187/ejced.2015.13.198. Available from: https://doi.org/10.13187/ejced.2015.13.198

[44] Mayer RV. Computer Model of the Empirical Knowledge of Physics Formation: Coordination with Testing Results. European Journal of Contemporary Education. 2016;16(2):239–47. doi:10.13187/ejced.2016.16.239. Available from: https://doi.org/10.13187/ejced.2016.16.239

[45] Mayer RV. Assimilation and Forgetting of the Educational Information: Results of Imitating Modelling. European Journal of Contemporary Education. 2017 Dec;6(4):739–47. doi:10.13187/ejced.2017.4.739. Available from: https://doi.org/10.13187/ejced.2017.4.739

[46] McNulty M, Smith JD, Villamar J, Burnett-Zeigler I, Vermeer W, Benbow N, Gallo C, Wilensky U, Hjorth A, Mustanski B, Schneider J, Brown CH. Implementation Research Methodologies for Achieving Scientific Equity and Health Equity. Ethn Dis. 2019 Feb 21;29(Suppl 1):83–92. doi:10.18865/ed.29.S1.83. Available from: https://doi.org/10.18865/ed.29.S1.83

[47] Omar MA. Design and Implementation of a Capstone Course to Satisfy the Industry Needs of Virtual Product Development and ABET Engineering Criteria. Educ Res Int. 2014;2014:578148. doi:10.1155/2014/578148. Available from: https://doi.org/10.1155/2014/578148

[48] Pei C, Weintrop D, Wilensky U. Cultivating Computational Thinking Practices and Mathematical Habits of Mind in Lattice Land. Mathematical Thinking and Learning. 2018;20(1):75–89. doi:10.1080/10986065.2018.1403543. https://doi.org/10.1080/10986065.2018.1403543

[49] Perig AV. How to teach students to make a simple experimental visualization of the macroscopic rotational modes of large deformations during pressure forming. Journal of Materials Education. 2017;39(5–6):193–208. Available from: https://icme.unt.edu/sites/default/files/vol.39issue5-62017.pdf

[50] Perig AV, Kostikov AA, Skyrtach VM, Lozun RR, Stadnik AN. Application of JModelica.org to Teaching the Fundamentals of Dynamics of Foucault Pendulum-Like Guided Systems to Engineering Students. Information Technologies and Learning Tools. 2017;62(6):151–78. doi:10.33407/itlt.v62i6.1926. Available from: https://doi.org/10.33407/itlt.v62i6.1926

[51] Perig AV. Didactic Student-Friendly Approaches to More Effective Teaching of the Fundamentals of Scientific Research in a Digital Era of Scientometrics. Eurasia Journal of Mathematics, Science and Technology Education. 2018;14(12):em1632. doi:10.29333/ejmste/97188. Available from: https://doi.org/10.29333/ejmste/97188

[52] Perig AV, Golodenko NN, Skyrtach VM, Kaikatsishvili AG. Hydraulic analogy method for phenomenological description of the learning processes of technical university students. European Journal of Contemporary Education. 2018 Dec;7(4):764–89. doi:10.13187/ejced.2018.4.764. Available from: https://doi.org/10.13187/ejced.2018.4.764

[53] Perig AV. Method for teaching students to make a simple geometric estimation of the macroscopic rotational modes of large deformations during pressure forming. International Journal of Continuing Engineering Education and Life-Long Learning. 2019;29(3):182–91.

doi:10.1504/IJCEELL.2019.101039. Available from: https://www.inderscienceonline.com/doi/abs/10.1504/IJCEELL.2019.101039

[54] Perig AV, Golodenko NN, Lapchenko OV, Skyrtach VM, Kostikov AA, Subotin OV. Recent postdigital transformations of undergraduate learning processes in the study of multidisciplinary materials science. International Journal of Continuing Engineering Education and Life-Long Learning. 2019;29(3):251–91. doi:10.1504/IJCEELL.2019.101045. Available from: https://www.inderscienceonline.com/doi/abs/10.1504/IJCEELL.2019.101045

[55] Perig AV, Golodenko NN, Martynov RS, Kaikatsishvili AG. Educational research into socio-economic dynamics of university graduate employment: Triple analogy-based physics-and-engineering approach to labor market oscillations. Work. 2020;65(1):3–29. doi:10.3233/wor-193054. Available from: https://doi.org/10.3233/WOR-193054

[56] Perig AV, Zavdoveev AV, Skyrtach VM, Kovalov OD, Arnout BA, Usković V, Gavrish PA, Hanevych OD, Sharapaniuk BY, Kostikov AA, Subotin OV. Materials extrusion-inspired engineering reflection of social pressure-induced environmental impact on academy community well-being. Work. 2021;68(2):333–52. doi:10.3233/WOR-203301. Available from: https://doi.org/10.3233/WOR-203301

[57] Plomp T, Nieveen N, editors. An Introduction to Educational Design Research. 3rd ed. Enschede, Netherlands: Netherlands institute for curriculum development (SLO); 2010.

[58] Pua PK, Lee MF, Lai CS. Construct Validity and Internal Consistency Reliability of Mental Health Monitoring Instrument for Technical University Students. Journal of Technical Education and Training. 2019;11(1):87–92. doi:10.30880/jtet.2019.11.01.11. Available from: https://publisher.uthm.edu.my/ojs/index.php/JTET/article/view/3059

[59] Rahman A, Ilic V, editors. Blended Learning in Engineering Education: Recent Developments in Curriculum, Assessment and Practice. 1st ed. London: CRC Press/Balkema; 2018. doi:10.1201/9781315165486. Available from: https://doi.org/10.1201/9781315165486

[60] Rahmandad H, Repenning N, Sterman J. Effects of feedback delay on learning. Syst Dyn Rev. 2009 Dec;25(4):309–38. doi:10.1002/sdr.427. Available from: https://doi.org/10.1002/sdr.427

[61] Saengchai S, Sawasdee A, Siriattakul P. Are corruption, demographic pressures and brain drain damaging the quality of education? Evidence from Asia. J Secur Sustain Issues. 2020;9:122–32. doi:10.9770/jssi.2020.9.J(10). Available from: https://doi.org/10.9770/jssi.2020.9.j(10)

[62] Sale D. The Challenge of Reframing Engineering Education. 1st ed. Singapore: Springer Singapore; 2014. doi:10.1007/978-981-4560-29-0. https://doi.org/10.1007/978-981-4560-29-0

[63] Sengupta P, Shanahan M-C. Boundary Play and Pivots in Public Computation: New Directions in STEM Education. Int J Eng Educ. 2017;33(3):1124–34.

[64] Soboleva EV, Isupova NI, Karaulova LV, Nimatulaev MM. Development of environmental thinking and lean manufacturing skills in the course of mobile robotics. Sci Educ Today. 2020;10(1):149–73. doi:10.15293/2658-6762.2001.09. Available from: https://doi.org/10.15293/2658-6762.2001.09

[65] Sokolowski HM, Ansari D. Understanding the effects of education through the lens of biology. NPJ Sci Learn. 2018 Oct 1;3(1):17. doi:10.1038/s41539-018-0032-y. Available from: https://doi.org/10.1038/s41539-018-0032-y

[66] Stern E. Individual differences in the learning potential of human beings. NPJ Sci Learn. 2017 Dec 12;2(1):2. doi:10.1038/s41539-016-0003-0. Available from: https://doi.org/10.1038/s41539-016-0003-0

[67] Sriraman B, Dickman B. Mathematical pathologies as pathways into creativity. ZDM-Math Educ. 2017 Mar;49(1):137–45. doi:10.1007/s11858-016-0822-8. Available from: https://doi.org/10.1007/s11858-016-0822-8

[68] Svyetlichnyy DS, Perig AV, Lach L, Straka R, Svyetlichnyy A. Edification in creation of Lattice Boltzmann models for materials science students. International Journal of Continuing Engineering Education and Life-Long Learning. 2019;29(3):151–81. doi:10.1504/IJCEELL.2019.101044. Available from: https://www.inderscienceonline.com/doi/abs/10.1504/IJCEELL.2019.101044

[69] Tzafestas S, editor. Web-Based Control and Robotics Education. 1st ed. Dordrecht: Springer Netherlands; 2009. doi:10.1007/978-90-481-2505-0. Available from: https://doi.org/10.1007/978-90-481-2505-0

[70] Uskoković V. Rethinking Active Learning as a Paradigm of Our Times: Towards Poeticizing and Humanizing Natural Sciences in the Age of STEM. Journal of Materials Education. 2017 Dec;39(5–6):241–57. Available: https://icme.unt.edu/sites/default/files/vol.39issue5-62017.pdf

[71] Uskoković V. Flipping the flipped: the co-creational classroom. Research and Practice in Technology Enhanced Learning. 2018;13(1):11. doi:10.1186/s41039-018-0077-9. Available from: https://doi.org/10.1186/s41039-018-0077-9

[72] Van den Beemt A, MacLeod M, Van der Veen J, Van de Ven A, van Baalen S, Klaassen R, Boon M. Interdisciplinary engineering education: A review of vision, teaching, and support. J Eng Educ. 2020;109:508–55. doi:10.1002/jee.20347. Available from: https://doi.org/10.1002/jee.20347

[73] Viskovich S, De George-Walkers L. An investigation of self-care related constructs in undergraduate psychology students: Self-compassion, mindfulness, self-awareness, and integrated self-knowledge. Int J Educ Res. 2019;95:109–17. doi:10.1016/j.ijer.2019.02.005. Available from: https://doi.org/10.1016/j.ijer.2019.02.005

[74] Wallace R. Computational Psychiatry: A Systems Biology Approach to the Epigenetics of Mental Disorders. Cham: Springer International Publishing; 2017. doi:10.1007/978-3-319-53910-2. Available from: https://doi.org/10.1007/978-3-319-53910-2

[75] Wallace R. Culture and the Trajectories of Developmental Pathology: Insights from Control and Information Theories. Acta Biotheor. 2018 Jun;66(2):79–112. doi:10.1007/s10441-018-9320-4. Available from: https://doi.org/10.1007/s10441-018-9320-4

[76] Wallace R. Embodied cognition and its pathologies: The dynamics of institutional failure on wickedly hard problems. Commun Nonlinear Sci Numer Simul. 2021 Apr;95:105616. doi:10.1016/j.cnsns.2020.105616. Available from: https://doi.org/10.1016/j.cnsns.2020.105616

[77] Warr M, West RE. Bridging Academic Disciplines with Interdisciplinary Project-based Learning: Challenges and Opportunities. Interdiscip J Probl-Based Learn. 2020;14(1):28590. doi:10.14434/ijpbl.v14i1.28590. Available from: https://doi.org/10.14434/ijpbl.v14i1.28590

[78] Wilensky U, Rand W. An Introduction to Agent-Based Modeling: Modeling Natural, Social, and Engineered Complex Systems with NetLogo. Cambridge, MA: MIT Press; 2015. Available from: https://www.intro-to-abm.com/

[79] West RE, Tawfik AA, Gishbaugher JJ, Gatewood J. Guardrails to Constructing Learning: the Potential of Open Microcredentials to Support Inquiry-Based Learning. TechTrends. 2020 Nov;64(6):828–38. doi:10.1007/s11528-020-00531-2. Available from: https://doi.org/10.1007/s11528-020-00531-2

[80] Yildirim A, Celikten M, Desiatov T, Lodatko Y. The analysis of teachers' cyber bullying, cyber victimization and cyber bullying sensitivity based on various variables. European Journal of Educational Research. 2019;8(4):1029–38. doi:10.12973/eu-jer.8.4.1029. Available from: https://doi.org/10.12973/eu-jer.8.4.1029