THE ATHENS INSTITUTE FOR EDUCATION AND RESEARCH

Abstract Book

10th Annual International Conference on Chemistry
18-21 July 2022, Athens, Greece

Edited by
Ellene Tratras Contis & Olga Gkounta

2022

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Olga Gkounta

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Preface

This book includes the abstracts of all the papers presented at the *10th Annual International Conference on Chemistry* (18-21 July 2022), organized by the Athens Institute for Education and Research (ATINER).

A full conference program can be found before the relevant abstracts. In accordance with ATINER's Publication Policy, the papers presented during this conference will be considered for inclusion in one of ATINER's many publications only after a blind peer review process.

The purpose of this abstract book is to provide members of ATINER and other academics around the world with a resource through which they can discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. ATINER was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world can meet to exchange ideas on their research and consider the future developments of their fields of study.

To facilitate the communication, a new references section includes all the abstract books published as part of this conference (Table 1). I invite the readers to access these abstract books –these are available for free– and compare how the themes of the conference have evolved over the years. According to ATINER's mission, the presenters in these conferences are coming from many different countries, presenting various topics.

Table 1. *Publication of Books of Abstracts of Proceedings, 2013-2022*

Year	Papers	Countries	References
2022	35	24	Tratras Contis E and Gkounta O (2022)
2021	19	12	Papanikos (2021)
2020	31	10	Papanikos (2020)
2019	24	17	Papanikos (2019)
2018	28	14	Papanikos (2018)
2017	16	12	Papanikos (2017)
2016	11	9	Papanikos (2016)
2015	48	18	Papanikos (2015)
2014	23	16	Papanikos (2014)
2013	29	16	Papanikos (2013)

It is our hope that through ATINER's conferences and publications, Athens will become a place where academics and researchers from all over the world can regularly meet to discuss the developments of their disciplines and present their work. Since 1995, ATINER has organized more than 400 international conferences and has published over 200 books. Academically, the institute is organized into 6 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of ATINER for putting this symposium and its subsequent publications together. Specific individuals are listed after the Editors' Note.

Gregory T. Papanikos
President

Editors' Note

These abstracts provide a vital means to the dissemination of scholarly inquiry in the field of Chemistry. The breadth and depth of research approaches and topics represented in this book underscores the diversity of the conference.

ATINER's mission is to bring together academics from all corners of the world in order to engage with each other, brainstorm, exchange ideas, be inspired by one another, and once they are back in their institutions and countries to implement what they have acquired. The 10th Annual International Conference on Chemistry accomplished this goal by bringing together academics and scholars from 24 different countries (Bulgaria, Canada, Croatia, Germany, Hungary, India, Israel, Italy, Japan, Kazakhstan, Kosovo, Mexico, Philippines, Poland, Portugal, Romania, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, UK, and USA), which brought in the conference the perspectives of many different country approaches and realities in the field.

Publishing this book can help that spirit of engaged scholarship continue into the future. With our joint efforts, the next editions of this conference will be even better. We hope that this abstract book as a whole will be both of interest and of value to the reading audience.

Ellene Tratras Contis & Olga Gkounta
Editors

10th Annual International Conference on Chemistry, 18-21 July 2022, Athens, Greece

Organizing & Scientific Committee

All ATINER's conferences are organized by the Academic Council. This conference has been organized with the assistance of the following academic members of ATINER, who contributed by reviewing the submitted abstracts and papers.

1. Gregory T. Papanikos, President, ATINER & Honorary Professor, University of Stirling, U.K.
2. Ellene Tratras Contis, Professor Emerita, Eastern Michigan University, USA.
3. Bala Maheswaran, Head, Electrical Engineering Unit, ATINER & Professor, Northeastern University, USA.

FINAL CONFERENCE PROGRAM

10th Annual International Conference on Chemistry, 18-21 July 2022, Athens, Greece

PROGRAM

Monday 18 July 2022

09.00-09.30
Registration

09:30-10:00
Opening and Welcoming Remarks:

- **Gregory T. Papanikos**, President, ATINER

10:00-12:00 TIME SLOT 1 – MORNING PRESENTATIONS

Coordinator: Bala Maheswaran, Head, Electrical Engineering Unit, ATINER & Professor, Northeastern University, USA.

1. **Riadh Habash**, Professor, University of Ottawa, Canada.
   ***Title**: Experiential Engineering Learning Model through Community of Design and Practice.*
2. **Mexhid Ferati**, Associate Professor, Linnaeus University, Sweden.
   Venera Demukaj, Assistant Professor, Rochester Institute of Technology, Kosovo.
   ***Title**: Generation Z Enters STEM: Obstacles and Opportunities in the Case of Kosovo.*
3. **Ildiko Holik**, Associate Professor, Óbuda University, Hungary.
   Istvan Daniel Sanda, Associate Professor, Óbuda University, Hungary.
   ***Title**: The Possibilities of Developing STEM Skills in Higher Education.*
4. **Shio Kawagoe**, Associate Professor, University of Tokyo, Japan.
   ***Title**: Workshop Design for Online STEAM Education in Collaboration with Industry.*
5. **Yelena Istileulova**, DAAD Bologna Expert, Evaluator of the EU Commission, Independent Consultant, DAAD Hub Peer Support Project (Bonn-Brussels), Slovenia.
   ***Title**: The Age of Enlightenment in the New Method of STEAM Approach: Apple-Tree of Johann Sievers (Germany).*

12:00-14:00 TIME SLOT 2 –NOON PRESENTATIONS

Coordinator: H**aiduke Sarafian**, Professor of Physics and Endowed Chair of John T. and Paige S. Smith Professor of Science, Pennsylvania State University, USA.

1. **Péter Odry**, Professor, University of Dunaújváros, Hungary.
   ***Title**: Robust Impedance Spectroscopy.*
2. **Damira Jantassova**, Head/Foreign Language Department, Saginov Karaganda Technical University, Kazakhstan.
   Daniyel Damiyev, Junior Researcher, Saginov Karaganda Technical University, Kazakhstan.
   ***Title**: Framework of Capacity Building for Internationalization of Engineering University on the Base of Digital Platform: Mechanisms of Interaction Via Heat Intensity Map.*
3. **Mateja Ploj Virtič**, Associate Professor, University of Maribor, Slovenia.
   Janja Majer Kovačič, Assistant Professor, University of Maribor, Slovenia.
   Eva Klemenčič, Assistant Professor, University of Maribor, Slovenia.
   ***Title**: The Role of Teacher Education in the Science Literacy Development.*
4. **Samuel Kosolapov**, Senior Lecturer, ORT Braude Academic College of Engineering, Israel.
   ***Title**: Time Effective Logistics of Hybrid Image Processing Course and Laboratory.*

14:00-15:30
Lunch

15:30-17:00 TIME SLOT 3 – AFTERNOON PRESENTATIONS

Coordinator: Olga Gkounta, Researcher, ATINER.

1. **Sergiusz Luczak**, Associate Professor, Warsaw University of Technology, Poland.
   ***Title**: MEMS Accelerometer as a Sensor of Geometric Quantities.*
2. **Nydia Lara Zavala**, Professor, National University of Mexico, Mexico.
   ***Title**: Thales of Miletus: Thinking About Nature as an Engineer.*
3. **Eva Anderl**, Professor, Munich University of Applied Sciences, Germany.
   ***Title**: Fostering IT Competencies in Business Students through IT-Based Business Development Projects.*

17:00-18:30 TIME SLOT 4 – AFTERNOON PRESENTATIONS

Coordinator: Periklis Papadopoulos, Professor, San Jose State University, USA.

1. **Mark Lin**, Principal, Lin Design Engineering, USA.
   Patrick Lewis, Aerospace Engineer, Maxar, USA.
   Periklis Papadopoulos, Professor, San Jose State University, USA.
   ***Title**: Utilising Magnus Effect to Increase Downforce in Motorsport.*
2. **Yazdan Pedram Razi**, Adjunct Professor, San Jose State, USA.
   ***Title**: The Linear Stability Analysis of Convective Flows under the Effect of Vibrations in a Hele-Shaw Geometry.*
3. **Mustafa Bakkal**, Professor, Istanbul Technical University, Turkey.
   ***Title**: Machine Tool Design Improvement via Topology Optimisation.*
4. **Thomas Kieffer**, Chief Engineer, Vishay Measurements Group, USA.
   ***Title**: Bolt Preload Temperature Cycling.*

20:30-22:30
Greek Night

Tuesday 19 July 2022

TIME SLOT 5 – MORNING PRESENTATIONS

08:30-10:00 Time Slot 5a1

Coordinator: Kostas Spyropoulos (ATINER Administrator).

1. **Celeste Joy Matias**, Researcher, Miriam College, Philippines.
   Ma. Nympha B. Joaquin, Researcher, University of the Philippines, Philippines.
   ***Title**: Being Female and At-risk in Mathematics: A Phenomenological Study.*
2. **Angelina Lumbre**, Teacher, San Mateo Senior High School, Philippines.
   Ma. Nympha Joaquin, Professor, University of the Philippines, Philippines.
   ***Title**: Relationships among Mathematics Teachers' van Hiele Levels, Teaching Styles and Students' Achievement in Geometry.*
3. **Thomas Fehlmann**, Senior Researcher, Euro Project Office, Switzerland.
   ***Title**: Intuitionism and Science – Why Scientists do not Like the Axiom of Choice.*
4. **Tonći Kokić**, Associate Professor, University of Split, Croatia.
   ***Title**: The Destiny of Scientific Theories: Oparin Coacervate Theory Case.*

10:00-11:30 Time Slot 5a2

Coordinator: Kostas Spyropoulos (ATINER Administrator).

08:00-11:00 Time Slot 5b

Old and New-An Educational Urban Walk
The urban walk ticket is not included as part of your registration fee. It includes transportation costs and the cost to enter the Parthenon and the other monuments on the Acropolis Hill. The urban walk tour includes the broader area of Athens. Among other sites, it includes: Zappeion, Syntagma Square, Temple of Olympian Zeus, Ancient Roman Agora and on Acropolis Hill: the Propylaea, the Temple of Athena Nike, the Erechtheion, and the Parthenon. The program

1. **Maria Rosaria D'Acierno Canonici**, Associate Professor, Parthenope University of Naples, Italy. ***Title**: Music and Art: Two Underestimated Disciplines.* 2. **Deon Vos**, Senior Lecturer, North West University, South Africa. ***Title**: The Influence and Value of Technology in the Education Systems of South Africa and Russia.* 3. **Sara Dias-Trindade**, Teacher, University of Coimbra, Portugal. ***Title**: Technologies and Digital Competences in Portuguese Education: History of their Integration in Pedagogical Practices since the Beginning of the 20th Century.* 4. **Javier Cubas**, Associate Professor, Polytechnic University of Madrid, Spain. ***Title**: UPMQuBe: An Academic/Educational PocketQube Proposal for the EU2Space Challenge.*	of the tour may be adjusted, if there is a need beyond our control. This is a private event organized by ATINER exclusively for the conference participants.

11:30-13:30 TIME SLOT 6 – MORNING/NOON PRESENTATIONS

Coordinator: Adrian Ionescu, Professor, Wagner College, USA.

1. **Haiduke Sarafian**, Professor of Physics and Endowed Chair of John T. and Paige S. Smith Professor of Science, Pennsylvania State University, USA.
   ***Title**: Negative Resistance and Its Impact on a RC-DC Driven Electric Circuit.*
2. **Mahmoud Huleihil**, Head, Computer Sciences Department, Bet Berl College Kfar Saba, Israel.
   ***Title**: General Solution of Two-Dimensional Projectile Motion with Air Resistance.*
3. **Masoud Ghezelbash**, Professor, University of Saskatchewan, Canada.
   ***Title**: Black Holes and Conformal Field Theories.*
4. **Igor Djerdj**, Professor, University of Osijek, Croatia.
   ***Title**: Band Gap Engineering in Novel Fluorite-Type Rare Earth High-Entropy Oxides (RE-HEOs) with Computational and Experimental Validation for Photocatalytic Water Splitting Applications.*

13:30-15:00 TIME SLOT 7 – NOON PRESENTATIONS

Coordinator: Masoud Ghezelbash, Professor, University of Saskatchewan, Canada.

1. **Adrian Ionescu**, Professor, Wagner College, USA.
   ***Title**: Computer Software Used To Introduce Some New Numerical Methods.*
2. **Dheerendra Kumar Dwivedi**, Professor, Indian Institute of Technology Roorkee, India.
   ***Title**: Joining of Copper-Steel Dissimilar Metals by Pulse Pressure Assisted Diffusion Bonding.*
3. **Alejandro Ramírez-Rojas**, Researcher, Autonomous Metropolitan University – Azcapotzalco, Mexico.
   Elsa Leticia Flores Marquez, Researcher, Autonomous Metropolitan University – Azcapotzalco, Mexico.
   ***Title**: Correlations of the Seismic Sequences Before and after the 2017 Tehuantepec Earthquake M8.2, Mexico by Using the Visibility Graph Method*

15:00-16:00
Lunch

16:00-17:30 TIME SLOT 8 – AFTERNOON PRESENTATIONS

Coordinator: Olga Gkounta, Researcher, ATINER.

1. **Genica Liliana Saftoiu Golea**, PhD Student, University of Bucharest, Romania.
   ***Title**: Vertical Assessment of Characteristics of Medium Thick Clouds over Bucharest-Magurele, Romania.*
2. **Vassil Delchev**, Professor, University of Plovdiv, Bulgaria.
   ***Title**: Excited State Intra- and Intermolecular Proton Transfers in Cytosine and Guanine.*
3. **Mingzhong Li**, Professor, De Montfort University, UK.

***Title**: Multi-component Crystal Forms of Nutraceuticals for Bioavailability Improvement.*

4. **Suzanne Hiller**, Assistant Professor, Hood College, USA.
   ***Title**: Citizen Science as a Vehicle for STEM Career Motivation: Research, Assessment, and Implications.*

19:30-21:00
The Official Dinner of the Conference hosted *by the President of ATINER*

Wednesday 20 July 2022
Educational Islands Cruise
Mycenae Visit

Thursday 21 July 2022
Delphi Tour

Eva Anderl
Professor, Munich University of Applied Sciences, Germany
Jessica Slamka
Professor, Munich University of Applied Sciences, Germany
Christian Greiner
Professor, Munich University of Applied Sciences, Germany
Felix Hopfl
Lecturer, Munich University of Applied Sciences, Germany
Harald Seitz
Lecturer, Munich University of Applied Sciences, Germany
&
Sophie Botz
Master Student, Munich University of Applied Sciences, Germany

Fostering IT Competencies in Business Students through IT-Based Business Development Projects

Computational thinking abilities have become an important skill for future employees (Tsai et al., 2019). Especially business students need to understand the basics of information technology (IT) and how to communicate with programmers, designers and developers in order to be able to compete successfully in a high-tech world (KeyStone MBA Studies, 2016).

Inspired by the „From Teaching to Learning" approach (Barr and Tagg, 1995), the authors investigate how group-based project work can be used to foster students' acquisition of IT competencies in a business context. For this purpose, in an undergraduate class on introduction to information systems and programming at a large German University of Applied Sciences, the mode of examination was changed from a written exam to an IT-based business development project. Groups of five students were asked to identify an existing business demand and develop a potential solution based on IT and implement a prototype using Microsoft VBA as a programming language. Project results were delivered in a final presentation including a demonstration of the prototype. To investigate the effects of this form of learning and examination, students were asked to submit a written reflection on the project.

174 self-reflections were analyzed using qualitative content analysis (Kuckartz, 2014). The analysis reveals three core topics which not only promote the acquisition of IT competencies as such but further enhance complementary professional and personal competencies: *teamwork, learning behavior* and *learning outcomes*.

Students consciously planned their *group work* and reflected on it afterwards, describing mutual support, the division of tasks, and time management as success factors.

Furthermore, the project induced a both structured and self-organized *learning behavior*. Students made use of concepts presented in class such as the structure chart in order to reach their goal in a structured manner. They used a broad range of sources for knowledge acquisition, including (internet) research, lecture notes and video tutorials, thus demonstrating information literacy. Overall, the "learning by doing" approach was perceived as highly effective by the students.

The *learning outcomes* are only partly related to IT and programming. Many students described that they had learned the usage of tools (mainly VBA and Excel) and have gained a better understanding of *IT*, its complexity, and its practical relevance. However, another noticeable part of the learning outcomes was *creativity* in the sense of creative ideas and knowledge of design principles. Along with other mentions such as deepening the business knowledge, learning how to cope with failures and training discipline and ambition, this represents a wide spectrum of positive learning outcomes. Several students explicitly mentioned high *self-efficacy*: "*Every time I solved a task, my motivation grew steadily. As if by magic, a positive feedback circle emerged, which in turn naturally increased the self-efficacy of each individual group member and of the group as a whole.*" To follow up on this outcome, the authors conducted a quantitative survey using an adaptation of the Computer Programming Self-Efficacy Scale (Tsai et al., 2019) among 73 participants of the class, indicating high levels of programming self-efficacy.

Given the mainly qualitative approach of this study, the results are only partly generalizable. However, they provide a clear indication that an IT-based business development project is a suitable tool for developing IT competencies with learning outcomes that go far beyond basic programming skills.

Mustafa Bakkal
Professor, Istanbul Technical University, Turkey
Deniz Özkan
Engineering Student, Istanbul Technical University, Turkey
Can Kumru
Engineering Student, Istanbul Technical University, Turkey
Bayram Mert Mollaahmetoğlu
Student, Istanbul Technical University, Turkey
Erdem Az
Engineer, Yılmaz Machine A.Ş., Turkey
Mahmut Yılmaz
Engineer, Yılmaz Machine A.Ş., Turkey
&
Alper Yeter
Head of R&D, Yılmaz Machine A.Ş., Turkey

Machine Tool Design Improvement via Topology Optimisation

Today, CNC machines are indispensable for the serial and defect-free production. Because of that the issues to be considered in the manufacture of these machines are gaining importance day by day. In this paper, design and improvement studies were carried out on the y-axis of the AIM7510 model 5-axis CNC machine tool which is used for Aluminum and PVC machining.

In the first part of the study, the modeling of the problem and the definition of the boundary conditions are made. In this process, the simplified model was created with the Solidworks software. After that, engineering calculations were made on current state of the Y-axis, and the static and dynamic analyzes made with the help of ANSYS analysis software. In the last part of the study, final design proposals were determined as a result of the topology optimization with Fusion 360 software. While determining these design proposals, natural frequency, mass and manufacturability were considered and compared with earlier design. Machine tool robustness improved 5 times and strength of machine tool increased more than 2 times with the new design proposal on Y-axis.

Javier Cubas
Associate Professor, Polytechnic University of Madrid, Spain

UPMQuBe: An Academic/Educational PocketQube Proposal for the EU2Space Challenge

In the present paper, the UPMQube PocketCube proposal for the EU2Space challenge (Figure1) is described. This proposal has been developed by a group of Master's Degree students led by Ph.D. students and Professors from the *Instituto Universitario de Microgravedad "Ignacio Da Riva"* (IDR/UPM) at *Universidad Politécnica de Madrid* (UPM). PocketQube is a recent new picosatellite concept, which is currently underdevelopment. Its reduced size and mass require a significant effort to reduce the characteristic size of the elementary subsystems. One of the subsystems that offers the greatest capacity for improvement is the Attitude Determination and Control Subsystem(ADCS), since most PocketQubes do not usually have one due to lack of space. The most relevant technical aspect from this proposal is the development of a new ADCS which fits the high restrictive size and mass requirements, and itis based on Commercial-Of-The-Shelf (COTS) components. This ADCS is composed by: (i) a purely Autonomous Magnetic Controller (AMC) based on magnetorquers and magnetometers on board the spacecraft (S/C)platform; (ii) an Attitude Determination System (ADS) based on solar sensors and thermal sensors on board the S/C and an On-Ground Attitude Determination Algorithm (OGADA)for post processing the sensors flight data.

The work carried out by the Master's Degree students is integrated within the academic program of the UPM's Master in Space Systems as a Case of Study. It also provides an excellent training program the Ph.D./Assistant Professors included in proposal's Team. The tasks assignments and responsibilities of all members of the Team are fully described in the paper. Additionally, it should be underlined that this proposal is quite well balanced in term of gender, as 40% of the Team (including the Principal Investigator) are women. This figure is higher than the mean percentage of women present in STEAM (Sciences, Technology, Engineering, and Mathematics) careers (29% of workforce, 19% of company board members, 3% industry CEOs).

Figure 1. *Mission Patch for UPMQube*

Maria Rosaria D'Acierno Canonici
Associate Professor, Parthenope University of Naples, Italy

Music and Art: Two Underestimated Disciplines

This study was suggested by the tragic event associated to the CORONA virus, which gave us a great lesson: the importance of arts to help our mind, our soul, and our economic growth, too. During the lockdown, music and visual arts seemed the only means to gather people, to share emotions and to fill in the isolation of our life, so to achieve a kind of new energy. Now, that the world seems to face a new era, theatre, cinema, art exhibitions and concerts occupy a large space to improve culture and economy. In Italy the Istituto Comprensivo in Monteforte Irpino has planned a special session for young kids and teenagers offering them the chance to study a musical instrument during the school hours. I'm observing these students' cognitive development with tests in order to compare them with those of the students following the regular curriculum.

Ancient Greece (Plato, Pythagoras, Aristotle) considered art and music the founding disciplines of their education. Music was associated to mathematics and poetry; theater to the art of speaking, and painting and drawing to the social aspect of society. Because the Greeks were an advanced civilization, neighboring countries adapted their teachings as their own. On the contrary, in our western school curricula, art in general does not seem to be much appreciated; it still has a Cinderella role. As educators, we have to revive art and music at any age, since not only they increase academic performance, rather they provide creative energy stimulating the future production of films, plays, designs, fashion, thus linking school and future professions. Most importantly, they arise the students' desire to learn. This desire will help them to live an active life full of projects; projects which will help them to face all the problems of their life with a serene spirit. There is also evidence that arts and music keep youths out of trouble, alcohol and drug abuse.

Vassil Delchev
Professor, University of Plovdiv, Bulgaria
T. D. Cherneva
University of Plovdiv, Bulgaria
I. G. Shterev
University of Food Technologies, Bulgaria
&
E. Horkel
Technical University of Wien, Austria

Excited State Intra- and Intermolecular Proton Transfers in Cytosine and Guanine

Cytosine and guanine are constituents of the DNA macromolecule. They link together to form a base pair through H-bonds forming the so-called Watson-Crick model. On the other side the two bases are chromophor systems that can utilize the UV light hitting the DNA molecule. In other words the two compounds should be photostable which is not very well clarified. In this aspect it is interesting to follow the ability of these single molecules to tautomerize in excited state. One of the proposed mechanisms for that is the PIDA (photo-induced dissociation association) one. Usually it occurs through the repulsive $^1\pi\sigma^*$ excited state. Thus the aim of the research is to check the PIDA mechanism for these two nucleobases. Two mechanisms are investigated: i) the proton transfer processes in single bases – intamolecular proton transfers, and ii) intermolecular proton transfers supported by a water molecule acting as catalyst. The mechanisms are investigated at the BLYP/aug-cc-pVDZ level of theory and the PCM solvent model. The optimized structures of the conical intersections S_0/S_1 were found at the CASSCF(6,6)/6-31G* level of theory. The research led to the next major conclusions: 1) the H-detachment mechanisms in the biologically relevant tautomer forms of cytosine and guanine proceed through the repulsive $^1\pi\sigma^*$ excited-state reaction paths. Only for the hydroxy-amino tautomer of cytosine and hydroxy-amino tautomer of guanine we found a barrierless relaxations of the $^1\pi\sigma^*$ excited state through conical intersections S_0/S_1. The remaining mechanisms show either low energy barriers or energy increase along the reaction coordinate. According to the CC2/aug-cc-pVDZ calculations the found conical intersections S_0/S_1 are mutually accessible along the $^1\pi\sigma^*$ excited-state reaction paths. They can transform one to another in excited state. 2) The performed IRC calculations over the thermal transition states of the proton transfer

reactions show almost parallel paths of the excited state curves as compared to the ground state. However the inclusion of a water molecule as catalyst drastically changes the reaction mechanisms. The energy barriers of the excited state curves are reduced more than 50% each. Moreover, the mechanisms are driven by the $^1\pi\pi^*$ or/and $^1n\pi^*$ excited states.

Acknowledgments

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Sara Dias-Trindade
Teacher, University of Coimbra, Portugal
&
J. António Moreira
Teacher, Universidade Aberta, Portugal

Technologies and Digital Competences in Portuguese Education: History of Their Integration in Pedagogical Practices since the Beginning of the 20th Century

Technology applied in the educational context is not a recent reality and should be considered from past experiences, so that the understanding of it does not remain hostage to the episodic technological novelty. With the introduction of Digital Technology (DT) in schools, new realities have been built and different challenges have been posed regarding the development of teaching and learning environments enriched with the digital. In this sense, networked learning and the potential of digital technologies have brought new and stimulating challenges for the whole school community. One of the main challenges relates to the need to design new learning scenarios using digital technologies, social networks, and virtual environments, being fundamental that teachers acquire digital competences that allow them to use these technologies effectively. However, it is also relevant to understand the forms of dissemination or the eventual difficulty of this dissemination, in a contemporary vision of the use and appropriation of Technology by Education and the way in which the evolution of Technology has deeply influenced the techniques of teaching and learning. This study aims to analyse the evolutionary context of the introduction of technology in Portuguese schools, from the beginning of the 20th century to the present day, and to identify the digital competences of Portuguese teachers at different educational levels. The analysis, qualitative and quantitative in nature, allowed us to conclude that technologies had a slow diffusion in Portuguese schools, because of the scarcity of resources and residual investment in teacher training, giving the use of technology in school a more irregular and playful character rather than truly integrated in pedagogical practices to promote the quality of learning. Although in recent years there has been still some conservatism in the use of technology, very focused on its instrumental use, there have been more practices with pedagogical intent and more focused on the active participation of students, also noting the growing importance of teacher training in this field of digital technologies, with the aim of making teachers more

competent and fluent in the pedagogical use of digital. Furthermore, the study focused on the teachers' perception of their digital competences in three dimensions: the teachers' professional and pedagogical competences and the students' competences from the *DigCompEdu* framework and the self-assessment questionnaire of digital competences built from the same framework - *DigCompEdu Check-In*. The analysis of the answers obtained in this questionnaire (collected from the participation of 434 teachers of Basic and Secondary Education and 118 of Higher Education) showed that teachers need to increase their levels of digital proficiency through specific training, since they present, globally, a moderate level of digital proficiency - level B1 -Integrators- being the areas 4 - Evaluation - and 6 - Digital empowerment of students, the ones that present the greatest weaknesses.

Igor Djerdj
Professor, University of Osijek, Croatia
Dalibor Tatar
PhD Student, University of Osijek, Croatia
Josip Juraj Strossmayer
University of Osijek, Croatia
Jelena Kojcinovic
Postdoc, University of Osijek, Croatia
Srijita Nundy
Postdoc, University of Exeter, UK
Asif Ali Tahir
Professor, University of Exeter, UK
Habib Ullah
Postdoc, University of Exeter, UK
&
Aritra Ghosh
Lecturer, University of Exeter, UK

Band Gap Engineering in Novel Fluorite-Type Rare Earth High-Entropy Oxides (RE-HEOs) with Computational and Experimental Validation for Photocatalytic Water Splitting Applications

Five different rare-earth-based high entropy oxides (HEOs) nanoparticles with fluorite type of structure and average crystallite sizes between 6 and 9 nm are prepared and their photocatalytic behaviour towards AZO dye degradation and photoelectrochemical water splitting for hydrogen generation is examined. The cationic site in the fluorite lattice consists of five equimolar elements selected from the group of rare-earth elements including La, Ce, Pr, Eu, and Gd and second-row transition metals, Y and Zr. Studied HEOs exhibit bandgaps in the range from 1.91 eV to 3.0 eV and appropriate valence and conduction bands for water splitting. They reveal high photocatalytic activity that is mostly attributed to the accessibility of more photocatalytic active sites which provided radicals responsible for the AZO dye degradation. The material successfully produces hydrogen by photocatalytic water splitting, suggesting the potential of HEOs as new photocatalysts. The photocatalytic performances of all studied HEOs outperform the single fluorite oxides or equivalent mixed oxides. The $Ce_{0.2}Zr_{0.2}La_{0.2}Pr_{0.2}Y_{0.2}O_2$ engender hydrogen in 9.2 $\mu molmg^{-1}$ per hour that is much higher content than for pristine CeO_2 material which amounts to 0.8 $\mu molmg^{-1}$ per hour.

Dheerendra Kumar Dwivedi
Professor, Indian Institute of Technology Roorkee, India
&
Neha Rajput
Post Graduate Student, Indian Institute of Technology Roorkee, India

Joining of Copper-Steel Dissimilar Metals by Pulse Pressure Assisted Diffusion Bonding

Joining of dissimilar metals combination imposes many difficulties in the form of cracking, hard and brittle weld, IMCs formation, residual stress and distortion, corrosion tendency due to difference in chemical, thermo-physical, mechanical and metallurgical properties of two-parent metals. These issues more predominant in case of fusion welding than solid state joining approaches due to limited scope of intermixing and dilution of metallurgical incompatible metals. The solid state joining processes like friction stir welding, diffusion bonding and ultrasonic welding are commonly applied for dissimilar metal joining.

The diffusion bonding however suffers from low productivity due to long time for diffusion bonding and tedious surface preparation requirements. In this work, therefore attempts have been made to study the effect of pulse pressure application during diffusion bonding of dissimilar metal combination of steel and copper surfaces of different roughness. The joining of copper and austenitic stainless steel (316L) using impulse pressure assisted diffusion bonding was performed to investigate the influence of surface roughness and pulse pressure application on the tensile load carrying capacity of the diffusion bonds.

Increase of pulse pressure in general increases the bond strength irrespective surface roughness. A window of process parameters was identified to achieve 100% joint efficiency of diffusion bonds leading to the failure from the base metal during tensile test. The FE-SEM analyses suggested that pressure pulsation helps in three ways to improve the strength of the joint. Firstly, it breaks the oxide film layer developed on the mating surfaces. Secondly, it fills the unbounded surface and voids at the interface, owing to the plastic flow of metal in the overlapped area at the interface. Thirdly, refining the grain structure across the interface owing to the compressive deformation at the surface by impulse pressuring which in turn accelerates grain boundary diffusion.

The diffusion bonds were developed using hot vacuum pressure at temperature range of 800 to 950°C for varying bonding time and pressure pulsation. Surfaces of different roughness for diffusion bonding were prepared by grinding, rough polishing and fine polishing

with the help of alumina powder. Surface roughness was measured with the help of atomic force microscope (AFM). Dissimilar metals having high surface roughness diffusion bonded using low maximum pulse pressure showed voids at bonding interface. Mechanical properties of the joint were analyzed in respect of the hardness and tensile strength of the joint. Pressure pulsation increases the strength of the joint and helps in reducing the number of voids produced at the interface. SEM of fracture surface was carried out to study the mode fracture and FE-SEM was performed to investigate diffusion across the interface.

Thomas Fehlmann
Senior Researcher, Euro Project Office, Switzerland

Intuitionism and Science – Why Scientists do not like the Axiom of Choice

The Axiom of Choice (AC) says that every set has a representative element. However, deterministic computers cannot produce arbitrary elements. They need some algorithm that tells them, which one to choose. But then, the element is no longer arbitrary. Even for a true random generator, you'll need Entropy. This is data gathered from outside the system, and we as Theoretical Computer Scientists do not like that. Thus, we need to understand the axiom of choice better. For this, we use a model of Combinatory Logic.

Mexhid Ferati
Associate Professor, Linnaeus University, Sweden
Venera Demukaj
Assistant Professor, Rochester Institute of Technology, Kosovo
Arianit Kurti
Associate Professor, Linnaeus University, Sweden
&
Christina Mörtberg
Senior Professor, Linnaeus University, Sweden

Generation Z Enters STEM: Obstacles and Opportunities in the Case of Kosovo

Women make up half of the society, however they account for 40% of the labor force, according to a report from the World Economic Forum (WEF, 2020). Data shows that globally, the number of women working in Science, Technology, Engineering, and Mathematics (STEM) careers is still low (ILOStat, 2019). In Europe, women hold only 17.2% of ICT-related jobs and only 13.1% of STEM graduates are women (Eurostat, 2019).

Data on emerging economies, such as Kosovo, exhibit similar trends. In the academic year of 2017/2020, out of the total number of active and graduated students in STEM fields at the University of Prishtina, women comprised 32% and 44%, respectively (MEST & KAS, 2018). Closing the gender gap was identified as a possibility for growth and reignition of the economies across Central and Easter Europe by a recent McKinsey report (Iszkowska et al., 2021). The need to keep up with the social, technological, and economic developments of our time has brought to the forefront the importance of preparing the new generations of citizens with skills in STEM. Indeed, the European Commission recognized that one of the most ambitious goals is to make STEM education and STEM careers attractive to youth, and that interventions to address the crisis should start early (European Commission, Horizon 2020).

Therefore, in this paper we report on our research insights aiming to have a better understanding of challenges related to women studying STEM fields. The research efforts reported in this paper have been conducted in Kosovo during December 2021. The approach used in this research was based on the future workshop method conducted with18 high school female students from two high schools in Prishtina and 9 university female students in Kosovo. Understanding STEM experiences of students during high school is important because this

period represents a critical juncture when decisions to pursue STEM are made and early interventions have been shown to be particularly effective (Kim, Sinatra, & Senyarian, 2018). The main goals of these workshops were to discover what factors have influenced the choice of these students to study STEM; understand if there are any challenges they face as STEM students; as well as their prospect for employment after graduation. The rich data collected during the workshops have been complemented with qualitative inputs from relevant stakeholders, consisting of representatives from government, educational, and civil society institutions through a panel discussion setup.

Preliminary data from the workshops as well as from panel discussions revealed numerous obstacles that young women in Kosovo face while pursuing STEM education. These obstacles could be clustered in in three main themes, namely: institutional (e.g., lack of information flow, institutional support and awareness); social (e.g., lack of support from parents and teachers to study STEM); and design (e.g., lack of gender sensitive design of premises).

Masoud Ghezelbash
Professor, University of Saskatchewan, Canada

Black Holes and Conformal Field Theories

Black holes are the most intriguing objects in the universe. The recent reports on the black hole interaction with the external magnetic field [1] have motivated further studies on the topic [2]. In the last decade, the correspondence between the rotating black holes and the conformal field theory (CFT), was explored extensively. Initially, the correspondence was used to relate the physical quantities, associated to an extremal Kerr black hole, to that of a CFT [3]. The microscopic Bekenstein-Hawking entropy, as well as the near-super radiant modes of the extremal Kerr black holes were only a few examples of black hole quantities, which could be related to a conformal symmetry. The conformal symmetry is generated by the diffeomorphisms of the near-horizon geometry of the Kerr black holes. Later, the correspondence was explored in vast varieties of the extremal rotating black holes, in four and higher dimensions [4], where in general, the near-horizon geometry includes a copy of the Anti-de-Sitter (AdS) space. The enhancement of isometries of the AdS, provides the underlying Virasoro algebra for a conformal structure.

For the non-extremal rotating black holes, there is no known AdS structure in the near- horizon geometry of the black holes. For the non-extremal rotating black holes, we may look at the symmetries of the solution space of a probe field, in the background of rotating non-extremal black holes. These symmetries can be used, to find out about the possible dual CFT to the black holes. The conformal invariance of the former theory is known as the hidden conformal symmetry. The hidden CFT was explored for different types of the non-extremal rotating black holes in four and higher dimensions.

Moreover, it was found that for certain four-dimensional rotating charged black holes, there is a possibility to find more than one dual CFT. The four-dimensional Kerr-Newman is a case, where there are two dual CFTs to the black hole. The first CFT is dual to the rotational degree of freedom of the black hole, and the second CFT is dual to the electric charge of the black hole. These two different dual CFTs to the black hole, are called J and Q pictures, respectively [5].

In this talk, we introduce the physics of black holes and then explain the recent interesting developments in the correspondence between the rotating black holes and the CFT.

Riadh Habash
Professor, University of Ottawa, Canada

Experiential Engineering Learning Model through Community of Design and Practice

Education in professional degree programs is charged with serious responsibilities in the classroom and practice spaces. To meet these responsibilities, educators must serve as both teachers and learners in both spaces. This research work demonstrates an experiential project-based learning model to enhance the teaching of an undergraduate engineering course on mechatronics. This model reflects on challenges of knowledge creation in group-based design projects and team competition experiences where learners including faculty and students collaborate to create their community of design and practice to physically and virtually share their knowledge, perspectives, and opinions. The model demonstrates the impact of collaboration, knowledge of ethics and judgment, and exhibition in the enhancement of engineering education by incorporating practice as part of the curricula.

This work is framed in the form of three research questions. First, what is the gain of integrating the practical experience into a course mostly organized around the modality of classroom learning? Second, what is the role of group-based student projects, competition teams, a community of learning and practice (CODAP), and physical and virtual exhibitions in experiential learning? The third research question is what "collaboration", "exhibition", and "judgment" mean to learning-by-doing (LBD).

Engineering as the art of shaping and navigating the design provides an answer that is based upon promoting the "invisible" learning that aligns with knowledge creation. To realize the above three questions, an enhanced experiential LBD-based model that feeds and enrich several competition teams, is proposed, implemented, and evaluated. This active learning is supported by an open educational resource (g9toengineering.com) developed by the author to enable virtual exhibition and knowledge transfer.

It is often hard when implementing the proposed experiential model to distinguish who has learned more from its implementation, the teacher, or the students. The author believes that the course is enriched by the ability to engage the classroom in various competition teams and consequently creating a CODAP via experience and the process of learning from it.

Suzanne Hiller
Assistant Professor, Hood College, USA

Citizen Science as a Vehicle for STEM Career Motivation: Research, Assessment, and Implications

Citizen science is an activity in which volunteers assist professional scientists in data collection as a form of *contributory* citizen science or in designing, interpreting, and disseminating information in *collaborative* or *co-created* citizen science programs. Citizen science activities can range from outdoor studies where students collect data on organisms such as butterflies (Jeanpierre et al., 2005), analyze urban decay through Mindcraft platforms with the support of architects (Magnussen & Elming, 2015) or evaluate stream quality with scientists in labs (Weigelhofer et al., 2019).

Regardless of the citizen science context, researchers and educators have recognized the potential for advancing learners' STEM identity formation and science achievement. Notably, in 2000, Bombaugh proposed that citizen science programs could reshape student identity in engineering fields, particularly for students who are traditionally underrepresented in STEM fields. The authentic nature of these types of activities provides a lens for students to view and participate in the work of professional scientists.

Initially, research studies on the impact of student development in the 2000s focused on content knowledge, environmental stewardship, and environmental literacy. Most recently, citizen science research has examined the impact on hobbyist/scientist collaborations in terms of career identity formation, self-motivational beliefs in the sciences, STEM motivation, and science achievement (Hiller & Kitsantas, 2022). For example, Hiller and Kitsantas (2014) found that students studying horseshoe crabs based on the work of a professional biologist showed significant gains in self-efficacy for scientific observation skills, interest, outcome expectations, identity formation, and content knowledge. These findings were subsequently reflected in a study conducted by Wallace and Bodzin (2017) with secondary students contributing to phenomenological databases. Moreover, there is a burgeoning group of scholars interested in the impact of these types of activities on students who do not typically follow a STEM oriented career path (Shim & Lee, 2019).

The proposed presentation entitled, *Citizen Science as a Vehicle for STEM Career Motivation: Research, Assessment, and Implications*, focuses on three areas related to citizen science research: (a) research trends, (b)

approaches to assessment in outdoor settings, such as citizen science, and (c) practical implications in classrooms and for college programs. The presentation will provide an overview in the ways citizen science research has transcended from covering content and environmental stewardship to encompass self-motivational beliefs, STEM career motivation, and student performance. Secondly, explicit examples of multiple ways to assess student gains in outdoor experiences will be given for researchers interested in measuring the impact of outdoor activities on student motivation and achievement. Finally, practical implications will be provided for ways to integrate citizen science in formal school settings as well as in collegiate courses.

Ildiko Holik
Associate Professor, Óbuda University, Hungary
&
Istvan Daniel Sanda
Associate Professor, Óbuda University, Hungary

The Possibilities of Developing STEM Skills in Higher Education

The development of information and technology in recent decades has entailed a change of attitudes in higher education (Wolhuter, 2020). In addition to academic knowledge, it is becoming increasingly important for students to acquire up-to-date, practical knowledge that will help them find their place in the world of work and in everyday life. Based on international analyses, the following characteristics, so-called soft skills, are essential in the labour market: higher level thinking; communication skills; cooperation; self-control and positive self-image (Daruka, 2017).

In our paper, we examine the possibilities of skills development in the field of STEM (Science + Technology + Engineering + Mathematics), especially in engineering education. "STEM competence refers to an individual's ability to apply STEM knowledge, skills and attitude appropriately in his or her everyday life, workplace or educational context" (Boon, 2019: 11). The aim of teaching STEM areas is not only to develop cognitive skills, but also to develop soft skills such as problem solving, collaboration and communication skills.

Our attention was drawn to the need for skills development by our empirical study of 475 first-year engineering informatics students, in which we examined on one hand, how important students considered a given competence to be for their future profession and on the other hand, to what extent they currently had that competence. In students' opinion, the skill of problem solving is the most needed for their future profession. Respondents (in their opinion) had the most skills in applying the acquired knowledge and in understanding context. The biggest differences between students' current competencies and those needed in the labour market were found in the areas of concentration of attention, problem-solving skills and the ability to learn, so development is especially necessary in these areas.

Although the frontal, knowledge-based form of education is also prevalent in STEM areas, it actually works better in groups with more homogeneous abilities and cannot take into account the individual abilities and skills of learners. It is not interactive, so it is unsuitable for

the development of certain skills. In the field of STEM subjects, a particularly important question arises as to how to motivate students, as math, physics, chemistry and biology usually seem scary to students. However, in order to make STEM subjects attractive, "traditional" frontal teaching is no longer an appropriate strategy – education requires constant renewal. The development of STEM competencies requires the use of methods by which participants recognize and identify their abilities and characteristics and consciously shape them through experiential learning and interactions (Seetha, 2013).

In our university's engineering teacher training, we strive to develop our students' STEM skills using a variety of methods and prepare them for the teacherly task of being able to effectively develop their own students' skills and motivate them in STEM areas. This requires students to view their own learning process not as passive onlookers but as active participants. In our paper, we present some methods that can be effectively applied in STEM areas (e.g., discussion, collaborative learning, cooperative methods, project method, problem-based learning, research-based learning, gamification, use of robots in education).

Mahmoud Huleihil
Head, Bet Berl College Kfar Saba, Israel

General Solution of Two-Dimensional Projectile Motion with Air Resistance

In this study, two-dimensional projectile motion is considered under the effect of a general power law model of air resistance. Classically, a projectile is treated as a point mass with mass m moving in a uniform gravitational field. The projectile is launched from the ground with an angle a to horizon. The drag force is proportional to the speed raised to the power n. The analysis of the problem is performed using Cartesian coordinates.

A general exact parametrical solution (with respect to the angle of motion) is derived for any power n, following simple steps: 1) find the speed in the direction of the axis x (horizontal – no gravity); 2) find the vertical component of the speed; 3) find the time; 4) find the horizontal position of the projectile; and finally find the vertical position of the projectile. Steps 1) and 2) give explicit closed form equations and the rest are given by exact integrals which can be solved numerically. In this study spreadsheet calculation are performed using trapezoidal rule of integration. The cases of motion in vacuum and linear drag law are used to check the accuracy of the numerical calculations.

The importance of the proposed study is three fold: a) The method of the derived solution is new, and couldn't be found elsewhere; b) The derived equations make it possible to use spreadsheets for presenting the subject (no programming capabilities is required), and thus, serve as a tool to enhance teaching; c) The derived equations are general for any power n, thus, the same procedure could be used to find the position of the projectile at any time.

Adrian Ionescu
Professor, Wagner College, USA

Computer Software Used to Introduce Some New Numerical Methods

This work uses previous papers, in which we have discussed and analyzed the new Goeken-Johnson methods used to solve autonomous ordinary differential equation initial-value problems

$$y_0 = f(y);\ y \in R^n;$$
$$y(x_0) = y_0;\ x_0 \in R;\ y0 \in R^n;$$

which implements these new Runge-Kutta method. The novel feature of this approach is the replacement of evaluations of f by approximations or evaluations of $f_{\underline{y}}$.

In this paper, we show how we have integrated the new methods in teaching Numerical Analysis at our College. We compare the classical Runge-Kutta methods of orders 3, 4 and 5, and the corresponding new Goeken-Johnson methods using both $f_{\underline{y}}$ and approximations of $f_{\underline{y}}$. Students are asked to compare the software and the algorithms in terms of both accuracy and time complexity. Part of the student cohort is familiar with the Analysis of Algorithms, which is taught in a separate course.

Yelena Istileulova
DAAD Bologna Expert, Evaluator of the EU Commission, Independent Consultant, DAAD Hub Peer Support Project (Bonn-Brussels), Slovenia

The Age of Enlightenment in the New Method of STEAM Approach: Apple-Tree of Johann Sievers (Germany)

The symposium was an instrumental part of ancient Greek culture from the 7th century BCE, where guests demonstrated poetic and intellectual skills, discussed different topics of philosophy, politics with the performance of singing and recitation of poetry. The goal of this article is to demonstrate a novel method within STEAM approach that is comparable to Greek symposiums' tradition. The methodology is based on the experimental design of author's Poetry, Music and Visual Arts incorporating the elements of aesthetics, creativity, and a research discourse about scientists' discoveries in the Age of Enlightenment (17th-18th century). The method entitled as SMS (Stories based on Music about Scientists) was introduced in 2013, and songs based on SMS have received 10 international awards on the International Music Festivals (romances, children, songs) of the Russian Center of Science and Culture in Ljubljana.

The theoretical background of STEAM SMS is based on research delivered in the form of song where contextual understanding is reached through the means of poetry, selected pictures (reflecting the idea of a scientist's discovery) and imagination. The author demonstrates her SMS method on the example of Johann Sievers, a German botanist of the 18th century, who was invited by the Saint Petersburg Academy of Sciences to implement research on plants. He discovered the apple tree (Malus sieversii) in the mountains of Kazakhstan which was proved as the progenitor of all apple trees on the Earth in the 20th century. The research is based on original, recently published sources, including Sievers' letters from Siberia (published in 2018). The song "Apples of Sievers" was awarded the 1st prize of the 2020 International Online Music Festival. The poem is provided with its translation in English, performed on piano with the illustrated pictures reflecting the context of song. The novel SMS method can be generally conceptualized as a transdisciplinary discourse and innovative teaching and learning approach for all groups of learners, including inclusive ones.

The unique examples (including SMS method) from the Age of Enlightenment, the intellectual and philosophical movement in Europe in the 17th and 18th centuries can be ideally used for the future of

STEAM's Symposiums. First, philosophers and scientists of the Enlightenment circulated their ideas through meetings at scientific academies (similar to Greek symposiums), with emphasis on learning, art and music. Second, the influence of science began appearing in poetry and literature, and poetry became infused with scientific metaphor, or poems were written directly about scientific topics. Third, the age of Enlightenment boosted a lot of innovations with a new conception of instruments - musical, artistic, or scientific—as vehicles of discovery.

Damira Jantassova
Head/Foreign Language Department, Saginov Karaganda Technical University, Kazakhstan
&
Daniyel Damiyev
Junior Researcher, Saginov Karaganda Technical University, Kazakhstan

Framework of Capacity Building for Internationalization of Engineering University on the Base of Digital Platform: Mechanisms of Interaction via Heat Intensity Map

Nowadays, the topic of HEIs' international activity remains one of the most important topics for professional community, and obligatory universities' participation in international ranking has added new standards to be discussed. It is obvious that the industrial production globalization and business internationalization lead to the demand for specialists with relevant knowledge and skills which help them quickly and with least costs adapt to any new conditions and national peculiarities. And, since in recent years, the international experience among graduates is becoming an increasingly important factor in their successful positioning in the labor market; a university's ability to provide great opportunities for internships or partial studying abroad is considered by an applicant as the HEI's significant advantage. In turn, it enhances the universities motivation to develop competitiveness due to presence of international relations. In other words, the internationalization criterion becomes very essential factor in integration of methods and technologies for teaching educational programs majoring in engineering in general.

The paper presents the project research that has its purpose to develop and implement a framework of capacity building for internationalization of technical university by means of digital learning technologies to implement sustainable and feasible strategies for internationalizing the educational process of training specialists in technical fields, taking into account the national and international context.

The framework of capacity building for internationalization of engineering university has been designed in the process of realization of the project "Capacity building for the internationalization of a technical university by means of digital learning technologies" funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan. The purpose of the Framework is to

develop the potential of integration in learning process, research and service functions of a technical university in an intercultural aspect. The developed vision of the Framework of the capacity building for internationalization is to effectively promote the sustainable development of engineering education and science, recognizable at the international level, with a focus on cross-cultural involvement with a its graphical representation.

The project studied the process of university internationalization, curriculum and learning outcomes affecting the indicators of academic mobility, educational technologies and integration of foreign students, implementation of joint degree programs, possibility to improve the level of English and use of digital technologies which activate the international activity at the university.

So, at the conference there will be presented the findings of the three phases research including framework, mechanisms of framework's components interaction, developed digital platform and heat intensity map that presents developed correlation matrix where the principles of the model, proposed approaches and identified recommendations are correlated.

Shio Kawagoe
Associate Professor, University of Tokyo, Japan

Workshop Design for Online STEAM Education in Collaboration with Industry

The practice of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education is being promoted internationally in response to the rapidly changing society. When students study STEAM subjects, it is essential to understand not only each subject but also the social roles and significance of science and technology, and it helps them understand the subjects. In Japan, the Sixth Science, Technology, and Innovation Basic Plan calls for promoting STEAM education for elementary and secondary education, and online learning has also been spreading rapidly.

The Office for the Next Generation (ONG), Institute of Industrial Science, the University of Tokyo, has organized various STEAM educational programs such as workshops and visiting lectures and developed teaching materials based on engineering research in collaboration with industries. The products of the industries can be good examples to deepen their understanding of the social aspects of science and technology.

This study aims to implement an online workshop that enables students to learn the relationship between science and technology and the real world to promote STEAM education. We designed online workshops and teaching materials in cooperation with the industry. We deal with the A in STEAM as both of "art" and "liberal arts, i.e., social sciences and humanities." Therefore, the workshop contents are based on school-level STEM subjects as well as the economy, politics, and modern society. Junior high and high school students who are participants solved the problem and thought their own opinion using the teaching material before the workshop. In the workshops, participants took lectures and discussed online.

We asked about 100 students to fill out questionnaires before and after the workshops to evaluate the workshops. The questionnaire survey results indicate that the workshops are efficient to make the students understand "school-level STEM subjects" as well as "the social roles and the significance of science and technology." Therefore, it was suggested that the workshops effectively increased interest in STEM and the social aspects of science and technology.

In Japan, school subjects are classified in detail. Therefore, this practice to foster the next generation capable of solving social problems

and creating social value while crossing various subjects would be considered "Japanese-style STEAM education."

Thomas Kieffer
Chief Engineer, Vishay Measurements Group, USA

Bolt Preload Temperature Cycling

Uniform application of clamping force to bolted assemblies is typically performed by incremental and sequential application of torque to individual bolts using a torque wrench until the maximum specified torque is obtained. However, the relationship between applied torque and the axial load developed in the bolts is complicated by such factors as the friction between mating surfaces and the stiffness of the structural components. A further complication to understanding bolt preload arises when the bolted assembly is subjected to temperature cycles in service, particularly if the structure consists of dissimilar materials. In this study, three circular plates 12 mm thick x 150 mm diameter made of steel (2 each) and aluminum (1 each) were fastened together with 8 mm diameter hex head bolts made of steel. The bolted assembly was subjected to temperature cycles between room temperature and 160°C. Bolt preload was monitored with strain gages installed inside 2 mm diameter holes drilled into the bolts. Bolt preload increased by approximately 15 percent at maximum temperature due to the higher thermal expansion of the aluminum plate. Strain gage installation techniques are described including adhesive selection and fixture design to achieve thin glue line.

Tonći Kokić
Associate Professor, University of Split, Croatia

The Destiny of Scientific Theories: Oparin Coacervate Theory Case

The scientific theories are subject to change: this means that (1) sometimes a theory does not represent the best current knowledge about a specific phenomenon anymore and has to be abandoned, (2) sometimes a theory loses parts of its scope and relevance, or (3) its elements need improvements according to new scientific insight and can be repaired. The example of the first is superseded Stahl's phlogiston theory, the second is classical causal classic physics, powerless in regard to the explanation of quantum phenomena limited to submicroscopic phenomena and probabilistic predictions, and the numerous models of atoms could be seen as an example of the third kind of the destiny scientific theory. A rejected theory is at fault because its propositions do not correspond to facts and/or is not very well supported by other scientific theories or when there is no successful prediction. In the two other cases, theories continue their existence. The Oparin hypothesis is located on the first of these possibilities: some of its premises are not known or definite (prebiotic soup, the long period of times needed for the emergence of life), some of them are even rejected (the coacervate) and recreation of life based on this hypothesis faulted. The Oparin hypothesis is restricted to the very narrow area of the possible prebiotic synthesis of the macromolecules we find in living systems and it did not decrease the most important gap between the most complicated organic substances and the most primitive living organisms.

Samuel Kosolapov
Senior Lecturer, ORT Braude Academic College of Engineering, Israel

Time Effective Logistics of Hybrid Image Processing Course and Laboratory

In "pre-COVID-19" time students of the ORT Braude Academic College of Engineering enrolled to the course "Image Processing", visited frontal lectures and, additionally, participated in the laboratories provided in the class equipped with computers. During the laboratories, students (organized by small groups – preferably pairs) were asked to implement a number of image-processing algorithms that were explained during frontal lectures. In the frames of this course C, C++, and C# languages are used to write code. Specifically, computers with Windows 10 and Visual Studio installed, are used to write the code. Additionally, students are asked to prepare a PowerPoint presentation, in which results obtained were analyzed. During the in campus laboratory students were free to ask for help and, in case of need, the educator provided relevant explanations. When the report was ready, students demonstrated the presentation and the working code to the educator. The grading policy was that if the presentation is good enough, and students reasonably answered the questions, they got a high grade and, as a backup, E-Mailed a presentation and the code by using a special format developed specifically for that course. Because of COVID-19 limitations, during 3 semesters logistics of the lectures and laboratories were changed, and, as lectures, as laboratories were provided online by using cloud services like ZOOM and Gmail. It so happens, that semester 2021-10 – 2022-03 was started as an online semester, but after 3 weeks it became a hydride semester: lectures and laboratories were provided in the campus, but students have had the right to stay at home and continue to use cloud services including ZOOM and Emails. This change created a number of logistics problems, and, thus, some modifications were provided in an attempt to ensure fair and non-biased grading as for the students who were physically present during the lectures and laboratories, as for the students participated remotely. In the frames of this course, each group of students prepared a set of assignments reports and two micro-projects presentations. Additionally, students physically present in the class participated in the short nonobligatory micro-exams. This paper discusses logistics decisions and their effect on the quality of the student' micro exams, assignments reports, and presentations.

Nydia Lara Zavala
Professor, National University of Mexico, Mexico

Thales of Miletus: Thinking About Nature as an Engineer

The aim of my talk is to show that the cradle of scientific-philosophical thought responds to the strategy of Thales of Miletus to know how to use the techniques and reasoning typically employed in technological creations, to theorize about the dynamics, processes and developments of natural events in terms of physical arrangements and components. This approach, combined with a commercial background, such as Thales inherited both from his Phoenician parents and from his life in Miletus, were part of the circumstances that strongly contributed to shape the intellectual turn that culminated in natural philosophy, antecedent of both science and philosophy.

The interest of this work is to rescue a very important part of the tradition and formation that propitiates the original thought of Thales of Miletus that practically nobody knows or recognizes. Among them we have: his engineering training, his commercial skills, his skillful handling of mathematics and something that generally goes unnoticed by many scholars of the pre-Socratics: his deep knowledge of astrology, learned from the Mesopotamian and Egyptian cultures.

Mingzhong Li
Professor, De Montfort University, UK

Multi-component Crystal Forms of Nutraceuticals for Bioavailability Improvement

Mark Lin
Principal, Lin Design Engineering, USA
Patrick Lewis
Aerospace Engineer, Maxar, USA
&
Periklis Papadopoulos
Professor, San Jose State University, USA

Utilising Magnus Effect to Increase Downforce in Motorsport

The Magnus Effect, according to Britannica Encyclopedia, is the generation of a sidewise force on a spinning cylindrical or spherical solid immersed in a fluid (liquid or gas) when there is relative motion between the spinning body and the fluid. This is most commonly seen in baseball, tennis, or European football where the ball's trajectory is curved due to its rotation.

The idea of using the Magnus Effect in an airfoil to produce lift was proposed in 1941 in a US Patent by Massey. This is also known as Kutta–Joukowski lift, first analyzed by Kutta and Joulowski in the late 19th century. In maritime applications, it is known as a Flettner rotor sails, first used in the 1920's.

Some good demonstrations of the magnus effects are found on the internet:

- Veritasium's Backspin Basketball Flies Off Dam (https://www.youtube.com/watch?v=2OSrvzNW9FE);
- Building an Advanced Magnus Effect Plane (https://www.youtube.com/watch?v=UG2O_GK7-R8);
- RC KFC bucket aeroplane (magnus effect) (https://www.youtube.com/watch?v=K6geOms33Dk);
- Rotor Sail Explained (https://www.youtube.com/watch?v=FJt8l80kGTg).

Although Magnus Effect is not new, the idea of using it on race car wings to improve downforce has not been extensively studied. The concept is to replace the front leading-edge of the wing with a rotating cylinder of the same diameter to produce additional circulation around the foil. This idea was born out of discussion at San Jose State University's Formula SAE team as a way to create variable downforce on their wings. Although the idea was proposed but it was never built

because of the complexity in the construction, plus the tight deadline of FSAE competition, and a lack of rigorous analytical results.

The central idea of this paper is that while it's time-consuming to build up a Magnus Effect wing, it is actually very simple to simulate it in CFD; and I do mean it is surprisingly simple! All that needs to be done is to replace a stationary-wall boundary condition, with a moving-wall boundary condition, with the rotational speed prescribed to the leading edge cylinder. One could even use the same mesh from the static-wing analysis, and simply select the surface cell zone that defines the LE cap. Then one could evaluate the Magnus effect to see if it's worthwhile to proceed with building a physical prototype.

From our CFD simulation, it shows that by imposing a +2U angular velocity to the front LE cap (i.e., rotating upwards in the +y direction), we would gain 4.25% of downforce. This may not seem significant to a Formula SAE car, but to Formula 1 this is significant because their wing design is already highly optimized, and they want to squeeze out every percentage of improvement. Since the leading edge cap is roughly cylindrical, physically replacing it by a cylinder would not be a visible change to the race car's geometry while improving the aerodynamics using Magnus Effect. This CFD data shows promise to take the next step of building a physical prototype and perform experimental aerodynamics to validate this finding.

Sergiusz Luczak
Associate Professor, Warsaw University of Technology, Poland
&
Maciej Zams
PhD Student, Warsaw University of Technology, Poland

MEMS Accelerometer as a Sensor of Geometric Quantities

Typical applications of MEMS accelerometers are measurements of linear acceleration and vibration. Mathematical processing (integration or differentiation) of the output accelerometer signals makes it possible to sense other physical quantities: linear displacement, velocity, jerk, jounce and higher-order derivatives of position vector. Single- or dual-axis tilt measurements under static or quasi-static conditions are also well-known. Appropriate positioning of an accelerometer makes it possible to sense angular velocity. Linear displacement may be also determined using the pedometer principle. Nevertheless, the paper describes and illustrates other sensing methods and instruments using MEMS accelerometers, which make it possible to measure some geometric quantities like: parallelism of datum axes (and thus axial run-out), angular displacement, tilt under specific dynamic conditions. Even though processing of the measurement signals is not as simple as in the typical applications, it seems that due to unique attributes of MEMS sensors, the proposed measurement methods are interesting and promising. The considerations are referred to latest patents pending and publications. Advantages and shortcomings of these untypical applications of MEMS accelerometers are discussed.

Angelina Lumbre
Teacher, San Mateo Senior High School, Philippines
Ma. Nympha Joaquin
Professor, University of the Philippines, Philippines
&
Diliman Sheryl Lyn Monterola
Professor, University of the Philippines, Philippines

Relationships among Mathematics Teachers' van Hiele Levels, Teaching Styles and Students' Achievement in Geometry

This study investigated the relationship among teachers' van Hiele levels, teachers' teaching styles, and students' achievement in geometry. Using non-experimental quantitative correlational design, the van Hiele levels and teaching styles of 30 grade 9 mathematics teachers were correlated with their students' achievement in geometry.

The results of the Chi-Square Test showed that there is not enough evidence to identify a significant association between the teachers' van Hiele level and teaching style based on clusters. The ANOVA results revealed a significant difference between teachers' van Hiele levels and students' achievement. Post hoc comparisons showed that the difference is between the achievement of students whose teachers are operating at level 5 in the van Hiele level than those students whose teachers are operating at level 2. For this result, a substantial effect size was computed at 0.6429 or 64.29%. Goodman and Kruskal's gamma test showed a weak positive correlation between teachers' van Hiele level and students' achievement which was statistically significant. However, the association between teachers' teaching styles and students' achievement showed no significant difference when the teaching styles by clusters made by Grasha was used. However, in another analysis based on highest mean score of teaching style of teachers and students' achievement, the results indicated significant effect. The estimated omega squared ($\omega^2 = 0.39$) indicated that approximately 39% of the total variance in students' achievement is attributable to difference between the teaching styles based on highest mean scores. Post hoc comparisons using Games-Howell test indicated that students whose teachers have high mean score on Expert style have a significantly higher achievement than students whose teachers have high mean score on Formal Authority style. Those students whose teachers have high mean score on combination of teaching style have significantly higher achievement than those students whose teachers have high mean score

on Formal Authority style. However, Goodman and Kruskal's gamma test showed no correlation between teaching style and students' achievement.

This study highlights that it is important to capitalize on teachers' van Hiele level of geometric thinking as it has a greater influence on student achievement compared to teaching style. Developing teachers' geometric thinking ability at the expected levels in order to improve students' achievement may require trainings, further studies, or curriculum improvement for pre-service teachers. Moreover, investigation on content areas other than geometry while determining which grade level has student achievement started to decline is recommended.

Celeste Joy Matias
Researcher, Miriam College, Philippines
&
Ma. Nympha B. Joaquin
Researcher, University of the Philippines, Philippines

Being Female and At-risk in Mathematics: A Phenomenological Study

The poor performance of learners in mathematics has been widely investigated across cultures. While many students find the subject difficult and demanding to a certain degree, the at-risk learners experienced how it was to struggle and fail in that course in grades nine and ten. Their year-end failing grades highlight their lack of proficiency in mathematics. However, it does not paint a full picture of how they faced the challenges in learning the subject, as rich descriptions cannot be deduced from quantitative values and studies. This study aimed to provide a description of the lived experiences of eight female at-risk high school learners, particularly on how they coped with the difficulties in learning mathematics. The descriptive phenomenological method was used to explore the "whatness" of an at-risk learner from the lens of those who experienced the phenomenon of being female at-risk high school learners in mathematics. Being at-risk learners whose encounters with success in mathematics was minimal, they made use of different coping strategies. Two themes emerged from the narratives: maladaptive coping strategies and adaptive coping strategies. On one hand, the maladaptive coping strategies, withdrawal of efforts and blame, allowed the learners to protect themselves from the source of their pain. On the other hand, the adaptive coping strategies focused on how the at-risk learners addressed the source of their pain. The meaning units under adaptive coping strategies highlight how the leaners attempted to bridge the gaps in their mathematical skills and knowledge.

Péter Odry
Professor, University of Dunaújváros, Hungary

Robust Impedance Spectroscopy

Electrical impedance spectroscopy (EIS) is a popular non-destructive material test procedure. In EIS process with AC current had been excited in a test environment, and the excitation response is measured at one or more points on the surface of the examined environment. The recorded characteristics can be represented on Bode or on Nyquist diagrams. Spectrum presents the frequency dependence of the complex electrical resistance of the tested substance at different excitation frequencies. For EIS, in the frequency range depending on electrochemical or biological processes, the frequency response can be analytically determined by the equivalent circuit elements. These elements include standard resistance and capacitors, but these are often unsuitable for biological measurement developments (e.g., diffusion, ion migration, etc.). Therefore, other special "circuits" have also been developed for the use of this method. There is still a need to overcome several technological barriers to the appearance of reliable future applications. Now, the sensitivity, accuracy, and reproducibility of methods are a major shortcoming in applications.

Our research group had been developed measuring instruments for measuring spectroscopy, for four and eight-channel high precision spectroscopy. Our instruments measure impedance spectrum in 1mHz and 2MHz frequency range. Our multi-channel electrical impedance meter is based on digital lock-in technology. We have a self-developed algorithm for solving inverse problems on impedance networks. We make physical validation of a residual impedance rejection method during ultra-low frequency bio-impedance spectral measurements [1].

In several medical biology researches, we use EIS technologies. Some interesting research topics would be listed in domain of bioimpedance-based measuring device for

- the primary tumor detection,
- the study of hypoxic and hyperoxic conditions in cell cultures,
- the diagnosis of Non-Alcoholic Fatty Liver Disease NAFLD,
- the development of graphene coated measuring plate for the investigation of "dark" neurons,
- preparation and validation of self-developed bioimpedance electrode array for tumor cells measurement.

The results of impedance spectroscopic measurements usually contain quite a lot of uncertainty. The source of uncertainty may result from different sources, such as noise, nonlinearity, crosstalk, etc. These effects may have been greatly deformed by the results when solving the inverse problem. This can be very critical, for example, during medical applications or accompanied by critical chemical processes.

Robustness is a fundamental issue for assessing research results and engineering applications.

We have research/development experience to measure the robustness of complex systems [2].

We used multi-objective and multi-scenario based optimization research during our research of hexapod walking robot. In the case of hexapod robot research, many degrees of freedom should also be solved. Similar problems occur in the evaluation of impedance spectroscopy measurement results too. Analysis of research results so, of measurement results, so far justify our expectations.

Mateja Ploj Virtič
Associate Professor, University of Maribor, Slovenia
Janja Majer Kovačič
Assistant Professor, University of Maribor, Slovenia
&
Eva Klemenčič
Assistant Professor, University of Maribor, Slovenia

The Role of Teacher Education in the Science Literacy Development

In addition to imparting knowledge, one of the aims of education is to produce wise and responsible citizens who are aware of their impact on the environment and who are able to address and solve problems of daily life. From this point of view, science education leading to science literacy is helpful for all students, regardless of their future careers. Recently, rapid economic development and persistent environmental problems have increased interest in developing basic science skills. In this paper, we first review the definitions of science literacy in the literature and present the strategies for its development in Slovenia and other countries. In Slovenia, we refer to the ongoing national project NA-MA POTI (Science and Math Literacy: encouraging critical thinking and problem solving). Most of the strategies studied focus on primary and secondary school students. However, for the development of science literacy in primary and secondary education, it is crucial that teachers themselves achieve a sufficient level of science literacy. The latter is one of the prerequisites for supporting primary and secondary students in developing science literacy. Therefore, prospective teachers play a key role in the long-term development of science literacy. A pilot study was conducted with a small group of prospective teachers, focusing on three components of science literacy: asking research questions, making hypotheses and designing an experiment. To better understand the results of the pilot study, the curricula of the science didactics courses in the teacher education program were analyzed. The findings show that there is a great need for a systematic change in the curricula. Finally, proposals and ideas for improving the curricula for the didactics of science are presented in order to enable the achievement of a higher level of science literacy of future teachers.

Alejandro Ramírez-Rojas
Researcher, Autonomous Metropolitan University - Azcapotzalco, Mexico
&
Elsa Leticia Flores Marquez
Researcher, Autonomous Metropolitan University - Azcapotzalco, Mexico

Correlations of the Seismic Sequences Before and After the 2017 Tehuantepec Earthquake M8.2, Mexico by using the Visibility Graph Method

Frequently, the processes occur in the real world are non-linear and their characterization from different points of view is the key to their understanding and the possibility of their modeling. In recent years, the ideas linked to the field of nonlinear time series analysis and those of complex network theory has been related. Among those ideas, the known the visibility graph (VG) method has been applied to the study different complex phenomena. One of the characteristics of this method is its ability to capture dynamic properties, such as non-trivial correlations in nonstationary time series, without introducing elaborate algorithms such as detrending. Seismic processes have been of great interest and their complete understanding is still an open problem. In this work we use the VG method to study the temporal correlations in the seismic sequences monitored before and after the great M8.2 earthquake that occurred on September 17, 2017, which was classified as an unusual event since it took place on the intraplate into the subduction zone of the Gulf of Tehuantepec, Mexico. Our results show important changes in the estimated connectivity before and after the event, which suggest changes in the temporal correlations in the local seismicity.

Yazdan Pedram Razi
Adjunct Professor, San Jose State, USA
&
Kittinan Maliwan
Lecturer, Prince Songkla University, Thailand

The Linear Stability Analysis of Convective Flows under the Effect of Vibrations in a Hele-Shaw Geometry

This paper addresses the influence of mechanical vibrations on the stability of fluid. The geometry under consideration is a vertical Hele-Shaw cavity filled with a fluid. The direction of mechanical vibration is taken parallel to the temperature gradient. We show that the linear stability analysis of the governing equations leads us to a Mathieu equation. This equation is a linear differential equation with periodic coefficients. Under the limiting conditions of high frequency and small amplitude of vibrations we use the time averaged formulation. According to this method, the time dependent coefficients will be replaced by their effective equivalents. Further based on a scale analysis method, the assumptions needed to adopt the time average methods are obtained. In the follow up of the paper, we show the onset of convection according to time averaged method leads us to a coupled algebraic system of equations. The solution of this system provides us with the critical wave and Rayleigh numbers. Several physical situations are discussed and the similarity of these solutions in the context of porous media is discussed. The relevance of this study in Space oriented application is also discussed.

Genica Liliana Saftoiu Golea
PhD Student, University of Bucharest, Romania
Razvan Pirloaga
PhD Student, University of Bucharest, Romania
Sabina Stefan
Emeritus Professor, University of Bucharest, Romania
Gabriela Iorga
Lecturer, University of Bucharest, Romania
&
Bogdan Antonescu
Researcher, National Institute for Research and Development in Optoelectronics, INOE 2000, Romania

Vertical Assessment of Characteristics of Medium Thick Clouds over Bucharest-Magurele, Romania

Clouds represent one of the key components of the Earth's radiative balance due to their interaction with radiation by absorption and reflection. Depending of cloud altitude, the structure and composition (water droplets or ice crystals), clouds will interact differently with the radiation. The aim of the study is to understand the cloud occurrence and characteristics of medium thick clouds (stratocumulus, altostratus and cirrostratus) using satellite data collected from Dec 2019 to Feb 2021. These clouds represent a high percentage (32.82%) of the total number of clouds detected. We used a statistical cloud classification model based on data on cloud optical depth and cloud pressure top. A series of macrophysical and microphysical stratocumulus, altostratus and cirrostratus clouds parameters (cloud cover fraction, cloud top temperature, cloud top pressure, cloud height, cloud optical depth, liquid water path, cloud water radius, ice water path and cloud ice radius) were extracted from the Clouds and the Earth's Radiant Energy System (CERES) database for Măgurele, a region in south-west Bucharest, Romania. We analyzed the seasonal distribution of these types of clouds (stratocumulus, altostratus and cirrostratus). The cloud vertical classification and their composition (water droplets for stratocumulus clouds, a mixture of water droplets and ice crystals for altostratus clouds or just ice crystals for cirrostratus clouds) is highlighted, according to the theory. The cloud climatology was further developed using data provided by 94 GHz cloud radar installed at Măgurele-Bucharest, Romania with the aim of better characterizing the cloud microphysics.

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Haiduke Sarafian
Professor of Physics and Endowed Chair of John T. and Paige S. Smith Professor of Science, Pennsylvania State University, USA

Negative Resistance and its Impact on a RC-DC Driven Electric Circuit

It is a common misconception that electric "resistance" always is a positive defined electric element. i.e., the plot of the voltage across the resistor, V vs. its current, i is a slanted straight line with a positive slope. Esaki diode also known as tunnel diode is an exception to this character. For a certain voltage range, the current recedes resulting in a line with a negative slope; it is interpreted as negative resistance. In this research flavored report, we investigate the impact of the negative resistance in a typical classic electric circuit. E.g., a tunnel diode, D is inserted in a classic electric circuit that is composed of an ohmic resistor, R and a capacitor, C which are all in series with a DC power supply. The circuit equation for the RCD circuit is a nonlinear ordinary differential equation (NLODE). In line with the ever-growing popular Computer Algebra System (CAS), this is solved numerically utilizing two distinctly different CASs. The consistency of the solutions confidently leads to the understanding of the impact of the negative resistance. The circuit characteristics are compared to the classic analogous RC circuit. The report embodies an atlas of characteristics of the circuits making the analysis visually comprehensible.

Deon Vos
Senior Lecturer, North West University, South Africa
&
Niconette Maree
Student, North West University, South Africa

The Influence and Value of Technology in the Education Systems of South Africa and Russia

The aim of this study was to identify the influence of technology on the education systems (Basic education and Higher education) of South Africa and Russia. In researching different aspects that have an impact on technology and add to the value thereof, in not only education but the classroom as well, it was determined that these two education systems experienced some of the same challenges but also were influenced by different factors. The study has brought to light the importance of technology, and by identifying key skills and factors, it contributes to education. Some of these skills and factors are alternative means of education, creativity, aids in research, higher-order cognitive thinking skills, technological skills and economic growth.

Moreover, the study created an opportunity to highlight differences and similarities in the purpose of technology, the access to and distribution thereof, the implementation thereof in classrooms and the challenges in terms of implementing them successfully. By using a comparative method, the researchers had the opportunity to identify gaps in the research for future studies, methods for the implementation of technology and universal challenges, such as the digital divide.

This study has provided ample evidence of the value that technology adds if successfully implemented and how much value it can bring towards an education system. This is also the reason why an education system of any country should assure the sustainability of the implementation of technology in the system. It is important that the education systems of both South Africa and Russia proceed to directly identify and address gaps in their approaches to implementing technology. It is also important for these countries to release more relevant data and policies regarding this topic, specifically in education. Although the role of the BRICS organisation is identified as the STI (science and technology innovation) initiative, there are no clear indicators in policy documents or references to technology in education. Moreover, looking specifically at the BRICS countries, it is clear that they have made strides in addressing such challenges as stipulated in the literature. To conclude, this research can be used to

further address the challenges and limitations that were identified in the study in order to assess the future impact of technology on an education system.

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