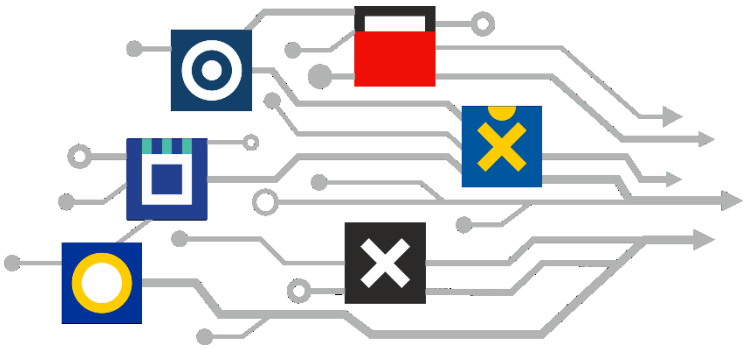
Univerza v Ljubljani
Fakulteta za kemijo in kemijsko tehnologijo

# STEM Continuous Professional Development at European Universities – STEM-CPD@EUni
# Final Conference of an Eramsus+ Project



**Programme**
**Book of Abstracts**
**List of Participants**

2nd June 2023
Ljubljana, Slovenia

# STEM Continuous Professional Development at European Universities – STEM-CPD@EUni. Final Conference of an Eramsus+ Project: Programme, Book of Abstracts, List of Participants

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# Lectures

**L1** **Iwona Maciejowska**

Why STEM CPD at European Universities?

**L2** **Nataša Brouwer**

The Roadmap for Sustainable CPD

**L3** **Matti Niemelä, Nataša Brouwer**

CPD Ambassador User Cases (User Cases Workshop)

**L4** **Črtomir Podlipnik, Krištof Kranjc**

Promoting STEM teaching through microMOOCs: Experiences and challenges with ectnmoocs.eu

**L5** **Oreste Tarallo, Vincenzo Russo**

Lessons Learned from the Summer Schools

**L6** **Craig Shealy, J. Styles, H. Nishitani, K. Acheson, J. Wiley, L. Sternberger**

Cultivating the capacity to cope with complexity: Global evaluation and engagement of STEM students [on-line lecture]

**L7** **Gabriel Pinto, Marisa Prolongo**

Contextualized cases related to real-life to investigate STEM topics for science teacher and engineering students [on-line lecture]

**L8** **Nitza Davidovitch, Dekel Basel, Shraga Shoval**

The effect of post COVID 19 on public higher education institutes - a case study in Israel

**L9** **Alicja Kluczyk**

Thin layer chromatography (TLC) – old method with new tricks

**L10** **Sławomir Domagala**

Application of tutoring methods on the basis of the Ministry of Education and Science of Poland project "Masters of didactics"

**L11** **David A. Schaaf, Christopher W. M. Kay**

Coding and digitalization in physical chemistry to enhance learning outcomes and digital skills

**L12** **Aleksandra Lis**

Evaluation of Continuous Professional Development Activities - Good Practices and Recommendations

**L13** **Sanjiv Prashar**

The Role of ECTN in Sustainable STEM CPD

# List of Posters

**PO1** **Brina Dojer, Matjaž Kristl**

Students' experimental work assessment

**PO2** **Miha Slapničar, Luka Vinko, Luka Ribič, Iztok Devetak**

Pre-service teacher education in the context of the Dissi framework

**PO3** **Louis Plyer, Alexandre Varnek, Céline Perves, Gilles Marcou**

Implementation of soft grading systems for chemistry in a Moodle plugin

**PO4** **K. Klank, J. Aires de Sousa, L. Belvisi, A. Camproux, G. Grabchyk, S. Pieraccini, Č. Podlipnik, S. Senderowitz, O. Taboureau, G. Marcou**

Master Erasmus Mundus "Chemoinformatics+: Artificial Intelligence in Chemistry"

**PO5** **David A. Schaaf, Christopher W. M. Kay**

Coding and digitalization in physical chemistry to enhance learning outcomes and digital skills

**PO6** **Črtomir Podlipnik, Krištof Kranjc, Sebastian Pleško, Sanjiv Prashar, Matti Niemelä, Vincenzo Russo, Oreste Tarallo, Stefania Grecea, Nataša Brouwer, Iwona Maciejowska**

Introduction of ectnmoocs.eu – Visit STEM-CPD@EUni microMOOCs

**PO7** **Oreste Tarallo, Vincenzo Russo**

STEM-CPD Summer Schools

**PO8** **Nataša Brouwer, Stefania Grecea, Krištof Kranjc, Iwona Maciejowska, Matti Niemelä, Črtomir Podlipnik, Sanjiv Prashar, Vincenzo Russo, Oreste Tarallo**

STEM Continuous Professional Development at European Universities

**PO9** **Natalija Sitnikova, Črtomir Podlipnik, Krištof Kranjc**

Facilitating project-based and problem-based learning with the use of Moodle

**PO10** **Janja Majer Kovačič**

Empowering pre-service chemistry teachers for project work

**Friday, 2nd June 2023, venue: Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenia**

entrance is through Building X: 46.05026°N, 14.46860°E

9.00 – 9.30 Registration (basement of Building X)

***all lectures are in the lecture room B (first floor) - also possible on-line attendance (link will be sent to registered participants before the event)***

***09.30 – 10.30 First morning session - chairperson: Krištof Kranjc***

9.30 – 9.40 Opening (short address by Prof. Dr. Andreja Žgajnar Gotvajn, the Dean of Faculty of Chemistry and Chemical Technology, University of Ljubljana)

9.40 – 10.05 Iwona Maciejowska (Jagiellonian University, Kraków, Poland): Why STEM CPD at European Universities? (20 min)

10.05 – 10.30 Nataša Brouwer (University of Amsterdam, The Netherlands): The Roadmap for Sustainable CPD (20 min)

**10.30 – 11.00** ***COFFEE BREAK & POSTER SESSION*** *(first floor)*

***11.00 – 12.30 Second morning session - chairperson: Nataša Brouwer***

11.00 – 12.00 Matti Niemelä (University of Oulu, Finland), Nataša Brouwer (University of Amsterdam, The Netherlands): CPD Ambassador User Cases (User Cases Workshop)

12.00 – 12.25 Črtomir Podlipnik, Krištof Kranjc (University of Ljubljana, Slovenia): Promoting STEM teaching through microMOOCs: Experiences and challenges with ectnmoocs.eu (20 min)

**12.30 – 14.00** ***LUNCH BREAK*** (FRI/FKKT Canteen, on your own budget) ***& POSTER SESSION*** *(first floor)*

***14.00 – 16.00 First afternoon session - chairperson: Sanjiv Prashar***

14.00 – 14.25 Oreste Tarallo, Vincenzo Russo (Università degli Studi di Napoli Federico II, Naples, Italy): Lessons Learned from the Summer School (20 min)

14.30 – 14.40 Craig Shealy, J. Style, H. Nishitani, K. Acheson, J. Wiley, L. Sternberger: Cultivating the capacity to cope with complexity: Global evaluation and engagement of STEM students (Western Washington University, USA, and other institutions) [on-line lecture]

**15.00 – 16.00 Short presentations of the participants outside project Consortium**

***chairperson: Črtomir Podlipnik***

15.00 – 15.10 Gabriel Pinto, Marisa Prolongo: Contextualized cases related to real-life to investigate STEM topics for science teacher and engineering students [on-line lecture]

15.10 – 15.20 Nitza Davidovitch, Dekel Basel, Shraga Shoval: The effect of post COVID 19 on public higher education institutes - a case study in Israel

15.20 – 15.30 Alicja Kluczyk: Thin layer chromatography (TLC) – old method with new tricks

15.30 – 15.40 Sławomir Domagała: Application of tutoring method on the basis of the Ministry of Education and Science of Poland project "Masters of didactics"

15.40 – 15.50 David A. Schaaf, Christopher W. M. Kay: Coding and digitalization in physical chemistry to enhance learning outcomes and digital skills

15.50 – 16.00 Discussion with all presenters of this section

**16.00 – 16.30 *COFFEE BREAK (and small bites) & POSTER SESSION*** *(first floor)*

**16.30 – 17.30 Panel discussion "Where we are, where we go"**

***chairperson and facilitator: Iwona Maciejowska***

16.30 – 16.50 Aleksandra Lis (Jagiellonian University, Kraków, Poland): Evaluation of Continuous Professional Development Activities - Good Practices and Recommendations (20 min)

16.50 – 17.10 Sanjiv Prashar (ECTN): The Role of ECTN in Sustainable STEM CPD (20 min)

17.10 – 17.30 discussion on the sustainability of CPD, future collaboration with others outside our project

17.30 – 17.45 Closing remarks and words of acknowledgement (Krištof Kranjc)

**17.45 – 18.15 INFORMAL TALKS AND NETWORKING (*first floor*)**

Leave for home or return to the hotel (participants of the dinner will be invited to go together on foot from the Faculty to the restaurant, 1.2 km walk)

19.30 – 22.00 Social dinner in a restaurant (Pri Žabarju, https://prizabarju.si/en/the-restaurant) in Ljubljana (on your own budget, 40–45 EUR *tout compris*, payment in cash only)

After dinner, participants will be accompanied (0.6 km walk) to the station "Bonifacija" (bus #6, which connects with the city centre and operates during the night as well.)

**Saturday, 3rd June 2023 (*lecture room B and rooms 2072 and 2036 for one-to-one consultations*)**

**only for STEM-CPD@EUni Project members**

09:00 – 12:00 TPM – preparation for final report, financial and subject matter issues

12.00 – 12.30 pizza

12.30 – 15.00 TPM – reflection on the Project and possible paths towards assuring its sustainability

15.00 – ..... individual consultations with Joanna (possible also on Friday, by appointment only)

# Acknowledgement

*All partners of the STEM-CPD@EUni project are gratefully acknowledged for their continuous work and ceasless efforts devoted to the success of this project. However, a special thanks needs to be awarded to the Coordinator of the project, Prof. Dr. Iwona Maciejowska from the Jagiellonian University, Kraków, Poland for all her work, organization efforts, leadership, guidance and support in the frame of this project. Without her the success of the project could be heavily jeopardized.*

*Special thanks are due to the Faculty of Chemistry and Chemical Technology, University of Ljubljana, for hosting this Final Conference and to Prof. Dr. Andreja Žgajnar Gotvajn, the Dean of this Faculty, for providing opening address as well as for her constant support of the STEM-CPD@EUni project and her continuous promotion of teaching excellence. Gratefully acknowledged are also Master Students Dominik Fendre, Bor Kolar Bačnik, Natalija Sitnikova, Blaž Užmah and Špela Založnik who helped with the organization and preparation tasks for the Final Conference.*

*Krištof Kranjc, Ljubljana 23rd May 2023*
*(chair of the Final Conference)*

# Foreword

Krištof Kranjc

*Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenia*
*e-mail: kristof.kranjc@fkkt.uni-lj.si*

Lecturers in Science, Technology, Engineering and Mathematics (STEM) need to prepare their students to be able to cope with the complex challenges of the constantly changing world. To be able to do this, it is necessary to continuously develop teaching and learning competences in higher education and to improve and adequately modify teaching approaches. The 3-year European Erasmus+ project STEM-CPD@EUni developed a framework and means for sustainable cooperation between lecturers and others interested in this field; evolving and promoting the so-called CPD Ambassadors who (wish to) organize continuous professional development (CPD) activities at their universities in order to improve the quality of higher education.

The main goals of this one-day final conference are sharing of the outcomes and results of this international project and discussing them with project partners and other participants. Additionally, evolving plans for further development of the continuous professional development in teaching in higher education in STEM disciplines and the sustainability of the CPD Ambassadors community will be discussed as well.

Participants will be immersed in this very promoting and eager group of STEM-CPD@EUni project partners and selected CPD Ambassadors and will be thus able to get new inspirations by exchange of ideas and good practices. In this way participants will become an integral part of the international STEM-CPD community. This event will enable networking to devise plans for future projects for cooperation to increase excellence in high education teaching and in the professional development of the stakeholders.

Final conference is composed of two parts: during the first day (2nd of June 2023), which is open to all participants and will be held in hybrid format, 13 lectures (some of them delivered on-line) will represent the main body of the event. The second day (3rd of June 2023) will be devoted to the members of STEM-CPD@EUni project consortium to discuss materials

connected with the completion of the project and to prepare the final reports. During both days there will be a lot of possibility for discussion and exchange of ideas. We are also organizing a small poster session which will act as a further stimulus to adhere to innovative approaches in teaching in higher education or to share your experiences about organizing professional development activities.

There was no registration fee, however registration was required for attendance (in person or on-line). The conference was funded by the EU Erasmus+ project.

Final programme of the Conference is available at:
https://ectn.eu/wp-content/uploads/2023/05/STEM-CPD-Final-conference-2023-programme-final.pdf

Warm greetings extended to all participants that are cordially invited to attend and help to co-create this final event of the STEM-CPD@EUni project in Ljubljana!

# L1: WHY STEM CPD AT EUROPEAN UNIVERSITIES?

Iwona Maciejowska

*Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30-387 Krakow, Poland*

*iwona.maciejowska@uj.edu.pl*

As research has shown, also this conducted as part of ECTN initiatives, Europe, a small but culturally diverse continent, is also characterized by a high diversity of approaches to the role of an academic teacher. In some countries, the centuries-old tradition of functioning of universities, which defines the educational process through the prism of dissemination/announcement of research results by scientists and the involvement of students in the research process they conduct, is still very popular. The position according to which the competence to conduct classes with students is legitimized primarily by the high discipline-related competence of the scientist, knowledge of the methodological workshop of his/her own scientific discipline and a certain practice in conducting the process of educating students is still reflected in the legal systems of many countries. To be a school teacher, in most countries special psychological and pedagogical preparation (pre-service teacher training) is required, the scope of which is usually regulated by ministerial standards. The situation is different in the case of lecturers. As academics, we tend to replicate the teaching patterns we experienced as students ("I teach the way I was taught"), replicating our own previous teaching experiences and those gathered from other professional and social roles.[1] Continuous Professional Development (CPD) of academic teachers is not required everywhere. Despite the fact that Schulman already in 1986 introduced the term Pedagogical Content Knowledge (PCK) to the English-language literature, however, in some of those countries where professional development systems for academic teachers exist, they still mainly cover Pedagogical Knowledge (PK). During the presentation, the goals and methods of conducting CPD for STEM (Science-Technology-Engineering-Mathematics) lecturers will be discussed.

[1] A. Oleson, M.T.Hora: Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices. *Higher Education*, **2014**, 68, 29–45.

# L2: THE ROADMAP FOR SUSTAINABLE CPD

Nataša Brouwer

*Teaching and Learning Centre Science, Faculty of Science, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands*

*e-mail: natasa.brouwer@uva.nl*

The content of teaching influences how teaching is carried out and how students are best supported in their learning. Teaching training courses for academic teachers are typically organized from a pedagogical perspective, leaving lecturers to apply the obtained pedagogical knowledge to their own teaching practice by themselves. At most universities, continuous professional development in teaching and learning (CPD) is left to the personal choice of lecturers. To support lecturers in their CPD, a new actor, the CPD Ambassador, was introduced by the Erasmus+ project STEM-CPD@EUni. The CPD Ambassador promotes the importance of CPD in teaching and learning from a disciplinary perspective and organizes CPD activities for fellow lecturers at their own institution.[1] The needs of the CPD Ambassadors are characterized by three dimensions: (a) STEM-teaching competences; (b) CPD attitudes; (c) CPD activities. The needs as recognized by lecturers and educational managers were mapped out in the Roadmap.[2] This presentation will demonstrate several examples of how the Roadmap can support the CPD Ambassadors in their mission and actions.

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1. Brouwer, N., Maciejowska, I., Lis, A., Machado, C., Grecea, S., Kärkkäinen, J., Niemelä, M., Kranjc, K.,. Podlipnik, Č., Prashar, S., Russo, V., Tarallo, O. (2020). The Need for STEM Continuous Professional Development at European Universities. VIRT&L-COMM, 21. ISSN: 2279-8773. Link: http://services.chm.unipg.it/ojs/index.php/virtlcomm/article/view/253

2. Brouwer, N., Grecea, Ş., Kärkkäinen, J., Maciejowska, I., Niemalä, M., & Schreuders, L. (2022). Roadmap for continuous professional development of STEM lecturers. In I. Devetak (Ed.). *University Chemistry Teaching in the 21. Century,* (85-111), University of Ljubljana, Slovenia, DOI: 10.26529/9789612532970/ch5.

# L3: CPD AMBASSADOR USER CASES - WORKSHOP

Matti Niemelä*[,a] and Nataša Brouwer[b]

[a] *Faculty of Technology, Research Unit of Sustainable Chemistry, University of Oulu, Pentti Kaiteran Katu 1, Oulu, Finland.*

[b] *Teaching and Learning Centre, Faculty of Science, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands.*

** e-mail: matti.niemela@oulu.fi*

The purpose of this workshop is to introduce participants CPD ambassador user cases. User case is a series of CPD activities for specific challenge. A STEM-CPD roadmap[1] and a framework are used as a starting point for the preparation of the user cases. User cases include context and goals, relevant information, and elements for the implementation of CPD activities and section for the evaluation and reflection. Teaching and learning materials for lecturers can be based on self-supportive learning and different collaborative activities. In the implementation phase, the CPD-Ambassadors organize activities at the local universities to solve specific teaching and learning problems and to improve the quality of courses. At the end of the workshop participants will be able to describe the structure and content of a user case and sketch a short user case using the template introduced in the workshop.

1. N. Brouwer, S. Grecea, J. Kärkkäinen, I. Maciejowska, M. Niemelä, L. Schreuders, Roadmap for continuous professional development of STEM lecturers. In University Chemistry Teaching in the 21. Century (Iztok Devetak eds.), **2022**, Ljubljana, Slovenia.
DOI: https://doi.org/10.26529/9789612532970

# L4: PROMOTING STEM TEACHING THROUGH MICROMOOCS: EXPERIENCES AND CHALLENGES WITH ECTNMOOCS.EU

Črtomir Podlipnik* and Krištof Kranjc

*Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana,*

** e-mail: crtomir.podlipnik@fkkt.uni-lj.si*

This presentation delves into the use of ECTNMOOCS.EU, a cutting-edge online learning platform built on the open-source Open edX framework. Through this platform, we have developed captivating microMOOCs as part of the STEM/CPD@EUni program. These microMOOCs are closely related to the STEM/CPD@EUni project and serve as a tool for CPD ambassadors to promote continuous professional development in STEM teaching. Our approach is based on the TPACK framework, which emphasizes the synergy of technological, pedagogical, and content knowledge of the lecturer.

Our microMOOCs cover a variety of topics, including lab safety, rubrics for assessing lab work, and effective use of digital tools for teaching and learning (TPACK). These modules follow a microMOOC format with a solid active learning course design that focuses on a single teaching/learning concept and takes about a couple of hours per student. These flexible and accessible courses allow busy professionals to stay up-to-date with the latest developments in their field. Our research has shown that microMOOCs can deliver targeted and engaging content through interactive multimedia and social learning tools. The expertise gained through this program will also enable us to develop even more microMOOCs in the future, such as bite-sized courses designed to popularize the fascinating world of chemistry through ECTN's themes.

However, there are challenges associated with using microMOOCs for STEM CPD. Ensuring relevant and up-to-date content requires close collaboration between subject matter experts and instructional designers. Additionally, it is important for learners to be able to apply their knowledge in their professional practice. To address this challenge, we have developed assessment and feedback tools that allow learners to demonstrate their understanding and receive feedback on their performance.

# L5: LESSONS LEARNED FROM THE SUMMER SCHOOLS

Oreste Tarallo and Vincenzo Russo

*Department of Chemical Sciences, University of Naples Federico II, Complesso Universitario di Monte Sant'Angelo, via Cintia, IT-80126 Napoli, Italy*
*e-mail: oreste.tarallo@unina.it; vincenzo.russo@unina.it*

*STEM-CPD Summer Schools* represent a fundamental part of the STEM-CPD@EUni project, where the problem of a lack of subject specific training in STEM disciplines for University Lecturers is addressed and solutions are put forward.

The characterizing feature of these Summer Schools is the *train-the-trainer* approach, i.e. to prepare participants in several dimension (teaching competences, attitudes, use of research-based teaching methodologies) thus transforming them into "CPD-Ambassadors" that are able to increase the quality of teaching at their home institutions by knowledge sharing and by organizing STEM-oriented CPD activities. In this way, CPD-Ambassadors trigger a cascade process that guarantees to reach sustainability of continuous professional development of teaching staff in STEM disciplines at European universities.

During the project, two summer schools have been organized: a first one in Krakow (October 2021), and a second one in Naples (October 2022). Both programs enabled participants to learn key concepts and discuss critical issues in the field of higher education in STEM disciplines, providing them with a broad, international perspective. The Summer Schools covered different topics and several intended learning outcomes, all tailored to the specific needs of the participants. Numerous activities based on co-creation, peer-learning and knowledge sharing based on the principles of the community of inquiry were implemented. An important part of both Summer Schools was dedicated to several hands-on sessions in which each participant had to develop their own user case, by identifying problems or challenges in teaching STEM disciplines in their home institution and putting forward possible solutions to be developed as CPD activities.

# L6: CULTIVATING THE CAPACITY TO COPE WITH COMPLEXITY: GLOBAL EVALUATION AND ENGAGEMENT OF STEM STUDENTS

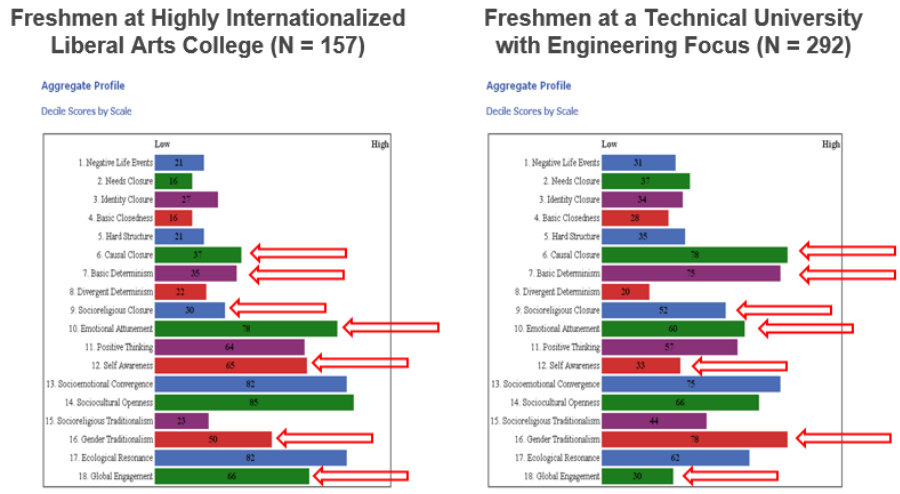
Craig Shealy,*[,a] J. Style,[b] H. Nishitani,[c] K. Acheson,[d] J. Wiley[e] and L. Sternberger[f]

*[a] Professor, Western Washington U, Bellingham, WA, USA; [b] Professor, Rovira i Virgili U, Tarragona, Spain; [c] Professor, Soka U, Tokyo, Japan; [d] Director, Purdue U Center for Intercultural Learning, Mentorship, Assessment and Research, West Lafayette, IN, USA; [e] Managing Partner, CoreCollaborative International, Harrisonburg, VA, USA; [f] Advisory Board, IBAVI, Western Washington U, Bellingham, WA, USA*

** e-mail: craigshealy@gmail.com*

STEM students are unique. With over 100,000 international administrations of a mixed methods measure – the Beliefs, Events, and Values Inventory (BEVI) – we can empirically demonstrate that overall, STEM students are qualitatively and quantitatively different from other undergraduate students, all over the world (e.g., Acheson et al., 2021; Nishitani, 2020; Shealy, 2016; Wiley et al., 2021).[2] These differences have real world significance for the STEM-CPD community, given its stated goal to help STEM students "cope with the complex challenges of the changing world" (e.g., see Figure 1). The implications and applications of this work will be presented and discussed along with collaborative possibilities in Europe and internationally (e.g., teaching and evaluating STEM competencies; applied assessment research and practice; curricular / program development; grant monitoring and evaluation; student / faculty exchange).

**Figure 1.** *BEVI Group Profile Comparisons Across Liberal Arts and STEM Institutions*




[2] References and other relevant materials are available at https://thebevi.com/ and https://www.ibavi.org/.

# L7: CONTEXTUALIZED CASES RELATED TO REAL-LIFE TO INVESTIGATE STEM TOPICS FOR SCIENCE TEACHER AND ENGINEERING STUDENTS

Gabriel Pinto*[,a] and Marisa Prolongo[b]

[a] *ETS de Ingenieros Industriales, Technical University of Madrid, José Gutiérrez Abascal 2, 28006 Madrid, Spain*

[b] *I.E.S. Mediterráneo, Idumea 1, 29018 Málaga, Spain*

** e-mail: gabriel.pinto@upm.es*

The central idea of this work is to show some applications carried out in past years with first-year Industrial and Chemical Engineering students who study Chemistry. The aim of these kinds of experiences is that students solve, as a team, a series of problems and cases contextualized in their day-to-day life. To do that, they must understand a given problem, search for the underlying data set, analyse different information sources (in Spanish and English) for the data search, discriminate between the contents of the subject (and others) that they must apply, carry out experiments (in some cases), proceed according to an accurate data processing, make approximations, analyse the results (whose outcome is open) and propose future inquiries and applications.

The cases included here, chosen among dozens of others that have been implemented (https://short.upm.es/nv6br) are an experimental study of the ice melting rate in various liquids, calculations, and analysis of the relationships between vehicle fuel consumption and $CO_2$ emissions, discussion about self-heating beverage containers, chemical and thermodynamic fundamentals of domestic condensing boilers, and critical analysis of pseudoscientific deceptive information. These examples show that students are more interested in the subjects and they acquire skills in a more appropriate way than with the use of more traditional problems, which are of a closed nature regarding the baseline data and with unique findings. Therefore, there is a clear contribution to the education of more responsible citizens with better knowledge of some products and technologies that they use in their daily lives. These experiences and other similar ones, have been made available in secondary teacher training courses to promote its use in other educational stages.

# L8: THE EFFECT OF POST COVID 19 ON PUBLIC HIGHER EDUCATION INSTITUTES – A CASE STUDY IN ISRAEL

Nitza Davidovich[a], Dekel Basel[b] and Shraga Shoval[b]

[a] *Faculty of Social Science Ariel University, Israel;* [b] *Faculty of Engineering Ariel University, Israel*

The COVID-19 pandemic affected almost all aspects of life, including academic studies. A report published by the UN Academic Impact forum [1] claims that several categories must be changed following the COVID-19 pandemic: continuity of teaching and research; shift in the learning process and facilitating quality higher education. The Global Education Coalition by UNESCO [2] claims that there is a needed to promote open, flexible and relevant learning systems during times of crises and to finance the participation of the private sector in academia.

In this study we examine the effect of the COVID-19 on off-campus learning experience of students in public institutes that is an addition to the on-campus learning based on a survey of attitudes conducted among 118 Engineering students. The study was conducted shortly after the return of students to the campus, following the long periods of off-campus studies.

The main research questions were:

1. What are the benefits of off-campus learning?
2. What are the difficulties in on-campus learning for which off-campus lessons are needed?
3. What needs to be done to improve on-campus teaching to reduce the need for additional off-campus teaching?

The results show a clear and unambiguous picture: The COVID-19 pandemic revolutionized the learning habits of students. This revolution is characterized by reduced attendance of student in campuses, and by a significant involvement of private/commercial entities in the academic programs. Information about the trends of off-campus courses shed light on the learning habits of students today and on possible future learning trends.

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1. https://www.un.org/en/academic-impact/covid-19-and-higher-education-learning-unlearn-create-education-future
2. (https://en.unesco.org/covid19/educationresponse/globalcoalition)
3. Hativa, N. (2015). What does the research say about good teaching and outstanding teachers? Hora'ah Ba'akademya, 5, 42-61. [in Hebrew]

# L9: THIN LAYER CHROMATOGRAPHY (TLC) – OLD METHOD WITH NEW TRICKS

Alicja Kluczyk

*Faculty of Chemistry, University of Wrocław, F. Joliot-Curie 14, 50-383 Wrocław, Poland*
*e-mail: alicja.kluczyk@uwr.edu.pl*

Thin layer chromatography (TLC) is a simple and relatively inexpensive separation method. Its educational role is nowadays frequently associated only with pigment separation during science fairs and preliminary chemistry courses. However, this limited approach does not do justice to this old but versatile technique and its applications in student curriculum, research and continuous professional development of chemistry educators. A series of Bachelor and Master level courses as well as experimental parts of BSc theses at the Faculty of Chemistry, University of Wrocław, provide examples of the use of TLC in studying advanced physicochemical concepts, developing analytical strategies, and stimulating creativity and critical thinking. The investigated areas of special TLC applications include:

- identification and differentiation of compounds by chemical derivatization (specific reactions, staining reagents),
- investigation of lipophilicity for logP comparison, pH influence on polarity of molecules as well as solvent strength and volatility for method development (bioactive substances, selectivity factors, good laboratory practices),
- analysis of products with difficult matrices (food, supplements, cosmetics),
- 2D separations of complex mixtures as introduction to 2D HPLC (plant extracts),
- preliminary quantitation by dilution or densitometry.

TLC lets us study wide variety of substances and conditions on small scale, challenging our chemical knowledge and ingenuity. Organic, physical and analytical chemistry concepts could be combined to solve real life problems and provide attractive learning opportunities, at the same time refreshing and strengthening our understanding of chemical sciences.

# L10: APPLICATION OF TUTORING METHOD ON THE BASIS OF THE MINISTRY OF EDUCATION AND SCIENCE OF POLAND PROJECT "MASTERS OF DIDACTICS"

Slawomir Domagala

*Faculty of Chemistry, University of Lodz, Department of Inorganic and Analytical Chemistry, Tamka 12, 91-403 Lodz, Poland*

*e-mail: slawomir.domagala@chemia.uni.lodz.pl*

The tutoring method is applied on the basis of the "*Master of Didactics*" (MoD) project that was launched by the Ministry of Education and Science of Poland and cofinanced by the Operational Programme Knowledge Education Development. This project supports the improvement and innovation of teaching processes. The importance of this project is related to teaching enhancement and better recognition as well as promotion of tutoring[1,2]. It highlights the impact of international experiences in developing and enhancing learning and teaching, with mobility opportunities for academic teachers to make improvements to their education offer. The project points out the international trends in learning and teaching, such as active and student-centered learning, as well as full implementation of the Bologna reforms in the framework of the European Higher Education Area.

The aim of the presented studies is to show how to improve the competencies of academic teachers in the use of modern and innovative teaching methods, such as the use of tutoring in education. It assumes the development of concepts and implementation of new solutions in the field of tutoring. The solutions were developed, tested and implemented at the Faculty of Chemistry, University of Lodz, Poland using the experience of international partners, that are the universities located in the first hundred of the best universities in the world according to the Academic Ranking of World Universities: Aarhus University, Ghent University, and University College London.

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# L11 + PO5: CODING & DIGITALIZATION IN PHYSICAL CHEMISTRY TO ENHANCE LEARNING OUTCOMES AND DIGITAL SKILLS

David A. Schaaf[1] and Christopher W. M. Kay[1,2]

*[1]Institute of Physical Chemistry and Chemistry Education, University of Saarland, Saarbrücken, 66123, Germany; [2]London Centre for Nanotechnology, University College London, 17-19 Gordon Street, London WC1H 0AH, United Kingdom*

Mastering digital skills is more important than ever as digitalization infiltrates every aspect of our lives in general and the scientific process in particular.*[1]* Analytical hardware, the evaluation of experimental data, laboratory journals and reports in universities and industry are now all digital, whereas computer science and coding classes at high school are still often rare, which means that many freshman university students have little experience of using computer software or writing their own code. This lack of experience and hence self-confidence in coding may become a serious hinderance for (successful) data analysis accompanying practical work as students progress through their academic training, especially in the natural sciences.*[2][3]*

In disciplines such as engineering, the use of computers is already a core competency, whereas in chemistry this aspect is often considered peripheral. Here we discuss our approach to integrate coding into physical chemistry education. In our opinion, chemists should not only learn how to carry out synthesis, perform analytical measurements with a "black box", and have the results evaluated on their behalf by an algorithm, but should have a deep understanding of the science, and be able to employ the equations and mathematics behind the results.*[4]*

Our concept to achieve both better understanding of the concepts and to simultaneously improve digital skills is twofold:

1) We switched from the traditional lecture format by applying aspects of the flipped (or inverted) classroom to oblige the students to immediately put into practice the concepts that they (should) have prepared, or have just been introduced to, by active participation in the exercises.*[5]*

2) We replaced the pocket calculator and graph-paper for numerical & graphical questions by computer software. Furthermore, rather than having a separate programming course, we decided to embed practical aspects directly in the undergraduate physical chemistry curriculum in order to directly employ the software for exercises encountered in each topic.

There are a number of different programs that could be used for this purpose. Spreadsheet-based programs such as Excel and Origin are widely used, but in our opinion may suffer from not giving a clear overview of what math is actually performed on the data at each step. This is especially problematic for large data sets. We prefer programs that involve structured, but relatively intuitive, coding. We chose MATLAB for the vast library of toolboxes that enable numerous problems to be addressed, its wide use in industry, and similarity to PYTHON, which allows students to build upon or easily transfer these skills in their future careers.*[6][7]*

Over the past 4 years, we have established MATLAB in physical chemistry courses for freshman and sophomore students. Importantly, any student who does not have their own laptop is provided with one. During the first semester, our aim is to give the students an understanding of the essential structure and basic commands with an initial focus on its use – essentially – as a calculator. The second step is the introduction of vectors and arrays in order to demonstrate how multiple calculations may be performed simultaneously. This naturally leads to the importing, visualization and fitting of data to analytical expressions. In the second semester, we employ MATLAB to model, evaluate and plot thermodynamic processes and to calculate kinetic behavior in a course introducing classical physical chemistry. The training culminates with a physical chemistry laboratory practical in the third semester. Herein, the experimental data are plotted, fitted, analyzed and put into the context of the literature data. By embedding MATLAB in the lectures and exercise classes from the beginning of their degree, we aim to give students both a modern tool and the self-confidence to tackle more onerous data analysis that they encounter in analytical and physical chemistry as they progress through their undergraduate studies and beyond.

Importantly, creating code naturally encourages students to structure their work logically and precisely. It also helps them and the teaching assistants (who are present in the lectures) to find errors when compared to an exercise performed on paper. Concepts are developed in short bursts, following which the students code the relevant math. This alternation repeats throughout the lecture, thus building up step-by-step longer codes with multiple sections. By the end of a semester the students have a library of their own codes covering many topics. Our approach allows students to concentrate on the equations and the graphical visualizations thereof that describe phenomena rather than mental arithmetic or repeatedly typing numbers into a calculator when changing variables.

In this contribution, we present our concept in detail and discuss the feedback from students, teaching assistants and professors. Our conclusion is that students who actively engage with both the watching/listening and coding parts of the lecture more rapidly acquire a deeper understanding of the material covered than in more traditional "frontal" lectures with separate "paper-based" problems classes.

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# L12: EVALUATION OF CONTINUOUS PROFESSIONAL DEVELOPMENT ACTIVITIES - GOOD PRACTICES AND RECOMMENDATIONS

Aleksandra Lis[a,b]

[a] *Faculty of Chemistry, Jagiellonian University in Krakow, 31-007 Krakow, Poland*

[b] *Faculty of Production and Power Engineering, University in Agriculture in Krakow, 31-120 Krakow, Poland*

*e-mail: aleksandra.lis@uj.edu.pl*

Evaluation is a key element in educational activities as it enables us to measure progress and enhance accountability. In the STEM-CPD@EUni project, it allows the evidence-based development of the proposed activities for CPD –Ambassadors, as well as supplying data for their refinement and adjustment, and ultimately provides recommendations and guidelines for similar initiatives in the area of professional development in higher education. A series of evaluation tools was developed throughout the project and put into practice. Through the evaluation of Summer Schools and local CPD User Cases, we proceeded according to a data collection protocol and performed analysis in order to allow a greater understanding of STEM-CPD at higher education institutions. The oral presentation will focus on the employed approaches and methods, showing the process and results of evaluation of CPD –Ambassadors and emphasizing the role of evaluation in providing CPD as well as good practices from which we can learn for the future.

## L13: THE ROLE OF ECTN IN SUSTAINABLE STEM CPD

Sanjiv Prashar

*President of the European Chemistry Thematic Network. ECTN*

The European Chemistry Thematic Network (ECTN) is a consortium of universities and other institutions that has as its raison d'être, excellence in chemistry education and research across Europe. Key to this is the recognition of the importance of Continuous Professional Development for Chemistry academics in Higher Education and its natural expansion to cover all STEM disciplines (Science, Technology, Engineering, and Mathematics).

Through the Erasmus+ project STEM-CPD@EUni, the ECTN has participated in the setting up of STEM-CPD orientated Users Cases, MicroMOOCs, Summer Schools and CPD Ambassador community.

The ECTN is responsible for the sustainability and legacy of the project, and so after completion date, will overlook the continuance of the work developed and promote the use of microMOOCs, user cases and STEM-CPD scenarios within and beyond the network. The ECTN webpage has a permanent link to the project web portal and provides free access to all the project's results and products.

To keep the flame of STEM-CPD burning, the ECTN will actively promote activities of the CPD-Ambassador community, namely, by organizing annual STEM-CPD workshops and Summer Schools.

# PO1: STUDENTS' EXPERIMENTAL WORK ASSESSMENT

Brina Dojer*[,a] and Matjaž Kristl[b]

[a] *Faculty of Natural sciences and Mathematics, University of Maribor, Koroška cesta 160, 2000 Maribor*
[b]*Faculty of Chemistry and Chemical Engineering, University of Maribor, Smetanova 17, 2000 Maribor, Slovenia*
** e-mail: brina.dojer@um.si*

University teachers do not often have enough time to assess all students or their products (seminar papers etc.). Therefore and since we would like to strengthen the competence of independent work and critical evaluations by future teachers of chemistry, in the Experiments 1 course, a compulsory subject for students in the 4th year of the study programme Subject teacher of educational chemistry at the Faculty of Natural Sciences and Mathematics of the University of Maribor one part of the final grade of the course contributes to the students' experimental work (demonstrative experiments) in front of first-year students of some other study programmes. The performance usually takes place in tandem. The other students are encouraged to observe and evaluate their colleagues. Their evaluation is quite relevant for the professor since these students have already acquired knowledge gained during their education in the subjects of general and special didactics (of chemistry) and laboratory techniques.

In a short survey we wanted to explore what strengths and weaknesses students perceive in their colleagues and how often they include them in their evaluation. We collected data on observed aspects from analyses performed by students. These aspects, which are usually included in assessment of the experimental work [1], include professionalism, structure, pedagogical skills, mastery of laboratory techniques, safety aspects, clarity and longevity. We included in our analysis the reports of twenty-eight (28) students who have taken the Experiments 1 course over the past four years.

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# PO2: PRE-SERVICE TEACHER EDUCATION IN THE CONTEX OF THE DISSI FRAMEWORK

Miha Slapničar,*[,a,b] Luka Vinko,[a] Luka Ribič[a] and Iztok Devetak[a]

[a] *University of Ljubljana, Faculty of Education, Kardeljeva pl. 16, 1000 Ljubljana Slovenia*
[b] *BEC Ljubljana, Cesta v Mestni log 47, 1000 Ljubljana, Slovenia*
** e-mail: miha.slapnicar@pef.uni-lj.si*

Diversity in Science towards Social Inclusion (DiSSI) – non-formal education in science for students' diversity is an international Erasmus+ project with partners from Germany, Ireland, United Kingdom, Northern Macedonia and Slovenia. The purpose of the project stems from the fact that inclusive teaching of science subjects usually focuses on only one dimension of diversity at a time. As a member, Slovenia is working on a project with gifted people in chemistry. The gifted show a high level of readiness, interest, good concentration skills and metacognitive maturity in learning new chemistry content. They use terms related to chemistry to describe chemical concepts and phenomena, and in this sense, have an extensive natural vocabulary. Understanding of chemical concepts by gifted chemistry students is quick, rapid, in-depth, and of high quality, and does not include incomplete- or misconceptions. They are the only ones who are able to recognize these among peers during a discussion and point them out[1,2]. As part of the project, we prepared: (1) contextual chemistry problems with pre-service teachers, (2) four research modules for the gifted students a) "Forensics Science", b) "Environmental Chemistry - hydrosphere pollution", c) "Green Chemistry of the Future", d) "Medical Active Substances in Pepper", and (3) two experimental research tasks with the content of chemistry of natural compounds a) Reuse of citrus peels in secondary school chemistry classes and b) Antioxidant capacity of piperine and other piperidine alkaloids in radical reactions in bovine cells liver.

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# PO3: IMPLEMENTATION OF SOFT GRADING SYSTEMS FOR CHEMISTRY IN A MOODLE PLUGIN

Louis Plyer,[a] Alexandre Varnek,[b] Céline Perves[c] and Gilles Marcou*[,c]

[a] *Faculté de Chimie, University of Strasbourg, France*
[b] *Laboratory of Chemoinformatics, University of Strasbourg, France*
[c] *Direction du numérique (DNUM), University of Strasbourg, France*
** e-mail: g.marcou@unistra.fr*

Drawing chemical structures is an essential skill but also a particularly difficult one to acquire. We are developing a set of tools in the ChemMoodle project that aims to facilitate the learning of this skill within MOODLE. The platform usually uses a binary grading system, which often fails to give a nuanced evaluation of the answers. This is particularly true in the case of chemistry drawing, where most questions simply cannot be evaluated on a true/false basis. Specifically, a strict comparison of the candidate and the expected drawings is insufficient when some tolerance is deemed acceptable. To alleviate this constraint, the herein proposed grading workflow is based on computing the similarity between the chemical drawings. It is implemented as a Moodle plugin, using Chemdoodle engine for drawing structures, and communicating with a REST server (open source) - that can be installed and managed locally- to compute the similarity using ISIDA descriptors and Tanimoto coefficient.

# PO4: MASTER ERASMUS MUNDUS "CHEMOINFORMATICS+: ARTIFICIAL INTELLIGENCE IN CHEMISTRY"

K. Klank,[a] J. Aires de Sousa,[b] L. Belvisi,[c] A. Camproux,[d] G. Grabchyk,[e] S. Pieraccini,[c] Č. Podlipnik,[f] S. Senderowitz,[g] O. Taboureau,[d] G. Marcou*,[a]

*[a] 1 University of Strasbourg; [b] University NOVA of Lisbon; [c] University of Milan; [d] University Paris Cite; [e] Taras Shevchenko National University of Kiev; [f] University of Ljubljana; [g] Bar Ilan University*

** e-mail: g.marcou@unistra.fr*

Chemoinformatics is a major discipline in theoretical chemistry, using physical chemistry models, artificial intelligence and data sciences to tackle the current social and innovation challenges. Chemoinformatics concerns the development, creation, organization, storage, dissemination, analysis, visualization and use of chemical information. As a Chemistry discipline, it is rooted into experimental skills, on which are based the essential expertise for data acquisition, processing and modelling, to solve chemical problems and innovate in chemistry with the help of chemoinformatics techniques. The Erasmus Mundus Master degree "ChEMoinformatics+: Artificial Intelligence in Chemistry" is proposed by a consortium of seven academic sites: the University of Strasbourg (France), the University of Paris (France), the University NOVA of Lisbon (Portugal), the University of Milan (Italy), the University of Ljubljana (Slovenia), the University of Bar Ilan (Israel) and the Taras Shevchenko National University of Kiyv (Ukraine). The project federates an existing network of double diplomas in Chemoinformatics into a joint master program, aiming to improve scientific excellence and employability of the graduates.

# PO6: INTRODUCTION OF ECTNMOOCS.EU

Črtomir Podlipnik,*[,a] Krištof Kranjc,[a] Sebastian Pleško,[a] Sanjiv Prashar,[b] Matti Niemelä,[c] Vincenzo Russo,[d] Oreste Tarallo,[d] Stefania Grecea,[e] Nataša Brouwer,[f] Iwona Maciejowska,[g] and other collaborators from STEM-CPD@EUni

*[a] Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenia; [b] European Chemistry Thematic Network (ECTN); [c] Faculty of Technology, Research Unit of Sustainable Chemistry, University of Oulu, Pentti Kaiteran Katu 1, Oulu, Finland; [d] Department of Chemical Sciences, University of Naples Federico II, Complesso Universitario di Monte Sant'Angelo, via Cintia, IT-80126 Napoli, Italy; [e] University of Amsterdam, The Netherlands; [f] Teaching and Learning Centre, Faculty of Science, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands; [g] Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30-387 Kraków, Poland*

*e-mail: crtomir.podlipnik@fkkt.uni-lj.si*

Web page ectnmoocs.eu offers short, open online courses for educators to enhance their professional development in STEM education. These courses cover topics such as lab safety, rubrics for assessing lab work, new teaching methods, assessment techniques, and the effective use of digital tools for teaching and learning. Designed with an active learning approach and constructivist orientation, the courses follow a microMOOC format that focuses on a single teaching or learning concept and takes a couple of hours to complete. By completing these modules, educators can improve their skills and knowledge in STEM-CPD, and enhance their teaching practices.

Visit our microMOOCS and start exploring the universe of microMOOCs for STEM educators! Scan the QR code on our poster and embark on a journay enhancing your professional development. Start now!

# PO7: STEM-CPD SUMMER SCHOOLS

Oreste Tarallo and Vincenzo Russo

*Department of Chemical Sciences, University of Naples Federico II, Complesso Universitario di Monte Sant'Angelo, via Cintia, IT-80126 Napoli, Italy*
*e-mail: oreste.tarallo@unina.it; vincenzo.russo@unina.it*

STEM-CPD@EUni Summer Schools are fundamental parts of the project. The participants of these summer schools are university lecturers who become CPD-Ambassadors. At the Summer School, participants gain knowledge on how to develop and how to organize Continuing Professional Development (CPD) activities in teaching and learning at the university. They strengthen their personal technological pedagogical content knowledge (TPACK) and when they return to their home universities, they set up CPD activities for their fellow lecturers and enthuse them to improve their competence in teaching.

We did it! Two successful STEM-CPD@EUni Summer Schools have already been organized in October 2021 and 2022 respectively in Kraków (Poland) and Naples (Italy), resulting in more than 35 CPD user cases to be applied in improving university teaching practice in Europe. And we would like to continue! Contact us, if you want to cooperate.

# PO8: STEM CONTINUOUS PROFESSIONAL DEVELOPMENT AT EUROPEAN UNIVERSITIES

Nataša Brouwer,[a] Stefania Grecea,[b] Krištof Kranjc,[c] Iwona Maciejowska,*[,d] Matti Niemelä,[e] Črtomir Podlipnik,[c] Sanjiv Prashar,[f] Vincenzo Russo[g] and Oreste Tarallo[g]

*[a] Teaching and Learning Centre, Faculty of Science, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands; [b] University of Amsterdam, The Netherlands; [c] Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, SI-1000 Ljubljana, Slovenia; [d] Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30-387 Kraków, Poland; [e] Faculty of Technology, Research Unit of Sustainable Chemistry, University of Oulu, Pentti Kaiteran Katu 1, Oulu, Finland; [f] European Chemistry Thematic Network (ECTN); [g] Department of Chemical Sciences, University of Naples Federico II, Complesso Universitario di Monte Sant'Angelo, via Cintia, IT-80126 Napoli, Italy*

*e-mail: iwona.maciejowska@uj.edu.pl*

Project aims and goals:

- to promote Continuous Professional Development (CPD) at European Universities
- to develop a sustainable cooperation between people who organize TPACK oriented CPD activities
- to improve the quality of education in university Science, Technology, Engineering, and Mathematics (STEM) faculties
- to share the experiences in STEM-CPD at European universities.

Following are the most important parts of the project:

- Roadmap to set STEM continuous professional development at European universities
- framework for STEM-CPD according to CPD-Ambassador principle
- STEM-CPD scenarios and user cases
- CPD materials and modules
- CPD summer schools
- evaluation framework of STEM-CPD.

# PO9: FACILITATING PROJECT-BASED AND PROBLEM-BASED LEARNING WITH THE USE OF MOODLE

Natalija Sitnikova*, Črtomir Podlipnik and Krištof Kranjc

[a] *Faculty of Chemistry and Chemical Technology, Univiersity of Ljubljana, Večna pot 113, SI-1000, Ljubljana, Slovenia*
** e-mail: natasa.sitnikov@gmail.com*

Diversifying the teaching process scan be a satisfying, yet daunting task. At the start it is difficult to choose the technique to focus on, and later on the problem of implementation arises. The μMOOC "Facilitating project-based and problem-based learning with the use of Moodle" was developed to provide assistance in implementation of project-based and problem-based learning with the help of Moodle.

We have chosen to focus on the project-based and problem-based techniques of learning, as they promote student engagement and group- and teamwork. When tackling the problem of implementation it was vital that the solution can be a common place one, that is perhaps not used to its fullest potential. So the learning platform Moodle was chosen, as it is quite common amongst higher education teachers worldwide, yet sometimes underused. Interactivity was also important, as learning in interactive environments can be beneficial to both teachers and students, promote participant engagement, and stimulate learning.

The course aims to teach users about the benefits of both learning techniques, to showcase the usefulness of Moodle and to provide a deeper instruction on its functions.

# PO10: EMPOWERING PRE-SERVICE CHEMISTRY TEACHERS FOR PROJECT WORK

Janja Majer Kovačič

*Faculty of Natural sciences and Mathematics, University of Maribor, Koroška cesta 160, 2000 Maribor, Slovenia*

*e-mail: janja.majer@um.si*

Experience with project work is of utmost importance for pre-service chemistry teachers as it has a transformative impact on their educational practices. Involving students in project work enables their cognitive, personal, and motivational development, fostering communication skills, creativity, and practical thinking. As teachers play a vital role in the educational process, they are responsible for introducing project work into school practice.

At the Faculty of Natural sciences and Mathematics University of Maribor, the subject "Project Work in Chemical Education" was introduced to the program for pre-service chemistry teachers, emphasizing the significance of project work and its implementation. Students from two generations (N = 13) of the fifth year of the master's programme in subject teaching participated in the short study with aim to investigate the value of the project work introduction model. First findings are promising. The approach includes collaboration with experienced teachers on project work at the elementary and secondary school levels, elements of formative assessment by monitoring students' progress in carrying out their own project in school, and a STEM approach, among others. The implemented model has proven to be highly effective in introducing pre-service teachers to project work. Moreover, the results indicate a positive shift in their attitude towards the utilization and implementation of project work in school practice. Our findings highlight the importance of equipping pre-service chemistry teachers with project-based learning experiences that involve planning, implementing project work and evaluating their own as well as students' project work not only for understanding but also cultivates a favorable mindset towards incorporating project work into their future classrooms.

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# List of Participants

**Bačnik, Andreja**
National Education Institute Slovenia
(Zavod Republike Slovenija za šolstvo)
Ljubljana, SLOVENIA
*e-mail: andreja.bacnik@zrss.si*

**Brouwer, Nataša**
University of Amsterdam
Amsterdam, THE NETHERLANDS
*e-mail: natasa.brouwer@uva.nl*

**Cimpoesu (Ferbinteanu), Marilena**
University of Bucharest
Bucharest, Romania
*e-mail: marilena.cimpoesu@g.unibuc.ro*

**Cioffi, Raffaele**
Università degli studi di Napoli Parthenope
Napoli, ITALY
*e-mail: raffaele.cioffi@uniparthenope.it*

**Cittoor, Girija Navaneedhan**
Indian Institute of Technology
Madras, INDIA
*e-mail: girija.navaneedhan@gmail.com*

**Cupiał, Michał**
University of Agriculture in Kraków
(Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie)
Kraków, POLAND
*e-mail: michal.cupial@mcpk.net*

**Davidovitch, Nitza**
Ariel University
Ariel, ISRAEL
*e-mail: d.nitza@ariel.ac.il*

**De Pertis, Marco**
Università degli studi di Napoli Parthenope
Napoli, ITALY
*e-mail: marco.depertis@assegnista.uniparthenope.it*

**Dojer, Brina**
Faculty of natural sciences and mathematics
University of Maribor
Maribor, SLOVENIA
*e-mail: brina.dojer@um.si*

**Domagała, Sławomir**
Faculty of Chemistry
University of Łódź
Łódź, POLAND
*e-mail: slawomir.domagala@chemia.uni.lodz.pl*

**Faginas Lago, Noelia**
ECTN and University of Perugia
Perugia, ITALY
*e-mail: noelia.faginaslago@unipg.it*

**Ferone, Claudio**
Università degli studi di Napoli Parthenope
Napoli, ITALY
*e-mail: claudio.ferone@uniparthenope.it*

**Gazvoda, Martin**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: martin.gazvoda@fkkt.uni-lj.si*

**Goodfellow, Brian**
University of Aveiro
Aveiro, PORTUGAL
*e-mail: brian.goodfellow@ua.pt*

**Grecea, Stefania**
University of Amsterdam
Amsterdam, THE NETHERLANDS
*e-mail: s.grecea@uva.nl*

**Grošelj, Uroš**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: uros.groselj@fkkt.uni-lj.si*

**Gwóźdź-Łukawski, Gertruda**
Łódź University of Technology
Łódź, POLAND
*e-mail: gertruda@p.lodz.pl*

**Hajdinjak, Melita**
Faculty of Electrical Engineering,
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: melita.hajdinjak@fe.uni-lj.si*

**Johnson, Kameyo**
University of Pikeville
Pikeville, KY, USA
*e-mail: kameyojohnson@upike.edu*

**Kay, Christopher**
Saarland University
Saarbrücken, GERMANY
*e-mail: christopher.kay@uni-saarland.de*

**Kluczyk, Alicja**
Faculty of Chemistry
University of Wrocław
Wrocław, POLAND
*e-mail: alicja.kluczyk@uwr.edu.pl*

**Kolodynska, Dorota**
Faculty of Chemistry
Marie Curie Skłodowska University
Lublin, POLAND
*e-mail:*
*dorota.kolodynska@mail.umcs.pl*

**Kozdęba, Michał**
University of Agriculture in Kraków
(Uniwersytet Rolniczy im. Hugona
Kołłątaja w Krakowie)
Kraków, POLAND
*e-mail: michal.kozdeba@urk.edu.pl*

**Kranjc, Krištof**
Faculty of Chemistry and Chemical
Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: kristof.kranjc@fkkt.uni-lj.si*

**Kristl, Matjaž**
Faculty of Chemistry and Chemical
Engineering
University of Maribor
Maribor, SLOVENIA
*e-mail: matjaz.kristl@um.si*

**Krzeczkowska, Małgorzata**
Jagiellonian University
Kraków, POLAND
*e-mail: malgorzata.krzeczkowska@*
*uj.edu.pl*

**Latala, Hubert**
University of Agriculture in Kraków
(Uniwersytet Rolniczy im. Hugona
Kołłątaja w Krakowie)
Kraków, POLAND
*e-mail: hubert.latala@urk.edu.pl*

**Lis, Aleksandra**
Jagiellonian University
Kraków, POLAND
*e-mail: aleksandra.lis@uj.edu.pl*

**Lombardi, Andrea**
University of Perugia
Perugia, ITALY
*e-mail: andrea.lombardi@unipg.it*

**Maciejowska, Iwona**
Jagiellonian University
Kraków, POLAND
*e-mail: iwona.maciejowska@uj.edu.pl*

**Majer Kovačič, Janja**
Faculty of natural sciences and
mathematics
University of Maribor
Maribor, SLOVENIA
*e-mail: janja.majer@um.si*

**Malaga-Toboła, Urszula**
University of Agriculture in Kraków
(Uniwersytet Rolniczy im. Hugona
Kołłątaja w Krakowie)
Kraków, POLAND
*e-mail: urszula.malaga-tobola@urk.edu.pl*

**Mammino, Liliana**
University of Venda
Thohoyandou, Limpopo Province
South Africa
*e-mail: sasdestria@yahoo.com*

**Mancini, Luca**
University of Perugia
Perugia, ITALY
*e-mail: manciniluca00@gmail.com*

**Manzi, Stefania**
DICAM, University of Bologna
Bologna, ITALY
*e-mail: stefania.manzi4@unibo.it*

**Marcou, Gilles**
University of Strasbourg
Strasbourg, FRANCE
*e-mail: g.marcou@unistra.fr*

**Markic, Silvija**
Ludwig Maximilian University of Munich
München, GERMANY
*e-mail: s.markic@cup.lmu.de*

**Niemelä, Matti**
University of Oulu
Oulu, FINLAND
*e-mail: matti.niemela@oulu.fi*

**Occhicone, Alessio**
Università degli studi di Napoli Parthenope
Napoli, ITALY
*e-mail: alessio.occhicone@assegnista.uniparthenope.it*

**Perdih, Franc**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: franc.perdih@fkkt.uni-lj.si*

**Pinto, Gabriel**
Technical University of Madrid
Madrid, SPAIN
*e-mail: gabriel.pinto@upm.es*

**Podlipnik, Črtomir**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: crtomir.podlipnik@fkkt.uni-lj.si*

**Popescu, Delia-Laura**
Faculty of Chemistry,
University of Bucharest
Bucharest, Romania
*e-mail: delia.popescu@chimie.unibuc.ro*

**Prashar, Sanjiv**
ECTN
*e-mail: sanjiv.prashar@urjc.es*

**Prosen, Helena**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: helena.prosen@fkkt.uni-lj.si*

**Roviello, Giuseppina**
Università degli studi di Napoli Parthenope
Napoli, ITALY
*e-mail: giuseppina.roviello@uniparthenope.it*

**Russo, Vincenzo**
University of Naples Federico II
Napoli, ITALY
*e-mail: v.russo@unina.it*

**Rutkowski, Piotr**
Faculty of Chemistry
Wrocław University of Science and Technology, Wrocław, POLAND
*e-mail: piotr.rutkowski@pwr.edu.pl*

**Schaaf, David A.**
University of Saarland
Saarbrücken, GERMANY
*e-mail: david.schaaf@uni-saarland.de*

**Shealy, Craig**
Western Washington University
Bellingham, WA, USA
*e-mail: craigshealy@gmail.com*

**Sitnikova, Natalija**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: natasa.sitnikov@gmail.com*

**Skalar, Tina**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: tina.skalar@fkkt.uni-lj.si*

**Slapničar, Miha**
Faculty of Education
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: miha.slapnicar@pef.uni-lj.si*

**Szeląg-Sikora, Anna**
University of Agriculture in Kraków (Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie)
Kraków, POLAND
*e-mail: anna.szelag-sikora@ur.krakow.pl*

**Tarallo, Oreste**
University of Naples Federico II
Napoli, ITALY
*e-mail: oreste.tarallo@unina.it*

**Trzewik, Bartosz**
Jagiellonian University
Kraków, POLAND
*e-mail: bartosz.trzewik@uj.edu.pl*

**Veber, Marjan**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: marjan.veber@fkkt.uni-lj.si*

**Woźniakiewicz, Michał**
Jagiellonian University
Kraków, POLAND
*e-mail: michal.wozniakiewicz@uj.edu.pl*

**Zienkiewicz, Elżbieta**
Faculty of Chemistry
Wrocław University of Science and Technology, Wrocław, POLAND
*e-mail: elzbieta.zienkiewicz@pwr.edu.pl*

**Žgajnar Gotvajn, Andreja**
Faculty of Chemistry and Chemical Technology
University of Ljubljana
Ljubljana, SLOVENIA
*e-mail: andreja.zgajnar@fkkt.uni-lj.si*