The Need for STEM Continuous Professional Development at European Universities

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Abstract

The quality of university education is dependent on organizational elements, students' competences, and the effort and commitment of academic teachers that are influenced by motivation, competences and personal views about what good teaching practice is. The European Chemistry Thematic Network (ECTN) is committed to sustainable improvement of the quality of the university chemistry teaching practice. The ECTN Working group Lecturing Qualifications and Innovative Teaching Methods promotes innovative active learning methods, cooperation and partnership between the lecturers at different European universities in their continuous professional development (CPD) and exchange of knowledge and teaching experiences in an international context. This ECTN working group has initiated a new European project on continuous professional development of lecturers who teach in STEM disciplines (STEM means Science, Technology, Engineering and Mathematics) at European universities called STEM-CPD@EUni. The way of teaching is strongly connected with the discipline, teaching science in particular. The complexity, specificity and high level of conceptual knowledge in higher education make the university teacher the very expert who has the privilege and the task to make his/her own choices about the relevant content to teach, the teaching methods and the appropriate digital tools in order to create powerful learning activities on the way to making more profound the conceptual knowledge of students. The central idea of the project is to create a new type of actor to promote continuous professional development in STEM teaching, the CPD-Ambassador. This idea is based on the TPACK framework (a synergy of technological, pedagogical, and content knowledge of the lecturer). The STEM-CPD@EUni is an Erasmus+ Strategic partnership project of 5 European universities and the ECTN Association.

In this position paper, the argumentation for the start of the new project is given and the explanation of how the project aims to realize its goals.

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Professional development of teaching staff at university

The quality of university education is dependent on organizational elements, students' competences, and the effort and commitment of academic teachers that are influenced by motivation, competences and personal views about what good teaching practice is. There is a widespread belief in science faculties that teaching competences are a kind of innate gift or talent (Chalmers and Gardiner, 2015) or are acquired automatically along with teaching experience. Educational research shows that many lecturers teach in a traditional way “talk and show”, in the same way that they were taught (Oleson and Hora, 2014). Traditional lecturers believe in knowledge transfer and the value of imparting information as the main goal of their work rather than in the guidance in construction of knowledge by students (McAlpine and Weston, 2002). Consequently, there is a lack of confidence felt by lecturers, insufficient educational management in the sense and need to participate in competence development programsorganized for the lecturers at science departments. Researchers agree that the influence of specificity and organizational culture of individual departments cannot be ignored in the professional development of lecturers (Oleson and Hora, 2014; Chalmers and Gardiner, 2015). Once lecturers have finished training they should not be left alone at their department dealing with the resistance of co-teachers, colleagues and often superiors when they want to make changes (Postareff, 2007; Stes, 2010).

ECTN the promoter of good university teaching practice

Since 1996 the European Chemistry Thematic Network (ECTN) has been committed to sustainable improvement of the quality of university chemistry teaching practice. The ECTN Working group Lecturing Qualifications and Innovative Teaching Methods strives to stimulate the quality of newly appointed teaching staff. The working group promotes innovative active learning methods, cooperation and partnership between lecturers at different European universities in their continuous professional development (CPD) and exchange of knowledge and teaching experiences in an international context. The result of this ECTN Working group is a massive open online course (MOOC) intended for the professional development of university teachers who teach in laboratory courses: Teaching in University Science Laboratories (Developing Best Practice). This MOOC is freely available on the Coursera platform (Brouwer, 2016).

In continuation of this effort the ECTN Working group has initiated a new European project on continuous professional development of lecturers who teach in STEM disciplines (STEM means Science, Technology, Engineering and Mathematics) at European universities, namely, STEM-CPD@EUni. The central idea of this project is to create a new type of actor to promote continuous professional development in STEM teaching, the CPD-Ambassador. A CPD-Ambassador is a lecturer who has an ambition to improve teaching and learning at his/her faculty by a specific teaching innovation in his/her course. The CPD-Ambassadors organize activities for their colleagues in order to achieve the same innovation and to be able to implement it together in the local educational practice and to share the experiences in the community of CPD-Ambassadors.

Teaching in university STEM courses

Digital technology has been part of our daily life since the end of the 20th century. It is also part of the teaching and learning process, i.e. learning activities and assessments. Designing technology-enhanced learning activities should be a part of lifelong learning and a part of the CPD of every lecturer. The aim of most courses in higher education is to reach profound understanding (Biggs, 2011) on a high cognitive level. The way of teaching is strongly

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connected with the discipline, teaching science in particular. The research has proved (Freeman, 2014) that active learning significantly increases student performance in STEM courses and the recommendation is to omit traditional lecturing in the teaching of science. Teaching science requires from the lecturers, knowledge about how the learners construct specific science concepts and how to track down the students' misconceptions during their learning process and prevent them.
Teaching effectively using technology in this sense, entails choosing the appropriate tool for specific content and teaching method and also requires adjusting the course content and the teaching method to the chosen digital tool. Moreover, the requisites need to be mutually adapted and reinforced in order to empower learning by students.

Professional development of lecturers and TPACK model

At almost all universities some teaching training or workshops are organized for the teaching staff. This is done in different ways. Often general explanations are given about course design which is not very effective (Stes, 2010). Lecturers, often researchers who generally work under a lot of time pressure, do not have time to translate knowledge and apply it in their own science teaching practice. This is also the most difficult step in learning. A better way to ensure that lecturers/participants of the CPD activities are able to apply the knowledge they have acquired in their own teaching practice is to make professional development activities part of their teaching practice and synchronize the activities with their needs. This fits the adult learning philosophy which is based on the assumption that adults want to learn what they need, and that they are willing to take responsibility for their learning. The complexity, specificity and high level of conceptual knowledge in higher education make the university teacher the very expert who has the privilege and the task to make his/her own choices about the relevant content to teach, the teaching methods and the appropriate digital tools in order to create powerful learning activities on the way to profound conceptual knowledge of students. In the TPACK model, Mishra and Koehler (2006) (Figure 1) argue that teaching is most effective when content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK) are used in an integrated technological pedagogical content knowledge (TPCK) way, while taking into account the contexts in which teaching takes place.

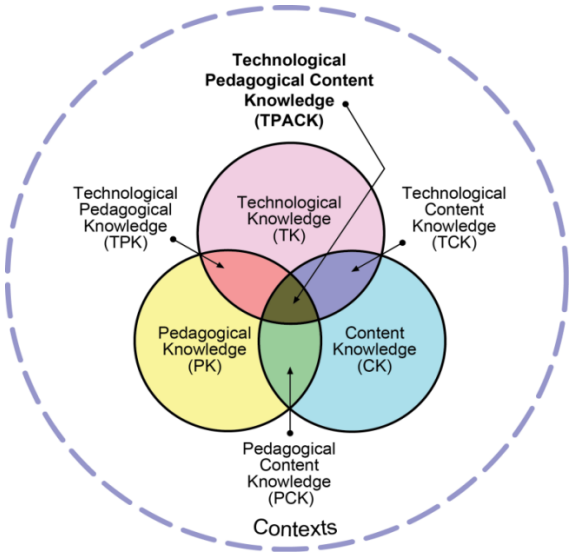

Figure 1: The TPACK model, taken from http://tpack.org © 2012 by tpack.org (Mishra & Koehler, 2006)

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By context, we mean specific aspects dealing with teaching such as specific level, specific discipline, specific situation of the learners or specific situation of the learning institution (Voogd, 2012). Using a TPACK approach, the professional development modules can be better integrated with the lecturer's teaching practice. In this way, it can be closer to the co-teachers and the institutional culture and as such are more powerful in changing the working environment of the participants of the modules (Brouwer, 2013).

STEM-CPD@EUni project

In 2019 the ECTN Working group Lecturing Qualifications and Innovative Teaching Methods designed an inventory to map out the situation of professional development of chemistry lecturers and teaching assistants (mostly PhD students). A pilot survey was sent to the ECTN partner universities and to other people involved with professional development of lecturers in European universities. 40 people from 38 different HE institutions from 19 different countries have completed the questionnaire. Except for three universities, in all the other universities professional development activities are organized. However, the differences between the activities that the universities organize are huge. They vary from some optional seminars for lecturers, training programmes with workshops, coaching and support, to certificated University Teaching Qualification programmes. None of the universities, however, require that the lecturers have a certificate in order to be allowed to start teaching. In the University Teaching Qualification programme the assessment / certification is based on the prior knowledge according to a list of required lecturer's competencies. According to this survey the portfolio is already used in 10 countries. Almost 70% of institutions organize general pedagogical training with no difference for participants regarding scientific disciplines in which they teach. Only at six universities (15%) the training is specifically organized for chemistry lecturers. At more than half of universities (56%) that took part in our survey, the training is organized as a mixture of traditional lectures and active learning sessions (workshops). In 2019, before COVID-19, when this survey was taken less than half (41%) universities paid any attention to the use of ICT tools in teaching.

Based on these results the ECTN Working group Lecturing Qualifications and Innovative Teaching Methods has decided to initiate anew project that will stimulate continuous professional development in STEM teaching (e.g. Chemistry) at university level and the use of digital technology in a pedagogically relevant way. We are convinced that the creation of a new actor in the field of CPD, the CPD-Ambassador will enhance the awareness of the importance of STEM teaching competence, continuously defining/recognizing the needs, and pinpoint the urgency of the STEM continuous professional development for sustainable improvement of the quality of teaching science, and specifically chemistry.

To achieve the goals of the project and enable sustainability the following activities will be deployed.

CPD-Ambassadors

To empower the local CPD activities at the STEM faculties in Europe during the project, a training programme will be developed for CPD-Ambassadors and during the project a summer school will be organized twice. The philosophy of these summer schools is to train the trainer in co-creation. At the summer school, the CPD-Ambassadors will gain knowledge, receive relevant material and also produce their own material to organize CPD activities at their home universities, the so-called user cases. To achieve these goals guidelines for the local CPD activities will be developed and tailored to the needs and expectations of the stakeholders. The guidelines will prioritize the output lecturer competences and establish the

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criteria for sustainable selection of topics/context of the CPD activities and the criteria for the certification of CPD-Ambassadors. The main goal of the certification of the CPD-Ambassadors is to reward their work in/for their local universities and make it visible also within the European context. In line with the needs for STEM-CPD at universities the training materials for CPD-Ambassadors will be developed in the form of short online CPD modules (microMOOCs). Alongside this, the framework to support CPD-Ambassadors in how to share their local experiences with other CPD-Ambassadors in the form of user cases will be developed. Last but not least, all activities in this project will be thoroughly evaluated.

Community of CPD-Ambassadors

After completion of the Summer school the CPD-Ambassadors will stay connected in a STEM-CPD community of practitioners to exchange their experiences and to support each other in their role of CPD-Ambassador. The Special interest group (SIG) STEM-CPD has already been established at the ECTN to connect lecturers and all those who acknowledge the importance of STEM-CPD in higher education. During the project period the members of this SIG can become an associate member of the STEM-CPD@EUni project and will be invited to join different activities of our project or become a follower who will be regularly informed about the project activities and its products.

The project consortium

The project consortium consists of 5 European universities: Jagiellonian University (Krakow, Poland), University of Amsterdam (Amsterdam, The Netherlands), University of Ljubljana (Ljubljana, Slovenia), University of Naples Federico II (Naples, Italy), University of Oulu (Oulu, Finland) and ECTN - European Chemistry Thematic Network**.** That group has been designed to combine partners representing the Faculties of Chemistry, with previous experiences and involvement in activities related to CPD as well as in international educational projects. Each partner brings their own expertise in the field as well as a particular experience in the project planning stage.

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