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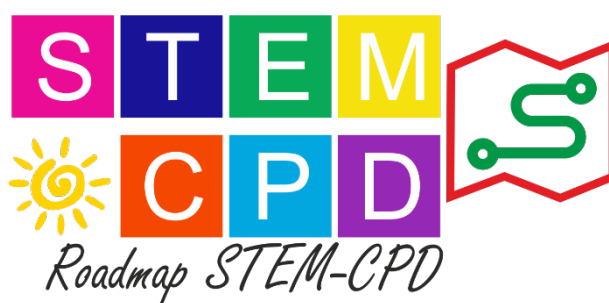


ROADMAP FOR

STEM

CONTINUOUS PROFESSIONAL DEVELOPMENT AT EUROPEAN UNIVERSITIES

Recommendations and Guidelines



<http://ectn.eu/work-groups/stem-cpd/>

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Table of Contents

| | |
|--|----|
| Executive Summary | 3 |
| Introduction | 4 |
| RECOMMENDATION 1 | 5 |
| Organize local CPD activities | 5 |
| RECOMMENDATION 2 | 7 |
| Promote student and CPD participant centred learning | 7 |
| RECOMMENDATION 3 | 8 |
| Follow Constructive Alignment and TPACK approach | 8 |
| RECOMMENDATION 4 | 10 |
| CPD-Ambassadors support three dimensions of STEM-CPD | 10 |
| RECOMMENDATION 5 | 13 |
| Train CPD-Ambassadors in the STEM-CPD Summer Schools | 13 |
| RECOMMENDATION 6 | 15 |
| STEM-CPD community support for the sustainable development of teaching and learning in HE STEM disciplines | 15 |
| References | 17 |



Executive Summary

Professional development in higher education (HE) continuously maintains and improves the teaching skills and knowledge of lecturers and is an indispensable element in ensuring the quality of higher education. An interplay between top-down and bottom-up approaches is essential to address and organize meaningful Continuous Professional Development (CPD) for lecturers in the context of their disciplines. Whilst top-down approaches are relevant in acquiring general knowledge in teaching and learning, a bottom-up approach is necessary to support its integration in practice and to develop knowledge in teaching and learning within specific disciplines, i.e. STEM disciplines (Science, Technology, Engineering and Mathematics). From November 2020 to January 2021, the STEM-CPD@EUni project conducted a survey of lecturers and education managers at European Universities with the aim of identifying the needs for continuous STEM professional development. Based on this survey we have proposed recommendations and established guidelines on how to develop and promote sustainable STEM continuous professional development at universities by organizing a bottom-up approach and introducing a new actor in CPD, the CPD-Ambassador.

The Roadmap for STEM continuous professional development at European Universities provides six recommendations with accompanying guidelines on how to follow them: (1) organize local CPD activities; (2) promote student and CPD participant centred learning; (3) follow Constructive Alignment and TPACK approach; (4) CPD-Ambassador support of the three dimensions of STEM-CPD; (5) train CPD-Ambassadors in the STEM-CPD Summer School; (6) STEM-CPD community support for the sustainable development of teaching and learning in HE STEM disciplines.



Introduction

New insights into teaching and learning in higher education Science, Technology, Engineering and Mathematics (STEM disciplines) are collected within the context of continuous growth disciplinary knowledge, the cross- and interdisciplinary connections to other disciplines and the complexity of social aspects of a changing world. Professional development in higher education that continuously improves the knowledge and skills of lecturers is an indispensable element in ensuring the quality of higher education teaching practice.

It is well known that content and context have an important implication on how we teach and what we teach (Shulman, 1987, Mishra, 2006). According to the report of the European University Association (te Pas, 2019) and based on results of the survey of the ECTN Working Group “Lecturing qualifications and innovative teaching methods” (ECTN WG, 2020), at most European universities there is some professional development organized. At most of them, the professional development programme follows a top-down approach, in line with the strategic aims of the institution and it has a general pedagogical focus. This implies that the lecturers need to apply the gained pedagogical knowledge to their own teaching context by themselves. Whilst top-down approaches are relevant to acquire the general knowledge in teaching and learning, a bottom-up approach is necessary to support its integration in the teaching and learning practice. In this way, new knowledge in teaching and learning in STEM disciplines is also created. The STEM-CPD@EUni position paper argues that CPD-Ambassadors, with the aim of improving the teaching competencies of university lecturers at their home universities and in consequence improving university courses, play a crucial role here (Brouwer et al., 2020). Ultimately, the interplay between top-down and bottom-up approaches is essential to address the complex and dynamic structure of the higher education programs as well as lecturers’ needs within their personal teaching practice and to create a meaningful CPD in the context of their disciplines.

Guidelines are needed on how to get insight into the needs of lecturers for sustainable continuous professional development which in turn will provide input for the necessary changes in university policy on CPD. From November 2020 to January 2021, the STEM-CPD@EUni project conducted a survey of lecturers and education managers at European Universities with the aim of identifying the needs for continuous STEM professional development. The survey contained 66 statements to evaluate. The survey was divided into three parts in which teaching competencies (Part 1), the educational attitudes (Part 2) and the type of CPD activities (Part 3) were mapped (Roadmap Survey, 2021). All statements were evaluated by the participants from two perspectives: general importance and the use in personal / programme practice. The results of this survey provided insights into the urgency in establishing STEM-CPD activities.

The Roadmap for STEM-CPD at EU Universities (STEM-CPD@EUni, intellectual output O1) aims to provide recommendations and guidelines for the bottom-up development of sustainable CPD activities in STEM disciplines to stimulate knowledge sharing. The sustainable CPD of lecturers can be understood as the approaches and activities that empower lecturers in their lifelong learning on how to teach while improving the quality of the courses and curricula in which they impart by improving their technological pedagogical content knowledge and skills (Mishra, 2006, STEM-CPD Framework, 2021).

The Roadmap for STEM-CPD supports lecturers in their personal educational professional development and encourages them to become CPD-Ambassadors and as such to become role models for their fellow lecturers. The Roadmap for STEM-CPD in higher education identifies six recommendations and provides guidelines on how to follow them.



RECOMMENDATION 1

Organize local CPD activities

The CPD-Ambassadors are the driving force of bottom-up professional development. They will organize CPD activities at their universities with the final goal of solving specific teaching and learning problems and to improve the quality of the courses. The CPD activities can be very diverse in their format. Relevant CPD activity formats will be discussed at the STEM-CPD Summer schools.

✓ Guideline 1

STEM-CPD User case

A STEM-CPD User case describes professional development activities that are organized by a CPD-Ambassador in a local context when facing a specific educational challenge. In general, several different CPD activities can take place in a certain period of time to solve one educational challenge. Each user case includes, among others, a microMOOC with interactive teaching and learning materials for lecturers for self-supportive learning (STEM-CPD Framework, 2021). The descriptions of the user cases are shared in the STEM-CPD community.

User cases are described according to a specific format (the format will be defined in STEM-CPD@EUni project, O3).

✓ Guideline 2

STEM-CPD Scenario

The STEM-CPD Scenario is a pedagogical description of a STEM-CPD user case. It defines the type and the sequence of the CPD activities in the learning environment over time (STEM-CPD Framework, 2021). Each user case is described by one STEM-CPD Scenario. Different user cases can be described by the same STEM-CPD scenario.

The format of how to present STEM-CPD scenarios will be defined in the STEM-CPD@EUni project, O3.

✓ Guideline 3

CPD activities take place in a blended learning environment

The CPD-Ambassadors organize the CPD activities closely related to the teaching practice, the so-called *workplace learning* (see STEM-CPD Framework).



A large part of imparting information and knowledge construction by the participants of the CPD activities takes place in a microMOOC as (inter)active asynchronous online learning. In this way, each participant can learn flexibly at his or her own pace.

Face-to-face or live online meetings with fellow lecturers enable discourse and collaboration to achieve deep learning (Biggs, 2011) and stimulate the implementation of knowledge gained in their own teaching practice.

In summary, the CPD activities take place in a blended learning environment consisting of the workplace, asynchronous online MOOC platform and synchronous face-to-face or virtual meetings.

✓ Guideline 4

CPD-Ambassadors use microMOOCs

The microMOOCs that are developed by the CPD-Ambassadors and shared in the STEM-CPD community are short and focussed on one topic / concept. They are developed following the ADDIE approach (Analysis, Design, Development, Implementation, Evaluation).

The microMOOCs have an active learning course design where learning outcomes, learning activities and assessment are in constructive alignment.

The microMOOCs are globally accessible for everybody and are exchanged / shared by CPD-Ambassadors for their use in the STEM-CPD User cases at local universities.



RECOMMENDATION 2

Promote student and CPD participant centred learning

The CPD-Ambassadors explicitly promote a student-centred approach and prioritize learning facilitation and interactive teaching over teaching by knowledge transmission and imparting information.

✓ Guideline1

CPD-Ambassadors enable (peer-)feedback and collaborative learning

Collect, share good practices and refer to literature on how to organize student-centred education. Organize collaborative learning and peer-feedback.

Organize collaborative learning in the group(s) of fellow lecturers based on the community of inquiry model (Garrison, 2000) (teach as you preach principle).

Organize meetings with guests (webinars) where good practices in the STEM student-centred teaching approach are shared.

Share experiences on collaborative learning in the STEM-CPD activities in the STEM-CPD community.

✓ Guideline 2

CPD-Ambassadors promote digital technology that supports active learning

Collect good practices and refer to literature on how to use a specific digital tool to support / organize student-centred education. Organize peer-feedback and collaborative learning.

Share experiences about the use of digital tools for active learning in the STEM-CPD activities in the STEM-CPD community.



RECOMMENDATION 3

Follow Constructive Alignment and TPACK approach

The aim of STEM-CPD is to improve teaching and learning in university STEM disciplines in order to make students more active, more engaged and more motivated in their learning process. To achieve this, the university courses need to have active learning course designs, which means that learning goals, learning activities and assessment are aligned with each other (Biggs, 2011) and the chosen digital technology fits the teaching and learning methods (activities) and the content (TPACK approach, Mishra, 2006).

The CPD-Ambassadors organize activities for fellow lecturers which help them to improve the design of their courses. The organized CPD activities follow the same principles (teach as you preach).

✓ Guideline 1

CPD-Ambassadors set and communicate Intended Learning Outcomes

The intended learning outcomes are set for every CPD activity and are clearly communicated to the participants.

✓ Guideline 2

CPD-Ambassadors evaluate CPD activities

Check if the intended learning outcomes of the CPD activities have been reached. This can be done by:

- Group reflection of participants (fellow lecturers) at the end of the activity
- Reflective journals (writing narratives)
- Self-evaluation, e.g. by using rubrics
- Peer-evaluation using rubrics
- Evaluation of learning outcomes using pre- and post-tests
- Combinations of the above

✓ Guideline 3

CPD-Ambassadors promote STEM teaching methods for active learning

Promote innovative teaching methods and small experiments that are used in STEM teaching practice in specific contexts to activate students in the learning process.



Collect the literature and good practices about STEM teaching methods and share them with fellow lecturers.

Meet with fellow lecturers to talk about innovative teaching and learning methods and how to apply them in local teaching practice.

Share experiences on organizing support for lecturers to encourage them to explore new teaching methods (experiments) in the STEM-CPD community.

✓ Guideline 4

CPD-Ambassadors promote relevant choices in digital tools

Encourage the use of digital tools that support active learning, critical thinking and stimulate learning to reach deep understanding (Biggs, 2011). Support mastery learning.

Demonstrate to fellow lecturers how to use a specific tool in the course or make a short manual for them.

Organize meetings with guests who present specific digital tools for their use in e.g. pre-lecture or pre-laboratory session preparation or bridging one's own (pre-) knowledge gaps at one's own pace.

Share experiences in the STEM-CPD community on organizing the support on how to make relevant choices in digital tools.



RECOMMENDATION 4

CPD-Ambassadors support three dimensions of STEM-CPD

In the STEM-CPD process we recognize three dimensions (STEM-CPD Framework, 2021):

1. development of teaching competences
2. development of teaching attitudes
3. development of CPD activities

The CPD-Ambassadors are the driving force of the three-dimensional development of STEM-CPD.

The Roadmap survey (2021) confirmed that the development in these three dimensions is necessary. It showed which competencies, attitudes and CPD activities the lecturers and educational managers find important and what is the actual situation in the personal / programme practice.

The CPD-Ambassadors are the driving force that stimulates STEM continuous professional development at their universities.

✓ Guideline 1

CPD-Ambassadors stimulate the continuous improvement of the STEM-teaching competencies in the local teaching practice

Motivate fellow lecturers to improve STEM-teaching competencies together.

Explore what the needs for innovation are in their local teaching practice. CPD-Ambassadors analyse, together with fellow lecturers, what problems students confront in learning specific content and together define competencies lecturers need to acquire in order to improve the courses in which they teach.

Exchange opinions about what needs attention and improvement with the local educational managers and motivate them towards innovation and developing a cadre of outstanding lecturers that can contribute with their expertise to local and national education frameworks.

Organize specific CPD activities that support the development of competencies that are required to tackle the different issues in the teaching practice. A list of STEM-CPD general competencies can be found in the Roadmap Survey (2021).

Organize the CPD activities that are of high importance and that need continuous attention:

- how to design interactive teaching
- how to engage and motivate students for active learning
- how to bridge (pre-)knowledge gaps



- how to organize peer-feedback
- how to stimulate deep learning
- how to use specific digital tools in STEM, e.g. laboratory teaching
- how to implement constructive alignment principle in the teaching practice

Propose instructional strategies that address the problems identified in the student learning.

Share knowledge and experience about the CPD activities in the STEM-CPD community and collaborate with other CPD-Ambassadors in Europe to address common goals.

✓ Guideline 2

CPD-Ambassadors stimulate continuous improvement of teaching attitudes

Act as a role model and motivate fellow lecturers to improve teaching competences together in the direction of student centred teaching and learning.

A CPD-Ambassador continuously improves his or her knowledge about teaching and learning in university STEM. The teaching attitudes as defined in the Roadmap survey (2021) are:

- Motivation / inspiration
- Evidence informed approach
- Pastoral interest
- Reflection, feedforward
- Sharing knowledge
- Giving peer-feedback
- Self-regulation (working on one's own development)

Reflect on their own teaching, attitudes and teaching beliefs and set personal professional development goals.

Motivate fellow lecturers to reflect on their teaching, exchange opinions (discussion) and to introduce different kinds of innovation.

Motivate, using their own examples and specific teaching approaches, fellow lecturers to develop knowledge and skills (competences) which are needed in order to improve local teaching practice in a specific field.

Support fellow lecturers in their individual professional development and give them feedback.

Use an evidence informed approach and estimate the changes and the effects after introducing any improvement or intervention.

Share the ideas about how to improve teaching attitudes in the local teaching practice in the STEM-CPD community and collaborate with other CPD-Ambassadors in Europe to address common goals.



✓ Guideline 3

CPD-Ambassadors choose appropriate CPD activities for their goal

Develop CPD activities that contribute to improvement of the teaching practice, in line with local needs and policies. A list of different CPD activities was defined in the Roadmap survey (2021):

- Learning facilitation (face-to-face or online)
- Imparting information
- Collaboration
- Peer-feedback
- Mentor-mentee support
- Personal / individual expert support
- Knowledge sharing
- Innovation project

Organize local CPD activities with the support of their own institution.

Select / design the CPD activities in alignment with the local culture and in collaboration with their fellow lecturers (participants).

Define intended learning outcomes of each CPD activity and communicate them to the participants.

Collect, select, develop and organize development of the necessary materials. The CPD activities provide lecturers with materials / instructions and guidelines on how to enhance and enrich student learning.

Actively monitor the materials and activities other CPD-Ambassadors are developing in Europe and share CPD materials with other CPD-Ambassadors.



RECOMMENDATION 5

Train CPD-Ambassadors in the STEM-CPD Summer Schools

The STEM-CPD Summer School is a study programme for CPD-Ambassadors. The programme covers fundamental concepts related to teaching and learning in STEM higher education and the role of the CPD-Ambassador. Lecturers from different universities (or different faculties) can join a STEM-CPD Summer School to become CPD-Ambassadors.

The STEM-CPD Summer School programme will be developed in the STEM-CPD@EUni project, O5.

✓ Guideline 1

CPD-Ambassador candidates apply for the STEM-CPD Summer School

Lecturers, who are potential candidates to become CPD-Ambassadors, need to apply for a STEM-CPD Summer School via an application form in which they provide a short proposal about their STEM-CPD User Case and provide motivation for their application by defining their personal CPD learning goals.

The application form will be developed in the STEM-CPD@EUni project, O5.

✓ Guideline 2

STEM-CPD Summer School is an active learning programme in a blended learning environment

The STEM-CPD Summer School study programme is based on active learning and is designed according to constructive alignment principle and TPACK model. Every STEM-CPD Summer School offers interactive workshops and training sessions, collaborative groups and (panel) discussion sessions. The STEM-CPD Summer School is strongly connected to the teaching practice of each participant (workplace learning principle). The STEM-CPD Summer School uses asynchronous online learning methods in combination with the synchronous (face-to-face or online) collaborative learning sessions.

In the STEM-CPD Summer School the CPD-Ambassador candidates work in small groups on their own STEM-CPD User Case that they bring with them to the STEM-CPD Summer School. During the STEM-CPD Summer School the CPD-Ambassadors develop their STEM-CPD User Case in order to improve their local teaching practice and give each other peer-feedback. The participants of the STEM-CPD Summer School implement the User Cases in their teaching practice when they return home from the summer school.



✓ Guideline 3

Implement user cases in practice and share Summer School information, knowledge and experiences in home university

Identify educational needs and define specific goals.

RECOMMENDATION 6

STEM-CPD community support for the sustainable development of teaching and learning in HE STEM disciplines

The STEM-CPD Summer School where CPD-Ambassadors are trained, the local STEM-CPD activities that are organized by the CPD-Ambassadors and the STEM-CPD community where CPD-Ambassadors share their knowledge and experience synergistically empower each other and support a sustainable development of teaching and learning in HE STEM (Figure 1).

✓ Guideline 1

STEM-CPD Summer School and STEM-CPD community support the local visibility and recognition of CPD-Ambassadors

The CPD-Ambassadors are issued with a CPD-Ambassador certificate for developing a local STEM-CPD User Case.

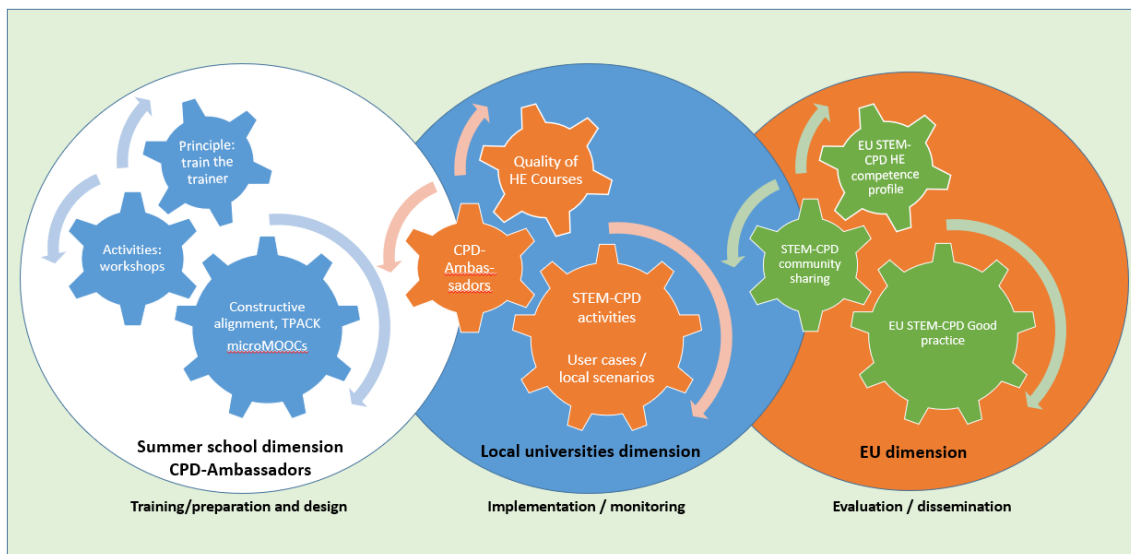


Figure 1: Sustainable development of teaching and learning in HE STEM at European Universities.



✓ Guideline 2

CPD-Ambassadors contribute, by sharing their local experience, to the development of knowledge about STEM-CPD in Europe

The experiences are collected in the STEM-CPD community. In the STEM-CPD community the knowledge and experience are shared in creative commons licence.

✓ Guideline 3

CPD-Ambassadors support each other and encourage fellow lecturers to become CPD-Ambassadors

The STEM-CPD community organizes activities and collects materials for both new and experienced CPD-Ambassadors.



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