

# ANALYSIS OF THE EVOLUTION OF A STEAM LECTURER-TRAINING PROGRAM BASED ON COMPETENCIES IN AN HYBRID CONTEXT

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## **ABSTRACT**

The objective of this work is to present an innovative lecturer’s training program developed at UPC-BarcelonaTech while transitioning to a semi-presential hybrid scenario due to the pandemic. This “Postgraduate Degree in University Teaching in STEAM” was designed based on the teaching competencies that a lecturer should possess in Engineering-related subjects. Focus was placed on a final project to help lecturers implement innovations in class with their students. When the confinement

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due to the pandemic started, it was evident that many lecturers had a clear deficit on digital competencies to conduct their teaching on-line. This paper presents an analysis on the changes undertaken in the program after a year of hybrid teaching, their impact on the teachers and on the participants of the program. A more flexible syllabus, the addition of digital education courses for lecturers, and a more research-oriented program are important factors that have improved the quality of the program. Results show that participation in the courses offered during this exceptional period radically increased for some areas such as digital on-line technologies for education, while the egressed number of participants did not change significantly from previous editions. Specific recommendations are provided for Engineering Education programs, as the perception of the importance of some of these competences by the instructors are found to be significantly different among different STEAM fields of knowledge. Valuable lessons have been learned in this process, with some of the changes undertaken having a good prospect to stay in the near future.

## **1 INTRODUCTION**

The pedagogical training of university lecturers is usually the result of voluntary self-training based on seminars or training activities, and above all on reflections arising from teaching experience. Lecturers' opinions of their own work as teachers derive from previous experience: former students who attend their lectures, the subject being taught, and mainly on their own beliefs, which induce them work as if these beliefs were true. Such beliefs are relatively static and resistant to change, as well as being consistent with the teaching style of each lecturer. It is difficult for lecturers to change their beliefs, particularly if they are intuitively reasonable [1].

We present a teachers' training program designed at our university, the Universitat Politècnica de Catalunya – BarcelonaTECH (UPC), undertaken by the Institute of Education Sciences (ICE), to which the authors of this work belong. This training is non-mandatory for the participants, because, no specific pedagogical background is required for teaching at our universities, other than knowledge of the subject to be taught. Since the training programme is voluntary, lecturer enrolment is usually rather low, so specific motivation tips are required to increase participation.

Our University is a technical one, specialized in architecture, mathematics, science and engineering. In our University we have no schools and departments of psychology or education, or any tradition of using social science methods. Provided this context, our lecturers have the technical competencies required for teaching, but not necessarily the professional competencies required for conducting this teaching.

Non-mandatory lecturer training is particularly problematic in the particular context of engineering studies, which traditionally have one of the highest dropout rates in higher education. We certainly agree with Patricia Cross [2] when she states that teaching will not acquire status until teachers do consider their classes as laboratories for research and innovation. The problem is that the innovation and research that are conducted at our university (mostly technical) do not use the same methods as those

traditionally used in the social sciences, which are precisely the ones that would apply to education. Thus, it is necessary for our faculty also to acquire competencies related to these issues.

Our previous training programme followed the pre-Bologna pattern: it measured on-site hours and was based on course content rather than on the competencies to be acquired by the teachers participating in the training activities. Degrees have moved from content-based learning to competencies-based learning, the focus being on learning rather than on teaching [3]. Hence we proposed a training program whose objectives were:

- To design a training itinerary for lecturers based on the competencies they must acquire as teachers, as well as providing a qualification certifying to that fact. This training should also cover lecturer evaluation and promotion.
- To increase the number of lecturers enrolling in our training programme.
- To use this training programme to promote a scholarship in engineering education research, a field of scientific inquiry that has usually been ignored by our teaching staff. Our aim is to promote the creation of an inner university network of engineering education researchers who innovate and publish their innovations.

First of all, we were interested in identifying which were the teacher competencies that were important for their professional practice at UPC, including an hybrid educational context. Second, we wanted to address the difficulties faced by the teachers following an academic career to improve their teachers competencies, with a design of an hybrid postgraduate training program based on competencies.

## **2 METHODOLOGY**

### **2.1 Understanding lecturers' competencies**

Lecturer training in Engineering has been the object of study in recent years (e.g. [4]). These studies focus on the methods and tools required for quality teaching practice. The inclusion of professional competencies in engineering studies has also been widely studied. The ABET engineering criteria [5] can be divided into hard and professional competencies. The rapid changes in contemporary society make the acquisition of professional competencies increasingly indispensable, so the question of how to teach and assess these competencies has in recent years been the focus of several works (see for instance, the comprehensive review by Shuman et al. [6]).

In 2011, the Interuniversity Training Group for Teachers (GIFD), consisting of teachers responsible for training at the eight Catalan public universities, conducted a bibliographic study on the competencies that a university professor should possess. These eight universities account for 149,116 out of the 169,418 university students in Catalonia at the time (88%). A focus group composed of 64 teachers in which all fields

of knowledge were represented discussed the initial results. From this study, and once the validation was concluded, the following six competencies required by a university teacher were identified:

- Interpersonal competence: know-how to help students to develop critical thinking, and the recognition of diversity and individual needs.
- Methodological competence: knowledge of the modern methods and strategies of teaching and learning, and awareness of different learning models.
- Communicative competence: teachers should develop communication processes in an appropriate and efficient way, which means reception, performance, production and transmission of messages through various media channels in a contextualized teaching-learning situation.
- Planning and management competence: know-how to design, guide and develop content; training and evaluation so that the results can be measured and suggestions for improvement be made.
- Teamwork competence: this competence does not consist in teachers leading a group of students working together, but rather the ability of teachers to collaborate and participate as the member of a group.
- Innovation competence: know-how to create and apply new knowledge, perspectives, methodologies and resources in the different dimensions of teaching.

As a consequence, our first decision was that the training programme should be based on these six competencies. The training for the lecturers was based on a continuous improvement process: design, teach, evaluate and supervise. Courses were designed by providing some basic principles of the topical skill followed by a reflection on the teachers' practice and a supervised action plan for improvement.

## **2.2 Scholarship of Teaching and Learning**

Promotion of lecturers is based mainly on research, so good teaching (and therefore lecturer training) seldom is an important factor taken into account and may even be a handicap, because every minute devoted to improving the quality of students' learning is time during which lecturers are neither producing papers nor applying for research grants. Given this situation, we decided to organize the training programme as a Postgraduate Degree for our lecturers. In order to bring about a real change in the way our teachers address the teaching-learning process, our lecturers must consider their classes as laboratories for research and innovation. Engineering Education Research has become an emerging field of scientific research. There is a growing community of scholars involved in reflective practice concerning the so-called "Scholarship of Teaching and Learning (SoTL)". Boyer [7] defined it and since then the concept has become a process in which "faculty frame and systematically investigate questions related to student learning".

It is perhaps somewhat ambitious to ask our lecturers to undertake a deep research task in education, because they are occupied in their own field of research. However, there exist three areas of this scholarship [8]: 1) Scholarship of discovery, where contributions are primarily in the form of new knowledge; 2) Scholarship of integration, where contributions are multidisciplinary, integrative, and/or interpretive syntheses across vast prior research to identify patterns, themes, trends, needs and opportunities upon which other scholars can build; and 3) Scholarship of application, where contributions often describe how prior research into learning and teaching has been applied to creating or designing educational activities. Part of the training programme is aimed at building a research network to enable lecturers interested in education to get to know each other, collaborate together and publish their findings. It is also necessary to detect the key players in our university Engineering Education Research network in order to provide them with institutional support to continue working in the teaching-learning process.

### **3 OUR STEAM LECTURER-TRAINING PROGRAMME PROPOSAL**

#### **3.1 Initial proposal**

After analysing and reflecting on what competencies were needed for our teaching staff, planning was started and a competency-based training programme for trainers was designed using an action research methodology [9] based on interviews with teachers and current and former students. A postgraduate degree in University Teaching in Science, Technology, Engineering, Arts and Mathematics (STEAM) was created and officially started in September 2015.

This postgraduate programme consists of 15 ECTS credits for student dedication, which are divided into 6 credits corresponding to the acquisition of the six basic competencies, 6 credits devoted to a Final Project, and the remaining 3 to complementary training. Learning consists of training activities in which postgraduate monitoring is based on a teacher portfolio. The Postgraduate diploma will be awarded if the student passes at least 1 ECTS (25 hours) for each of the six core skills; and successfully defends her or his Final Project.

#### **3.2 Transition to an hybrid teaching context**

After 15th March 2020 a strict lockout was ordered by the Spanish Government due to the pandemic outbreak. The Mayor of the University ordered that all presential classes should continue online. By then, it was evident that many of the academic staff did not have the technology nor the skills to undertake such a sudden radical

change in their teaching. The Institute of Education Sciences (ICE) in our University, responsible for teachers training, immediately started a fast-track series of online courses specifically aimed at this emergency requirements. Among them, there were courses designed to use the technology (hardware and software including Google Meet), design classes online, provide communication skills in an online environment, and providing videos and podcasts with tips to increase teachers' competencies.

Regarding the Postgraduate program, we introduced some changes that were scheduled for the next course, and others specific for this situation. Flexibility measures were enforced letting all students undertaking the Final Project to present it in the format of a research or practice paper, instead of requiring a 50-page project. Taking into account the huge load of work and pressure that the academic staff was experiencing at the time, we were sure that this was going to facilitate the completion of their degree without renouncing to the academic rigour of the Degree. All courses were changed to online settings, including the defence of the Final Projects. Regarding the already scheduled changes for the next year, we allowed that mandatory workshops could be substituted by other courses in the ICE teachers' training program which also contributed to the training in the same skill. An accountability was enforced so that each student will be assessed by the successful completion of training in each of the aforementioned skills, taking into account that different courses may provide training in different skills at the same time, with a differentiate training load for each one of the competencies. At the end, all students in the program should have completed 1 ECTS of dedication in training for each of the skills. Finally, an additional skill ("Training in digital education") was added as mandatory to complete the program. This skill considered training in online teaching design, use of technology, educational software and tools, and digital skills.

## **4 RESULTS**

### **4.1 Initial Results**

The Postgraduate Degree in University Teaching in Science, Technology, Engineering and Mathematics (STEM) started in September 2015. A total of 114 participants (approximately 5% of the total number of teachers at our university) enrolled for this programme. Most participants come from the Civil Engineering department (19), Management (15) and Computer Science (15).

Most participants are in the mid-stages of their careers (associate professors, 64%), while the least represented category in the programme corresponds to Full Professors (7%). Initial stage teachers represent 29% of the participants. With respect to teachers' perceptions, the general average of surveys in mandatory subjects is 4.3 (out of 5, Likert Scale). We sought the participants' opinions on the training received in two basic ways: open questions when being surveyed and some focus groups with

external observers at the end of this latter term. Participants outline as very positive the workshops structure of the program, as they perceived that their teaching experience has benefit from it. This may be the result of a design based on the SoTL principles. They also expressed their difficulties for having to followed a fixed presential schedule to be able to complete the program. Current regulations in Universities in Spain do not make training programs such as this one as mandatory, as the promotion of lecturers are mainly based on their research productivity. It is expected that a creation of SoTL culture in higher education may present this field of practice more attractive for the lecturers to invest their time on it.

## 4.2 Results after the transition to an hybrid context

The demand for immediate training from the UPC Faculty was huge, but a big effort was put in place by ICE and the Academic Board of the Postgraduate Program to respond to these unprecedented training requirements. More than 50 online courses were programmed since lockout in the academic course 2019-20, with more than 1,500 hours of online training being put in place for the first time. At least 1 out of 3 teachers from the UPC academic staff took at least one training course, which is an unprecedented number. These facts reflect the outstanding interest by the academic staff for training in order to respond to the needs of their students in this obviously unexpected learning context. Ten students from the STEAM Postgraduate Degree successfully finished their Final Project, which is a figure reported similar to that in previous years (Table 1) or indeed higher. When compared to previous training programs such as PROFI and PIDU, the STEAM program scores favourably in terms of teachers participation and certification. An estimate number of 15 students more are expected to finish their Degree during this Academic Year 2020-21. During the academic course 2020-21, as restrictions due to the pandemic were still enforced, all the training courses were held online, and all previous changes in the training program were held.

*Table 1. Participants and certified students at ICE-UPC teacher's training programs.*

Program	PROFI	PIDU	STEAM
Years	1999-2012 (13 years)	2012-2015 (3 years)	2015- ongoing (6 years so far)
Training hours	130	150	375
Total participants	979	70	1.536
Certified	197	7	45 (15 more expected by 2021)

Regarding the students' satisfaction, according to the usual survey conducted at completion of each training course, an average of 4.6 out of 5 in a Likert scale was obtained, which is very satisfactory outcome, higher than the average value in the last three academic courses (4.2). Some open comments were received, including a specific approval of the flexibility measures introduced in the Postgraduate Degree.

## **5 DISCUSSION**

In our opinion, engaging our lecturers in the teaching-learning process requires similar approaches to those employed in student engagement, such as those presented by Astin [10]. We have applied the same principles to our lecturers: First, to encourage them to participate in challenging activities; second, to show them that the knowledge they are acquiring is relevant for their professional future. In the third place, convince them that the profession they chose has a real impact on the world, and stimulating them to reach creative solutions for resolving real problems, and, finally, Create collaborative activities to enable lecturers to cooperate in order to achieve a deep knowledge of their profession. It is our aim that our former Postgraduate Degree students become mentors of the new projects by involving them in the Education Engineering Research network and encouraging them to try new approaches and get out of their comfort zone. To this end, a new Doctorate in Engineering Education has started this academic course in our University, based on this EER group.

The pandemic outbreak has tested the capacity of the teachers' training programmes and staff in an unprecedented and unexpected way. The key elements to overcome the huge challenge of responding to a peak of sudden demand in training were:

- Rapid determination of new needs and evaluation of resources.
- Use of digital technologies
- Flexible syllabus
- Rapid adaptation to the online format for training
- Proactive communication with the teachers
- Orientation to skills training rather than teaching based on contents.

## **6 CONCLUSIONS**

In this paper an innovative STEAM Postgraduate Teachers' Training Program based on competencies has been presented. Its design was based on the principles of the Scholarship of Teaching and Learning as a reflective practice. A successful fast transition to an hybrid educational context has been described. Results from its implementation in a technical university after six years of implementation have been shown and discussed with a promising outcome.



We are certainly convinced that the main reason for the success of the programme is that our lecturers find the training programme both challenging and useful for their present needs, and for their career as well. They also benefit from the incentive of belonging to a network of colleagues who share the same interests, concerns and goals. This is particularly true for a sudden, unexpected situation such as the pandemic outbreak.

More research is required to detect the real impact this work is having on both students learning and performance and on the number of lecturers who are becoming increasingly involved in the engineering education innovation and research field. Some of the changes undertaken regarding an online, hybrid teaching environment are likely to stay after the pandemic restrictions are over. New studies will be needed to evaluate how this evolution enforces new changes in the way quality higher education teachers' training is conducted.

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