

International practice of capacity building in engineering education: a comparative case study

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INTERNATIONAL PRACTICE OF CAPACITY BUILDING IN ENGINEERING EDUCATION: A COMPARATIVE CASE STUDY

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ABSTRACT

Capacity building is a corner stone for having well prepared and effective teaching staff in engineering education. Despite the importance of capacity building in engineering education, there is relatively little research on this topic. In this paper, we address this gap by reporting on an international comparative study on capacity building practices in university-level engineering education. We examine how capacity building is organised in seven European institutions (in Belgium, Finland, France, Germany, Hungary, Sweden, UK) and Australia, based on institutional education policies and practices. We compare the preparation of teaching staff, their initial training, and continuing capacity building activities throughout their careers. To do this, we applied a qualitative approach, collecting data through (1) a structured questionnaire answered by the members of the SEFI SIG on Capacity building and (2) written notes produced during an international workshop on capacity building at the 2021 SEFI conference. We then conducted a comparative case study, exploring similarities and differences between incentives for permanent academic staff to engage in capacity building, how capacity building is organised, and at what point in their careers staff engage in it. Our findings indicate very diverse approaches, rules and practices as well as different obstacles and challenges for engineering education. The outcomes of our study can be used by policy makers to inform capacity building practices and engineering education in HEIs (Higher Education Institutions), and our questionnaire provides a tool for monitoring and reporting practices throughout the sector.

1 INTRODUCTION

Accelerated technological development, population growth and environmental change lead to constant changes in the sociotechnical landscapes in which engineers operate. These changes necessitate responsiveness in engineering education to prepare students for the shifting realities of the workforce and society at large. As the purveyors of technical content and professional socialization, engineering educators play a key role. Changing expectations for engineering graduates and developments in cognitive science have emphasized the need for educators and institutions to engage in capacity building [1]. Capacity building, also known as pedagogical training or professional development, is an important mechanism for improving engineering education [2]. Academic staff who participate in capacity building are more likely to use active learning pedagogies and student-centered approaches [3], and the adoption of such evidence-based practices improves learning and student outcomes [4].

In this study, we collected and analysed data regarding the ways in which capacity building (pedagogical training) is organised for permanent academic staff at nine institutions that offer engineering programs. Employing an exploratory, comparative approach, we address the following research questions (RQs):

RQ1 What are the incentives for permanent academic staff to engage in pedagogical training?

RQ2 How is this pedagogical training organised (who designs and delivers the provision, and how tailored to a specific discipline is the training)?

RQ3 At what point in their careers, and how frequently, do permanent academic staff engage in pedagogical training?

2 LITERATURE REVIEW

The notion of *capacity building* has been defined as 'the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time' [5:5].

Even though capacity building has been shown to benefit staff development and student learning, research in the United States has shown that participation is generally low and that most engineering educators continue to learn by trial and error [6]. Further, most capacity building opportunities in the United States are organised by social scientists (having no, or little, engineering background and teaching expertise) for a campus-wide audience and without discipline-specific examples and practices [7]. Consequently, 'there is generally neither a meaningful incentive for engineering faculty members to participate in instructional development nor meaningful reward for any improvements in teaching that may result from their participation' [7:90-91]. Perceptions of incentives and barriers can vary depending on the different roles academic staff have in their institutions; According to Sabagh and Saroyan's [8] comparative study, there are significant differences between permanent and non-permanent (tenured and non-tenured) academic staff's

continuous engagement in capacity building for pedagogical improvement. In particular, non-permanent academic staff are more influenced by institutional cultures, which are often perceived as unsupportive of teaching excellence compared to research due to, for example, perceptions of a lack of appreciation, professional rewards and support for teaching activities and development. Permanent academic staff identified high workload and lack of time as the main barriers to engage in capacity building. However, in their study, Felder et al. [7:90] identified several incentives for engaging in capacity development, including institutions placing high value on teaching, teaching improvement activities, self-motivation, efficiencies of time, and teaching evaluation [see also 12].

Another challenge in capacity building is the lack of time and incentives for sharing results and effective practices, unlike in research where there are clear and relevant incentives for sharing results [9]. Furthermore, even when staff have an individual interest in teaching improvement activities, high requirements for research productivity can prevent academic staff from dedicating effort and time for it.

The challenges for academic staff to engage in capacity building are different during early-, mid- and late-career stages [7]. Therefore capacity building programmes need to ensure relevance throughout academics' entire careers. Provision of capacity-building opportunities for early-career academic staff is crucial for an institution's education performance as these educators often provide the majority of undergraduate and practical courses, thus playing a significant role in students' education [10]. Contrarily, if there is no required initial training (e.g., teaching certificates) for new academic staff – or only limited opportunities for participating in adequate professional development programmes –, early-career staff are forced to resort to developing their teaching skills through trial and error, based on their personal experience and with limited efficiency.

3 METHODOLOGY

To explore similarities and differences in capacity building practices across institutions, we developed and distributed a survey among the members of the Special Interest Group of SEFI focusing on Capacity Building (https://www.sefi.be/activities/special-interest-groups/capacity-building/). The following 9 institutions are considered in this study: (1) Budapest University of Technology and Economics (Hungary), (2) ENSTA Bretagne (France), (3) Hamburg University of Technology (Germany), (4) KU Leuven (Belgium), (5) LAB University of Applied Sciences (Finland), (6) University College London (UK), (7) University of Technology Sydney (Australia), (8) Umeå University (Sweden) and (9) Vrije Universiteit Brussel (Belgium).

The survey was designed based around qualitative data and arising themes from a preliminary discussion in the SIG meeting at the 2021 SEFI conference covering capacity building approaches at 7 of the included institutions. We developed four multiple-choice questions with response alternatives that covered all scenarios we identified during the preliminary discussion. For each question, we also included two

open-ended alternatives (“other”, “comments”) to allow participants to enter responses that had not previously emerged. Finally, we added an additional open-ended question (“comments”) at the end of the survey. Participants were required to respond to all multiple-choice questions, but open-ended questions were optional. For each question, it was possible to select multiple answers. The survey (See Appendix) was administered through a web survey tool.

4 RESULTS

The findings of the study are presented in the following three sub-sections, directly related to the three research questions (see above).

4.1 Incentives

To gather information regarding the reasons why staff engage in pedagogical training, we asked: “What incentives do permanent academic staff at your institution have to engage in pedagogical training?” Response items are related to three types of incentives: (1) formal requirements (mandatory for all/part of the permanent academic staff or required for promotion), (2) formal incentives (wage setting or non-economic incentives, such as diploma or awards) and (3) informal incentives (valued by colleagues, students or others outside of the institution). The exact wording of the response items can be found in the Appendix.

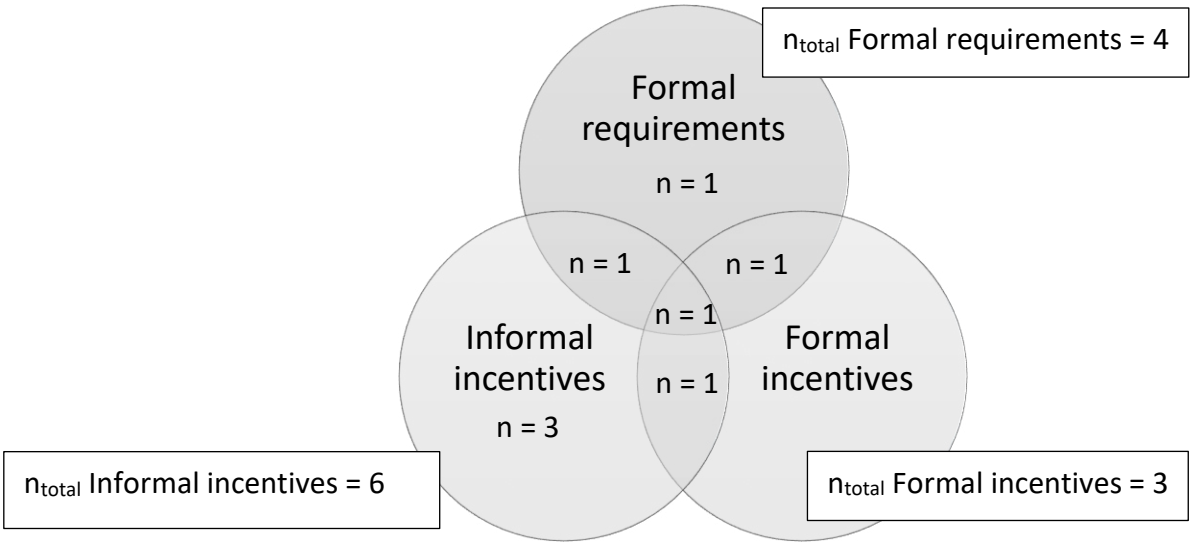


Figure 1. Overview of responses concerning incentives

The responses to this question indicate that all three types of incentives are used at the included institutions, but that informal incentives may occur slightly more often than formal requirements or formal incentives (Figure 1). For only one institution, no incentives or requirements were reported. More specifically, the results indicate that *formal* requirements are in place at only 4 of the included institutions. *Formal incentives* were identified for 3 institutions, two of which also have formal requirements. Examples of formal incentives are: (1) including criteria related to

pedagogical training for wage setting or promotion, or (2) pedagogical awards and diploma. In total, formal requirements and/or formal incentives were identified for five institutions.

Six institutions provide *informal* incentives, such as (1) opportunities for teachers to meet for stimulating pedagogical discussions, supportive networks, opportunities to meet pedagogical experts, (2) support for dealing with teaching challenges and saving time, (3) recognition by colleagues and university leadership, and (4) intrinsic motivation. 3 institutions provide only informal incentives and only one respondent indicated that their institution has both formal requirements, formal incentives, and informal incentives.

4.2 Organisation

Participants were asked about the ways in which pedagogical training is organised at their institutions. We asked two separate questions to explore this aspect of pedagogical training. The first aimed to explore the level within the institution where pedagogical training is designed and delivered. Response items for this question included organisation at the national/regional, institutional, faculty, or departmental level (see Appendix). 7 of the 9 participants indicated that pedagogical training at their institutions is organised in a top-down manner, by a pedagogical development centre or other entity at their institution (Figure 2). 3 of these participants also indicated that faculties organise additional training for their teachers. Free text answers related to this item further indicate that training at the faculty level tends to be organised in a bottom-up manner – as a response to pedagogical challenges experienced by the faculties' staff. One participant indicated that pedagogical training at their institution is organised at a national level. Thus, 3 of the included institutions appear to combine top-down and bottom-up approaches to pedagogical development, while 5 institutions only employ top-down approaches. One participant indicated that no pedagogical training is offered at their institution at any level.

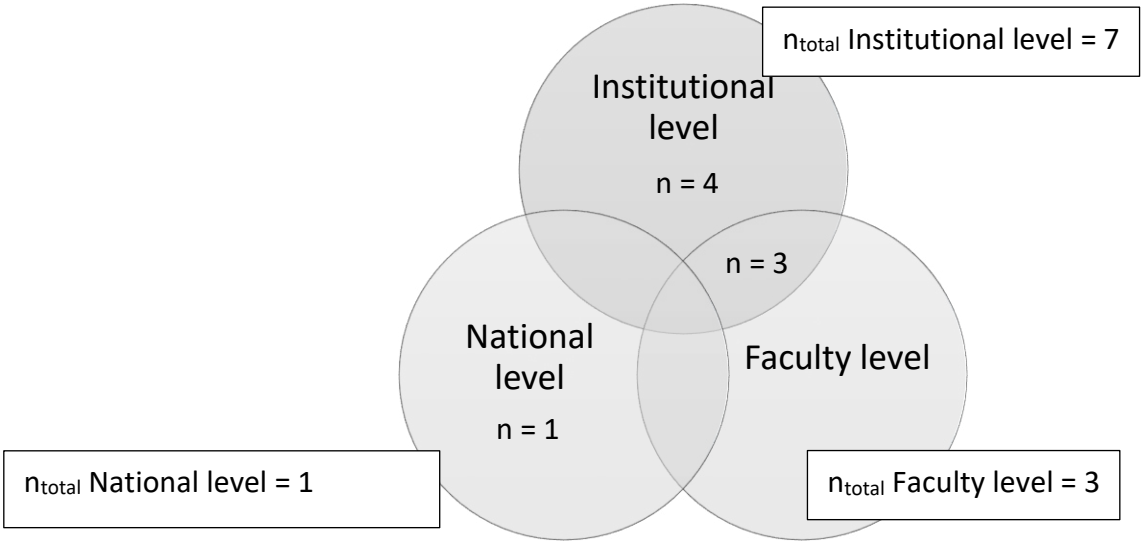


Figure 2. Overview of responses concerning organizational levels

The second question focused on the level of discipline specificity with which pedagogical training is organised: “How is pedagogical training organised across different faculties/disciplines at your institution?”. Response items for this question included options indicating (1) multidisciplinary (open to staff from all faculties/disciplines), (2) disciplinary (tailored to staff from a specific faculty/discipline), and (3) generic monodisciplinary (offered to staff from one faculty/discipline, but not tailored to their disciplines) approaches.

Participants’ responses indicate that the majority of the included institutions (n=8) employ multidisciplinary approaches, often combined with monodisciplinary or generic monodisciplinary approaches. One institution was categorized as not offering any pedagogical training.

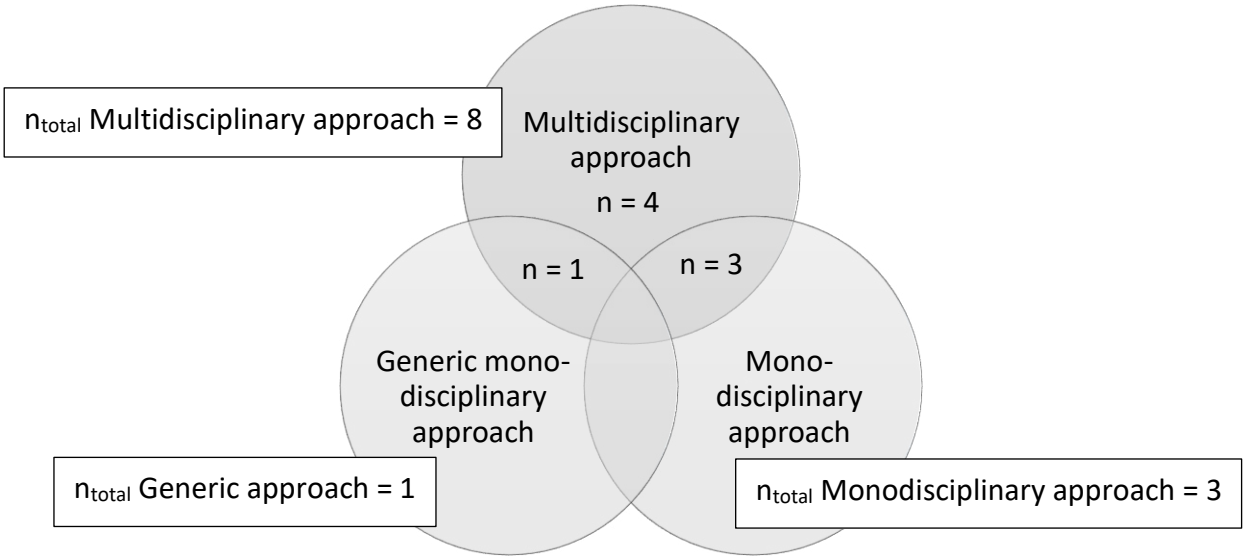


Figure 3. Overview of responses concerning organizational approaches

4.3 Participation

To gather information about participation in pedagogical training, we asked: “At what point(s) in their careers (after obtaining a permanent academic position) do staff at your institution engage in pedagogical training?”. Response items for this question included options indicating whether staff primarily participate in pedagogical training early (first five years after obtaining a permanent position) or later (after more than five years after obtaining a permanent position) in their careers. Most of the responses (n=7) indicated that training typically occurs early in academics’ careers. Just one institution indicated that pedagogical training is more common during later career stages and one institution was, again, categorized as not offering any pedagogical training.

Finally, we asked about the frequency with which staff members engage in pedagogical training. Only three of the participants indicated that staff members at their institution), on average, engage in pedagogical training at least once a year.

5 DISCUSSION

Our results indicate a diversity of approaches, rules, policies and practices related to capacity building. This is in line with findings from other studies: even research focusing on just research-intensive institutions within a single country (UK) have found that "job titles, expectations, development opportunities, reward systems and careers structures of educators vary widely across institutions" [11]. It would be valuable to explore possible reasons for, and effects of, this diversity, as it may indicate both strengths (e.g., that many capacity building programmes are developed in context-sensitive approaches) and weaknesses (e.g., that many capacity building programmes are developed ad hoc and without clear aims and strategies).

Our analysis of *incentives for engaging in capacity building activities* shows that no institution in our study solely offers formal incentives; these are always coupled with either formal requirements, which may indicate commitment from senior leadership, or with informal incentives such as peer esteem and networks, which may indicate an environment where good practice and engagement with pedagogical development is valued locally. We have also observed a relatively low overlap between formal requirements and informal incentives, which raises questions about whether and how they are related. Are there any systematic differences in how formal requirements and informal incentives are organised across contexts? Could formal requirements decrease rather than strengthen a culture in which pedagogical training is valued by students and colleagues? Or do institutions that lack a strong tradition of valuing pedagogical training resort to formal requirements to increase participation and the perceived value of training activities?

In our analysis of *how pedagogical training is organised*, we noted that some institutions combine top-down and bottom-up approaches, while others only seem to employ top-down approaches. It would be interesting to explore opportunities and challenges that may arise when institutions in different contexts employ either or both of these approaches and the reasons for their decisions to do so. This may be related to Felder et al.'s [7] conclusion that there is no meaningful perceived incentive for engineering educators to participate in capacity building organised at institutional level where there is a lack of discipline-specific examples.

Further, our results indicate that permanent academic staff, on average, *engage in pedagogical training less than once a year.* We also found that staff at most of the included institutions primarily engage in pedagogical training during their first five years of employment. These findings suggest that continuous pedagogical development may not be adequately valued or prioritised at some of the included institutions. More specifically, it appears that pedagogical training is often deemed necessary/desirable for junior academics, but that senior staff do not need to continue developing their pedagogical skills.

Finally, we observed the following *potential relationships between dimensions* explored in this study*:* (1) If pedagogical training is not valued throughout the organisation and as part of permanent academic staff members' careers, informal incentives will likely be weaker. It may also be that the relationship with the incentives on offer may change over an individual's career or that the opportunities for engagement with relevant capacity building decrease as careers progress. (2) In our sample, we noticed that institutions with monodisciplinary approaches have 'formal' requirements and institutions with frequent engagement in pedagogical training have 'formal' incentives or requirements. We therefore suggest that future research should explore any potential relationships between the ways in which pedagogical training is enforced or valued through different forms of incentives, how pedagogical training is organised in terms of disciplinary approaches and levels of organisation, the frequency with which permanent academic staff engage in it, and at what stages in their careers they do so. We expect that both large-scale, quantitative analyses and in-depth qualitative studies will be needed to better understand the role of capacity building for improving engineering education practice.

Limitations

Due to the complexity and large variety in institutional organisation of capacity building, interpreting the results has been challenging. More in-depth research will be needed to explore nuances, for example regarding different groups of academic staff. It should also be noted that all participating institutions are active members of SEFI, with staff who engage in the Capacity Building SIG, which may have influenced their experiences of and knowledge about how capacity building is organised at their institutions.

Also, in a written comment, one participant added an option we had not included in our survey: pedagogical training is also regularly organised in a *decentralized* manner, for example by the institution's digital learning team. This is likely the case in other institutions as well and should be taken into account in future studies.

Finally, participants may have relied on different interpretations of "permanent academic staff". For example, "permanent" can be interpreted more narrowly – as staff who have obtained tenure, or more broadly – as staff with other types of long-term contracts. There are also distinctions to be made around academic staff on research and teaching tracks and those on teaching and scholarship tracks.

6 CONCLUSION

In conclusion, our study has taken a snapshot of capacity building for engineering educators at nine institutions across seven European countries and Australia. It offers preliminary data and a framework for studying and monitoring capacity building across institutions which can be used to inform policy makers and create a common understanding of activity across the sector. This is particularly important at this time, since the expectations of staff at all levels in organisations related to their own and colleagues' future engagement with education are changing. The international Teaching Cultures Survey [12], for example, indicates an expectation

from university staff at all levels that reward and recognition for quality teaching will increase.

We intend to follow up on this study with a larger, explanatory mixed methods study, including more institutions and an in-depth investigation of incentives and motivation related to participation in capacity building. We welcome other engineering education scholars to join our group and projects.

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APPENDIX

Question: What incentives do permanent academic staff at your institution have to engage in pedagogical training?
Response items for incentives

A. Pedagogical training is mandatory for all permanent academic staff.
B. Pedagogical training is mandatory for part of the permanent academic staff.
C. Pedagogical training is required for promotion.
D. Pedagogical training automatically leads to salary increase.
E. Pedagogical training is one of several aspects considered in salary setting.
F. Pedagogical training is rewarded through non-economic incentives
G. Pedagogical training is valued by colleagues.
H. Pedagogical training is valued by students.
I. Pedagogical training is not acknowledged or valued at the institution, but at a national/regional level.
J. Pedagogical training is not acknowledged or valued at the institution, nor at a national/regional level.
K. No pedagogical training programs are offered for permanent academic staff.
L. Other

Question: What type(s) of entity/ies organize pedagogical training for permanent academic staff at your institution?
Response items for organizational levels

A. Pedagogical training is organised by national/regional entities.
B. Pedagogical training is organised by a pedagogical development center/entity at the institution.
C. Pedagogical training is organised separately by each of the institution's faculties.
D. Pedagogical training is organised separately by each of the institution's departments.
E. No pedagogical training is organised for permanent academic staff at the institution, but staff are encouraged to engage in pedagogical training on their own.
F. No pedagogical training is organised for permanent academic staff.
G. Other

Question: How is pedagogical training organized across different faculties/disciplines at your institution?
Response items for organizational approaches

A. Pedagogical training programs are tailored to each faculty's/discipline's specific needs.
B. Pedagogical training programs are offered separately for each faculty/ discipline, but they are generic and not tailored for each faculty's/discipline's specific needs.
C. Pedagogical training programs are open for staff from all faculties/disciplines, but they are often dominated by participants from one or a few faculties/ disciplines.
D. Pedagogical training programs are open for staff from all faculties/disciplines and participants typically come from various faculties/disciplines.
E. Pedagogical training programs are organised to guarantee that participants come from various faculties/disciplines.
F. No pedagogical training programs are offered for permanent academic staff.
G. Other

Question: At what point(s) in their careers (after obtaining a permanent academic position) do staff at your institution engage in pedagogical training?
Response items for participation

A. Permanent academic staff engage in pedagogical training primarily during the first five years after obtaining a permanent position.
B. Permanent academic staff engage in pedagogical training throughout their careers, but they engage more often during the first five years after obtaining a permanent position.
C. Permanent academic staff engage in pedagogical training throughout their careers, but they engage more often during later stages in their careers (more than five years after obtaining a permanent academic position).
D. Permanent academic staff engage in pedagogical training primarily during later stages in their careers (more than five years after obtaining a permanent academic position).
E. On average, permanent academic staff engage in pedagogical training at least once a month.
F. On average, permanent academic staff engage in pedagogical training at least once a year.
G. Permanent academic staff typically do not engage in pedagogical training.
H. Other