Workshop report

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REFINING A TAXONOMY AND LEXICON FOR CONTINUING ENGINEERING EDUCATION

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1 MOTIVATION AND LEARNING OUTCOMES

1.1 Motivation

An effective and current Continuing Engineering Education (CEE) ecosystem is vital to support the millions of practising engineers globally. CEE is considered as education of an engineer, technologist or technician after their initial educational phase (Uhomoibhi & Ross 2019). However, previous work has identified (Gomez Puente et al. 2023) the need for a shared lexicon around practices in CEE to allow better knowledge sharing that would enable a faster and more effective diffusion and adoption of concepts.

A taxonomy offers such a shared lexicon is a "*hierarchical classification system that makes categorising or finding terms within text easier"* (Pack 2002) and one that involves a clear vocabulary*.* Previously there was no taxonomy aligned specifically to CEE, which led to a creation of an initial taxonomy for CEE (Caratozzolo et al. 2024) to align CEE concepts and their implementation. Methodologically, this initial taxonomy was developed from an inductive analysis of eight case studies (Gomez Puente 2023), then refined and combined with a scoping review of literature (Caratozzolo et al. 2024, 2025). Such a methodology aligns with an empirical (a posteriori approach) to taxonomy development (Bailey 1994) and allows sequential inductive and deductive consideration of the emerging terms and their structure. In line with the approach of Finelli et al (2015), then this taxonomy benefits from an iterative refinement, particularly from experts within the field, and this workshop is intended to contribute a further stage of refinement from a broader sample

The workshop reviewed this initial taxonomy with the SEFI CEE expert community to validate and to refine further.

1.2 Learning Outcomes

The workshop brought together a range of experts (from universities, and professional and accrediting bodies), to review and refine the taxonomy for CEE.

At the end of this workshop, participants had:

1. Contributed their perspectives on what terms are important when considering CEE;
2. Gained an understanding of the existing CEE taxonomy;
3. Supported the authors to evaluate the coverage and validity of the CEE taxonomy, based on participant's own experiences and perspectives;
4. Identified areas to enhance the CEE taxonomy and enabled an iterated version to be developed (will be completed after the workshop through further ongoing engagement).

2 BACKGROUND AND RATIONALE

Engineers have influenced society, communities and the economies for centuries, with this impact historically being seen as broadly positive. However, we are increasingly aware of the (unintended) consequences of engineering practice on society and the world, as we better understand local, national and international interconnectedness. In essence, engineers need to be able to deal with "wicked" problems and fully recognise the more holistic impact of their practice (from an

ethical, inclusivity, sustainability, human-centred and community perspectives). Moreover, they need to ensure society benefits from an appropriate fusion of technology and people (aspirations, skills, and their communities), e.g., as per Industry 5.0 (Huang et al. 2022).

In addressing these challenges, we need to find educational and training approaches for engineers throughout their educational and practice preparation and working lives. Considering the number of practising engineers and scientists globally, e.g. seven to 25 million in USA (NSB 2019); 17.2 million in EU (Eurostats 2019), then the need for an effective ecosystem around Continuing Engineering Education (CEE) is vital for engineers, society and industry.

For this ecosystem, we need to facilitate faster exchange of approaches to respond to the rapidly-changing skills demands and ways to deliver this education and training.

The current CEE taxonomy (Caratozzolo et al, 2024) has a limitation of being based on a small sample of perspectives from university academics, along with a corresponding review of literature for terms.

This workshop, with the range of roles and backgrounds involved in CEE, allowed a review of the taxonomy to ensure it has broader validity and utility as a tool to enable sharing of practices and approaches.

3 WORKSHOP DESIGN

The workshop was attended by a range of experts – from academic institutions from different countries (Europe, North America, and Australia) and from Professional and Accreditation Bodies. The overall goal of the workshop was to engage the workshop participants to help refine the current version of the CEE Taxonomy, with the intention that it better reflects a range of stakeholders in CEE.

The 60-minute workshop was organised in three main parts:

1. Participants individually noted what terms and concepts around CEE were important to them, and in their context and then clustered these through small group work;
2. The current taxonomy was introduced;
3. Participants worked to add their terms to the existing taxonomy to identify overlap with existing concepts, as well as to highlight new ones.

4 WORKSHOP FINDINGS

4.1 Participants' terms and clustering

There were two separate groups that noted down their own terms and then in group-work clustered these together. Figure 1 gives an example of the grouping by one of groups with a similar approach taken by the other group.

Figure 1: clustering of terms relevant to CEE from one of the groups.

Regarding the group discussions, group 1 output indicates institutional factors such as supporting policies, and recognizes institutional factors influencing permanent CEE. Some general points of attention are for instance, time availability; teachers' skills development; lifelong learning approaches; online/hybrid education, and alike. With regards to external factors, some elements mentioned are IP; government regulations, funding and budget possibilities; possibilities for the companies to pay for CEE offerings; national regulations within the EU; (pre-)defined set of skills; and, CEE organization differences, e.g. education vs. industry.

Group 2 indicated external factors, such as government policies, as well as institutional policies including how CEE was resourced, as well as recognising that CEE needed to be organised differently by universities. Importantly, they brought out the different types of learning, not just formal learning but also informal. Additionally, they detailed that the IT infrastructure for CEE is important. The important point of who teaches CEE, what motivates them to teach and remuneration for this work was detailed.

4.2 Update to the taxonomy

The current taxonomy was presented (version 2.1) (Caratazollo et al. 2025). In the open discussions around the taxonomy, then a number of enhancements were identified.

Key additional points that were not covered within the current taxonomy included:

- Intellectual Property;
- Consideration of IT/technical infrastructure to achieve this;
- Continuing Professional Development (CPD) as a term was missing and important;

- Digital badging (recognition of successfully engaging in and completing CEE courses);

Refinements of language suggested included:

- Referring to learning and not teaching (to reflect that CEE is not only taught, and that learning is the desired outcome);

Clarity was sought around the differences between hybrid and blended learning, and so links to recognised definitions will need to be included in the associated definitions for terms within the taxonomy.

Additionally, further terms/configurations were highlighted, such as

- “Diplomat” (course with greater than 106 hours of learning) and nano-credentials;
- Whether workplace learning should differentiate between ‘Off-the-job’ and ‘on-the-job’ training.

To validate the current taxonomy (version 2.1), then participants were asked to place their CEE terms (post-it notes) physically on a printed-out version of the taxonomy. This process saw strong overlay with terms; Figure 2 below gives a snap-shot of this overlay.

5 CONCLUSION AND NEXT STEPS

In conclusion, we perceived the acknowledgment of the participants to have a taxonomy that compiles a set of elements crucial to map CEE practices, organizational approaches and regulations. Furthermore, the taxonomy was recognized as a suitable method for further analysis of CEE practices.

Next steps will be to refine the taxonomy, and to engage further participants to ensure that the taxonomy is valid, useful and reflects international perspectives. Thereafter, clear definitions (lexicon) will be developed.

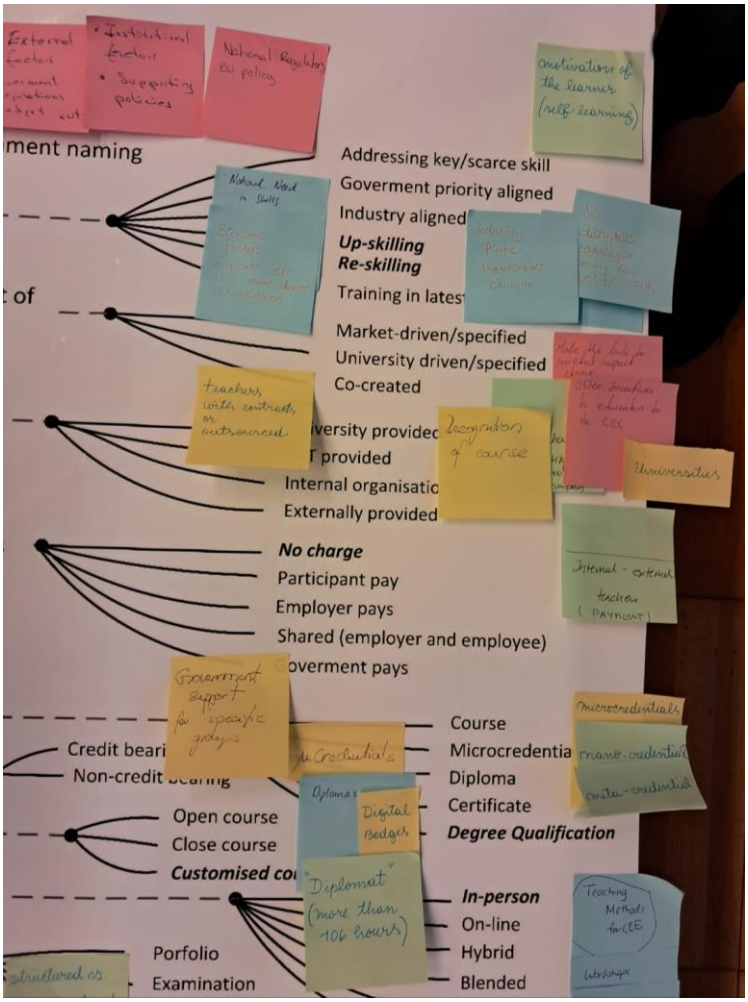

Figure 2: photo of overlay of participant Post-It notes on current taxonomy

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