FROM UNIVERSITY TO WORK: ALUMNI VIEWPOINTS

Helena Kovacs*, Iris Capdevila, Patrick Jermann***, Isabelle Lermigeaux-Sarrade****

* EPFL, Centre for Learning Sciences LEARN;
** EPFL, Teaching Support Centre;
***EPFL, Centre for Digital Education

ABSTRACT

Alumni studies are often overlooked in engineering education research, despite holding great potential for improving engineering programmes and creating the links that are missed when it comes to university-workplace transitions. Besides better understanding the strengths and weaknesses of the taught and learnt curriculum, being aware of the perspectives of the alumni contributes to identifying the array of knowledge, skills and attitudes graduates need for successful job integration. In exploring the Conceive-Design-Implement-Operate (CDIO) framework, there is a question: "[w]hat are the full set of knowledge, skills, and attitudes that engineering students should possess as they leave the university, and at what level of proficiency?" (Crawley et al., 2007:45). In this study, we intended to ask the same question. This paper presents the results of a part of an alumni survey which focuses on the skills they gained and the strengths and needs of the degrees they obtained. In the results, we noticed that more than 80% of respondents are highly satisfied with skills in the research domain, such as using maths, information skills, and research skills, while the less convincing are project management and teamwork. Skills related to sustainability, ethics and entrepreneurship, were identified as definite weaknesses. We experimented with the CDIO framework analyse the open-ended answers, where the most mentioned professional skills were real-life content and interdisciplinarity, while autonomy was the most frequent personal skill missing. Although the results indicate a lingering difficulty in developing a comprehensive and holistic curriculum in engineering education, there are a number of lessons we can draw from it both in terms of further efforts in developing academic offers and in terms of alumni-oriented research in fields of engineering education.

KEYWORDS

Alumni research; Work readiness; Competence frameworks; Program evaluation (12)

INTRODUCTION

There are not many reliable ways to determine the quality and worth of educational programmes and courses. Learning outcomes as presented through student exam success might not provide an accurate picture of the long-term retention nor the impact on knowledge, skills and competencies gained through courses, and, in many ways, examination and most of the summative assessments do not give a clear indication of the skills and attitudes students might have acquired during their studies. On the other hand, alignment of the educational programmes

and courses with the external “value” points, such as accreditation bodies and their requirements might provide a stamp of quality for employers and industry, but given the ambiguous use of words and vagueness in pedagogical implementation (Junaid et al., 2022), they still might not vouch for the quality of teaching and learning experience.

Working on developing a relevant and coherent educational programme is the single common desire of all higher education institutions. Most engineering education institutions and programmes see a great deal of their purpose in providing “the learning required by students to become successful engineers - technical experience, social awareness, and a bias toward innovation” (Crawley et al., 2014, p.1). Hence, there is a recognised need and an imperative from all stakeholders, including academia, industries and governments, to continuously improve the quality and learning experiences within engineering education.

Alumni research is “designed to elicit individuals’ reflections about the quality of their education experience that are tempered by their experiences since graduation” (Pike, 1994, p.105). While this kind of research is not common or fully exploited in Europe in comparison to the US or UK (Saunders-Smits & de Graff, 2012), we can argue that there are aspects of this kind of research that are highly valuable for refining the quality of educational programmes. From the perspective of a graduate who has been involved in other life experiences, most notably their employment, it is valuable to understand if there is any connection between the two lived experiences - academia and industry. This might be even more interesting in highly practical domains, like engineering, where theoretical concepts mean very little if not applied adequately to a tangible situation. Thus, in this paper, we showcase our intention to understand better the educational programmes and courses through the words of alumni. We, as others have before us, question "[w]hat are the full set of knowledge, skills, and attitudes that engineering students should possess as they leave the university, and at what level of proficiency” (Crawley et al., 2007:45), even though we acknowledge that this might never be completely possible with our approach, nor with any other existing ones.

In the following sections, we provide a very brief insight into the relevant literature in an attempt to position our analysis and discussion. This is followed by a methodology section, an overview of the results and the conclusions.

LITERATURE PERSPECTIVES

We focused our study on the learning outcomes of alumni, and the competencies that alumni report as important for their work after graduation. With this in mind, we position our analysis within the three most relevant research domains: work readiness, competence frameworks and alumni research.

Work readiness

In general, there is a misalignment between graduates’ skills and competencies, and the labour market needs and demands of employers (Winterton & Turner, 2019). While there are large differences in terms of scientific and industrial domains, Winterton and Turner (2019) present a general overview of recent studies looking at satisfaction with educational programmes. Looking from the perspective of employers' satisfaction with graduates, there seem to be evident skill gaps, particularly with respect to transversal, personal and relational competencies. Mentioned among others are skills such as responsiveness to feedback, self-learning strategies, solving problems, but also communication skills, self-management and even team working. These points are well

corroborated by more specific studies that focus on the viewpoints of graduates and supervisors in engineering education (e.g. Jollands et al., 2012).

A body of education research connected to work readiness often examines elements that form a gap between competencies acquired through tertiary education and competencies demanded by the world of work. Caballero et al. (2011, p. 41-42) define it as "the extent to which graduates are perceived to possess the attitudes and attributes that make them prepared or ready for success in the work environment". Other synonyms include work preparedness and graduate employability, and these include a range of interchangeably used terms such as generic skills, core skills, basic skills, transferable skills and employability skills. The terminology might differ depending on the domain, however, Caballero et al. (2011) suggest a generic work readiness scale consisting of dimensions such as personal characteristics (e.g. resilience, adaptability), organisational acumen (e.g. motivation, maturity, attitude to work), work competence (e.g. technical focus, problem-solving), and social intelligence (e.g. interpersonal orientation).

Combining this overview with the more focused literature on the variety of professional roles graduates in engineering undertake (i.e. Trevelyan 2010; Brunhaver et al., 2013; Craps et al., 2017), it becomes evident that the technical knowledge and skills are not enough. Additionally, there is often a simplicity in how transversal skills are thought of which does not resonate with the needs of the professional setting. For instance, in their study Craps et al. (2017) noted that communication skills are often oversimplified in writing technical reports and preparing oral presentations. However, up to 60% of work-related communication of practising engineering can be seen through their interaction with professionals from other fields, other backgrounds and cultures, and the success of these interactions relies on good listening and collaboration skills (Craps et al., 2017; Trevelyan, 2010).

Thus, studies show that quite often the academic stakeholders see and agree on the issues of graduates being ill prepared for work (Winterton & Turner, 2019; Jollands et al., 2011). Saunders-Smits & de Graff (2012) found out that especially for managerial positions, there is a relatively high agreement from both alumni and employers on the importance of skills such as people management, oral communication, lifelong learning and analytical skills. Perspectives in trying to mend the identified gaps, such as work-based, work-integrated and project-based learning formats are only a few current best practices. Yet, these formats are less widespread and often not well scaffolded in order for students to consciously gain a wide range of skills, hence gaps persist even when such formats are in place.

Competence frameworks

Competence frameworks are currently best-known practices that ensure the upholding of quality standards within disciplines and professions. Most authors define competencies in a similar way - as personal traits or characteristics, sometimes also as skills, abilities and behaviours, that play an important role in work performance and delivery of desired work-related results (Prifti et al., 2017). However, similarities often end here. Different competence frameworks follow different logic in clustering, classifying and hierarching sets of specific competencies, and to date, there is no agreed approach that satisfies all educational stakeholders.

Results of a meta-analysis of studies using the Great Eight competency framework have shown moderate to good results in terms of how these competencies relate to employers and work situations mostly from a sample of management, technical and sales positions (Bartram, 2005). Elsewhere, competencies are separated into four categories, such as personal,

social/interpersonal, action-related and domain-related in Erpenbeck and Rosenstiel model, or likewise classified at different levels, such as meta, domain, method and social competencies in Egeling and Nippa model (Prifti et al., 2017). In their literature review, Prifti et al. (2017) note that there are many models that are specific for a certain type of work, e.g. leadership and management, and that from the literature “communicating with people" is the competency that is most mentioned, followed by “IT/technology abilities, big data and problem-solving”, and “lifelong learning, work in interdisciplinary environments”. Beyond those in research papers, governmental bodies have also worked on their own competency frameworks, normally by applying methods to align human capital planning (education) with employment and organisational strategies (workplace), for example in France (Gestion Prévisionnelle des Emplois des Compétences - GPEC). Finally, stakeholders such as educational programme accrediting bodies play a role in suggesting what gets value in the programmes they accredit, yet this might heavily vary from context to context, and there are a few shortcomings in these as well (e.g. Junaid et al., 2022).

Developing “the model” in the engineering domain has been an accepted challenge too. Leslie (2016) for instance proposed a multi-tier hierarchical model which was developed by a team through a review of available information, including ABET and other bodies and societies, the current curricula and related resources, as well as experts from industry and academia. In their model at the base are the personal effectiveness competencies, including interpersonal skills, integrity, professionalism, initiative, adaptability & flexibility, dependability & reliability and lifelong learning. These are followed by academic competencies such as reading, writing, mathematics, science & technology, communication, critical & analytical thinking and computer skills, and at tier 3: workplace competencies (such as teamwork, planning & operating, creative thinking, and problem-solving). Tier 4 and 5 are the industry-wide technical competencies (e.g. professional ethics, sustainability & societal & environmental impact, engineering economics), and industry-sector functional areas which are defined by industry representatives. Finally, at the top of this hierarchical model are the management competencies and occupation-specific requirements, the latter being defined by the domain, and the prior including skills such as networking, entrepreneurship, and managing conflict & team building (Leslie, 2016).

In a similar attempt to get unique model competencies for engineering education, CDIO was developed underlying a “critical need, recognised through dialogues between academia, industry and governments, to educate students who are able to Conceive-Design-Implement-Operate complex, value-added engineering products, processes and systems in a modern, team-based environment” (Crawley, 2007, p.1). The added value of the CDIO model is that it looks in detail at the engineering lifecycle from the point of conceiving ideas, such as in business strategy or customers' needs, all the way to operating which includes evaluation and system improvements but also logistics, recycling and upgrading. Recognising that an innovation process is being able to conceive, design, implement and operate systems in the enterprise, societal and environmental context, the model upholds UNESCO’s four pillars of education: learning to know, learning to do, learning to live together and learning to be (Crawley, 2007, p. 54). In our analysis, we were particularly inspired by the CDIO syllabus and the three levelled structure that it proposes, particularly covering (1) disciplinary knowledge and reasoning, (2) personal and professional skills and attributes, (3) interpersonal skills: teamwork and communication, and (4) conceiving, designing, implementing, and operating systems in the enterprise, societal and environmental context - the innovation process. This framework was detailed and wide enough for us to engage in a more exploratory way.

Alumni studies

In the university ecosystem, there is a lot of attention to student learning outcomes. In almost all cases and for all taught content, the learning outcomes are assessed at the immediate end, through examination and assessment. The bottleneck of exams is that they might not accurately evaluate student learning, but rather students' ability to recall from memory under a great deal of stress. Alumni research is, on the other hand, done partly with the same aim to evaluate the learning outcomes but in a retrospective manner and from a point of view where graduates had other different experiences than studying.

The relevance of alumni research was first picked up by Pace who in 1979 identified the slow rise of this kind of educational inquiry (Delaney, 2000; Cabrera et al., 2014). In the early exploration of the focus of alumni studies, about 70% focused on competencies and the remaining 30% on alumni satisfaction and the relationship between education and employment (Cabrera et al., 2014). In her paper, Delaney (2000) explores the potential of using alumni research to assess graduates' preparedness for the demands of professional work and changing face of the labour market. She points out, "a unique feature of alumni surveys is the capability of documenting students' assessment of the quality of their educational experience tempered by their experiences since graduation" (Delaney, 2000, p. 139). There is much value in the notion that graduates gain first-hand experience in professional practice and are capable of contrasting that with their abilities to answer the demands.

Furthermore, alumni studies can provide more information about the various careers graduates undertake, as much as it can show the level of alignment between employers', academics' and graduates' positions and positionalities. Furthermore, as an evaluative model (e.g. Bisagni et al., 2010), well prepared alumni studies may result in valuable insights that can help modify the educational offer, both in terms of content and in terms of pedagogical approaches. Apart from pointing to slight differences in what is important for experts and alumni in managerial and specialist roles, Saunders-Smits and de Graff (2012) also give an example of how an alumni study was used to bring changes to the existing Aerospace Engineering programme at Delft University.

METHODOLOGY

Context and the tool

At EPFL, alumni surveys are part of the institutional data collection process. A specialised institutional unit, Career Centre, has been in charge of administering a standardised alumni survey which would serve institutional leadership to gain a general feeling for the trajectories of its graduates. These surveys are carried out each year, reaching alumni that have graduated one year ago. However, besides this, the Alumni Department has been working together with the Teaching Support Centre on delivering a special alumni survey that longitudinally collects data on alumni from the point of knowledge and skillsets gained and their needs during their education and their workplace. This survey is administered every 5 years with an objective to monitor and improve the content of the educational courses and programmes offered by the institution and as such is tied with the process of accreditation (c.f. Wiklnd et al., 2005; Bisagni et al., 2010). In this research, our focus is on the latter survey which is oriented towards knowledge and skills.

The structure of the survey is two folded. The survey is sent out to all alumni the same, and depending on the year of graduation, a part called "education assessment" changes slightly in terms of questions asked. The alumni that have graduated within the period of last five years since the survey (i.e. 2014-2019), are asked more detailed questions about the "offers" of the

educational programmes, while those that have graduated beyond five years (i.e. 1980-2013) are asked one more generic question about skills needed for industry. For the purposes of this paper, we are only focusing on the section on education assessment and particularly on the self-assessment and opinions about knowledge and skills. The structure of most of the questions remains the same for the alumni of 1980-2013, with a change in the two open-ended questions.

The reason behind having this distinction and relating it to the year of graduation is that we can assume that alumni that have graduated more than five years ago would not have a clear memory and awareness of the curriculum in place. However, it is still valuable to know their opinions on the skillsets they assess necessary for the industry, hence the alternated question.

Data collection and analysis

Data was collected by means of an email sent out to the former students of EPFL through the alumni database. The email was sent in December 2021 to 18765 alumni that have graduated in the period from 1980 to 2019. The email contained a unique link and no identifying information was requested from respondents. Out of 18765 alumni, 2830 provided validated responses. The data was then separated into two graduation groups according to the previously set survey structure: alumni of 2014-2019 (n=908, response rate of 16.3%), and alumni of 1980-2013 (n=1922, response rate of 14.5%).

For both alumni groups, the close-ended answers were analysed quantitatively by applying simple descriptive statistics. The two open-ended questions for 2014-2019 were analysed qualitatively using MAXQDA, and manually coded by three researchers, authors of this paper. The researchers undertook two rounds of internal coding validation by each coding the same 20 answers. After each iteration, the researchers met to discuss discrepancies which resulted in an aligned codebook. Coding was done through a mixed approach, deductively and inductively. The researchers drew inspiration from the CDIO framework and in the first iteration wanted to test how some of the competencies in the CDIO framework could be used for coding and analysis.

Once the codebook was developed for the alumni group of 2014-2019, the same framework was used for analysing data of the “older” group 1980-2013. Since in this group, the respondents had a choice to input three lines of answers corresponding with a question about three top skills, we applied R to generate the list of words that appear in the answers using 1-word and 2-word structure. In the next step, clustering using a 2-word structure was done using the same CDIO-inspired coding framework, resulting in the final results for this alumni group.

Limitations

This paper shows an exploratory use of CDIO with an attempt to analyse and understand data, and as such we are aware of the limitations it contains. For the start, we used CDIO as a framework for analysing the strengths and needs of educational programmes that do not necessarily apply this method in its forms of instruction and content. While this may lead to a mismatch in our analysis, our main objective was to experiment with applying the CDIO framework and understand what general gaps the education programmes might have, as well as how aligned might the programmes be even if not applying the model in the first place. Additionally, with alumni data from 1980-2013 where the analysis was done using R, we recognise that there might be some data that could have been taken out of context. The 1-word and 2-word structure supported an easier analysis but we admit that there might have been longer textual answers that could have been missed.

In terms of limitations for the type of study, there are obvious questions about the reliability of alumni self-reported assessments. Pike (1993) asks “can they be trusted” and the answer is both “yes” and “no”. Indeed, as the study shows, the more senior alumni become, the less accurate the reflections around their study programmes are. The same is true with job satisfaction and level of perceived accomplishments at the time of answering the survey - there is a positive correlation between university experience and employment experience, hence, alumni who are unsatisfied with their employment, working conditions or accomplishment status tend to evaluate their education in a more negative pattern (Pike, 1994; Carbera et al., 2014). In order to manage the limitation around alumni studies, questions related to education assessment were modified in a two-tier system depending on the year of graduation, as explained in the section above.

RESULTS

In this section, we first present the results of the alumni of 2014-2019, followed by comparisons to opinions given by the alumni of 1980-2013. In our presentation of the results, we will as much as possible use the words of the respondents from the open-ended questions about the strengths and needs of the programmes in order to expose the experiences in their own words. The quotes offered in the text are identified by a respondent’s number and the section of the question (e.g. respondent 21, a question on Strengths / Needs).

Results: alumni of 2014-2019

When assessing the level of competence in core areas, out of 908 respondents only up to 9% answered they found it insufficient in relation to their work situations (0.5% mathematics, 1.8% physics, 6.3% chemistry and 8.9% computer science). Overall, the respondents seemed very satisfied with the “*very strong theoretical knowledge*” (455, Strengths). The education experience at EPFL seems to bring a recognised “*exposure to strong scientific facts and ways to solve problems*” (315, Strengths) and a “*strong foundation in science and critical thinking*” (141, Strengths). EPFL education is seen as strong in its “*high rigour, breadth of knowledge, state-of-the-art research*” (384, Strengths).

Similarly, when asked about scientific or technical gaps, 52% of the respondents did not select any of the multiple-choice items which points to a relatively moderate satisfaction level in terms of quality of scientific and technical curricular content. The education experience provided “*analytical skills and ability to grasp technical concepts quickly*” (368, Strengths), and capacity for “*critical thinking, and strong theoretical background*” (1657, Strengths). Open-ended comments corroborate the numeric results in telling a story of “*strong theoretical courses in all science subjects leading to good critical thinking and problem-solving approach*” (1918, Strengths) and alumni in general feel they had a chance to “*develop a structured way of thinking and being able to find information and learn fast*” (271, Strengths). Among the selected items, programming and software development appeared in 22% of responses and modelling/machine learning in 13%. All other items were selected less than 10%.

On the other hand, when asked about their level of competence with regard to professional skills, alumni of 2014-2019 seemed less confident, particularly around skills like “*teamwork, entrepreneurship skills, environmental sustainability knowledge and skills*” (384, Needs). Project management skills were frequently mentioned, in addition to “*fundamentals on sustainability and critical thinking on the role of engineers for climate and biodiversity issues*” (2658, Needs).

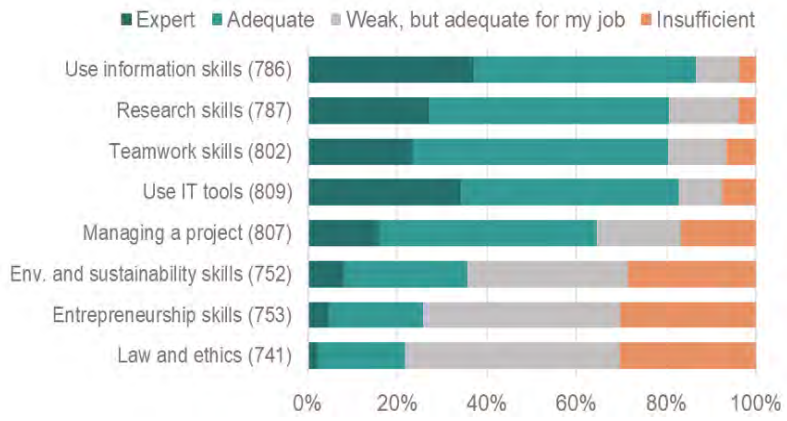

Figure 1. How do you assess your level of competence in these core areas at the end of your education at EPFL?

This result corresponds directly to the question about gaps with regard to professional skills in Figure 2. For this question, more than 40% of the respondents mention having to additionally work on their project management and real-world experiences, while other gaps were felt related to social aspects of conducting projects, particularly around project management and "real world" experiences. Respondents strongly advocated for "*more mandatory internships*" (603, Needs) and "*more projects completed from beginning to end, closer to what you would get when working in the industry (but not in a research position)*" (3910, Needs). To have a more work-ready education, a suggestion would be to have "*way more practical experience: there should be a mandatory internship and more focus on 'real world' projects. EPFL professors need to create more networks with the industry not simply for project partnerships but also for students to work. Despite being one of the top of my class the only options I got were working overseas or doing a PhD - Swiss companies were simply not interested in a fresh graduate with little experience*" (1276, Needs). Also, "*mandatory basic training in finance, project management, sustainability*" (368, Needs) would positively reflect on job preparedness and as this statement complements:

"*Social skills are an important aspect of being an engineer and a human being living in society. It is important to know how to communicate, share, transmit, and understand one's ideas. Studying less technical fields also helps to learn how to communicate to other people who are not engineers. Travelling/studying abroad helps a lot to develop these characteristics*" (1007, Needs).

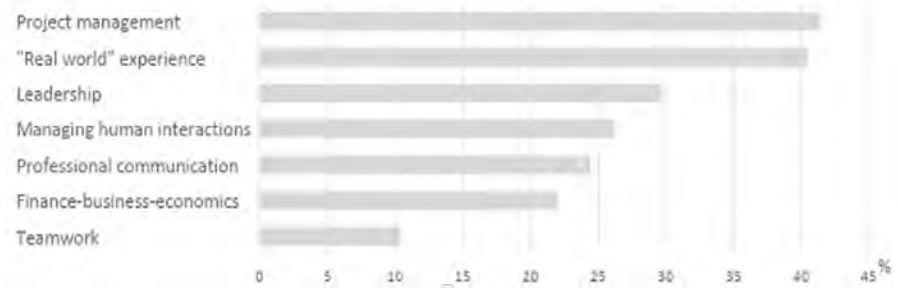

Figure 2. Did you need to fill any other professional gaps?

Hence, not surprisingly, when asked to rate the importance of different professional skills in their current jobs (Figure 3), according to the more than 50% of the respondents all professional skills

were considered important, with the highest proportion given to working independently and the capacity for critical thinking. It seems highly important to "*make future engineers question their social impact on society (environmental, political and social impact of technology), via ethics and critical social sciences (as opposed to management or mainstream economy)*" (4206, Needs), as well as to have "*soft skills and interdisciplinary work could be introduced into the curriculum*" (4068, Needs).

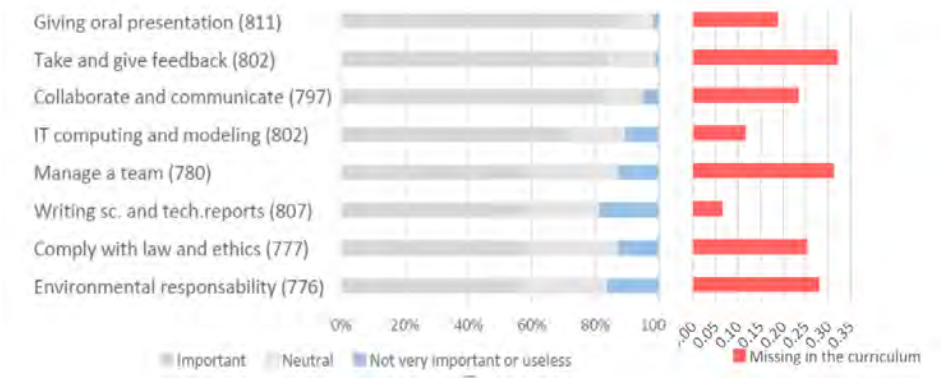

Figure 3: How would you rate the importance of the following skills in your current job?

Finally, in terms of balancing the pedagogical activities in order to better prepare students for the demands of work, the opinion of the alumni is that there should be more project management, integrated project units, interdisciplinary components, task management and more contact with the alumni. All these items were mentioned in more than 50% of the respondent population.

CDIO-inspired framework: Alumni of 2014-2019 and Alumni of 1980-2013

Alumni of 2014-2019 were asked three open-ended questions, about the strengths and needs of the programmes they finished, and an open comment as to why they would recommend the institution forward.

The textual answers (n=281) on strengths and needs were coded and analysed inductively, and as such, the most used codes included real-life/work (n=80), autonomy (n=70) and interdisciplinarity (n=59). These outcomes correspond to the quantitative ones, as they give more illustrations of struggles, for instance, "*lack of experience was a pain when trying to find a first job for me and many other students. Need more practical experience*" (220, Needs). Even in the fields where alumni work in predominantly theoretical fields, there are notions that "*for my field (academic research in mathematics): too much emphasis on purely technical aspects of the notions presented in courses, and maybe not enough emphasis on ideas/motivations*" (374, Needs). These results really talk about the more "human" aspect of the educational experience. Given that engineering careers can widely differ and alumni might take very different parts, it seems important to give a more prominent role to transversal skills, as in the case where "*my studies do not match what I am doing. The most important criteria that apply for me now would be: oral skills, quick learning/proficiency in any field, and good analysis skills*" (601, Needs).

Finally, we discussed our coding patterns and analysed it against a CDIO framework (Crawley et al., 2007) which led to the CDIO-inspired scheme that was used on the "older" alumni of 1980-2013. After categorising the outcomes, we developed a visual chart of skills the alumni would suggest students take time to develop.

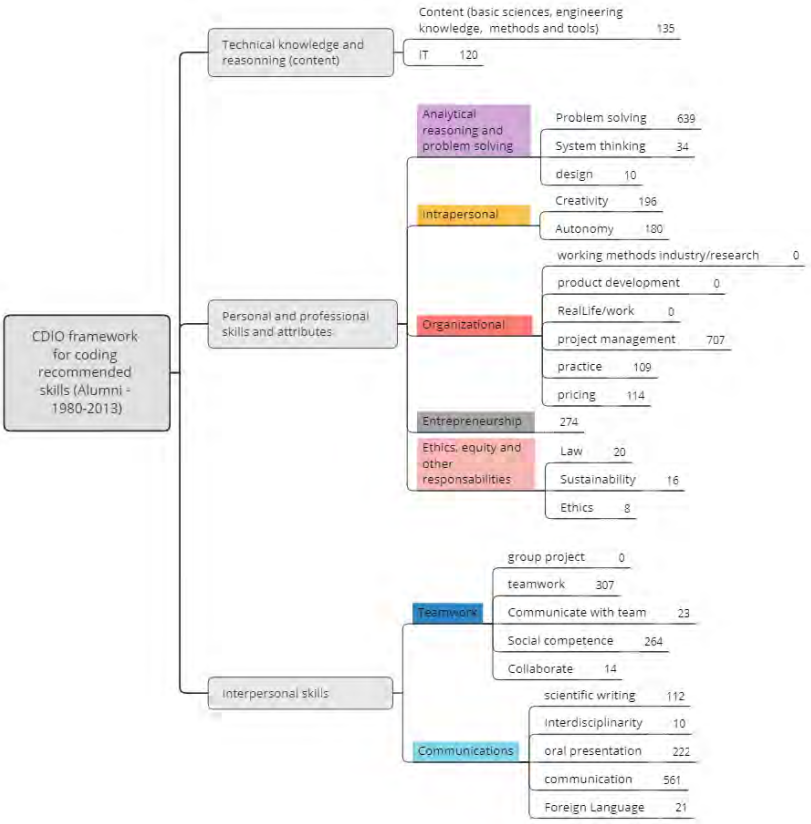

Figure 4. Alumni of 1980-2013: categorised skills alumni recommend to be developed

In Figure 4 we represent a blend of two approaches, the CDIO framework that we experimented with in our coding and our institutional approach to framing a competence model. While inspired by CDIO as a tool to analyse data, we wanted to react to our own limitation that as an institution EPFL has not been using CDIO in the courses and programmes offered.

CONCLUSION

In this paper we targeted a discussion around engineering graduates, trying to understand better what competencies could help better transition between academia and industry, as well as what would make future engineers feel competent to address current and future societal and environmental issues through their work.

We maintain our agreement with previous advocates for alumni studies about the value and necessity of regular and continuous research and inclusion of alumni in educational revision and programme development. As pointed out in our literature framework, this is a work that needs to reflect a careful exploration of the appropriate competence model(s) and comprehensive discussions with all education stakeholders.

From our results, we notice that the scientific base of our educational programmes is strong, and lacks are mainly observed in aspects of transversal skills, such as those in the area of interpersonal skills and personal and professional skills and attributes. In our discussions, we further ask the question of how and where in the curriculum should the transversal skills be taught

and whether all skills and competencies should be taught in classrooms by teachers, or whether there are other avenues within academia to nurture learning environments that would provide opportunities for these competences to be developed. Our question relates to the limitation of formal curriculum and scaffolding necessary for the development of the mentioned skills.

Nevertheless, while these reflection questions can sparkle future research, the current study gives us food for thought in terms of ongoing discussions on programme development and graduates' work preparedness. Particularly embedding the results of our exploratory efforts in using a framework such as CDIO into our local context was a useful activity to gauge where our capacities and shortcomings are. The exercise of this character provides a potential for our own institution in its efforts to advance the continuous review and development of a competence framework for engineering education.

FINANCIAL SUPPORT ACKNOWLEDGEMENTS

The author(s) received no financial support for this work.

REFERENCES

Bartram D. (2005). The Great Eight Competencies: A Criterion-Centric Approach to Validation. Journal of Applied Psychology, Vol. 90, No. 6, 1185-1203 DOI: 10.1037/0021-9010.90.6.1185

Bisagni, C., Ghiringhelli G.L., and Ricci S. (2010). Survey for program evaluation of aerospace engineering at Politecnico di Milano. *Proceedings of the 6th International CDIO Conference, École Polytechnique, Montréal, june 15-18, 2010*

Brunhaver, S., Gilmartin, S.K., Grau, M.M., Sheppard, S., and Chen, H.L. (2013). Not all the same: A look at early career engineers employed in different sub-occupations. ASEE Annual Conference and Expositions

Caballero, C., Walker, A., & Fuller-Tyszkiewicz, M. (2011). The Work Readiness Scale (WRS): Developing a measure to assess work readiness in college graduates. Journal of Teaching and Learning for Graduate Employability, 2(2), 41-54 https://files.eric.ed.gov/fulltext/EJ1236283.pdf

Craps, S., Pinxten, M., Sounders, G., Leandro Cruz, M., Gaughan, K. & Langie, G. (2017). Professional Roles and Employability of Future Engineers. Proceedings of the 45th SEFI Annual Conference 2017 https://pure.tudelft.nl/ws/portalfiles/portal/27938163/paper_83.pdf

Crawley, E.F., Malmqvist, J., Östlund, S., & Brodeur, D.R. (2007). Rethinking Engineering Education: The CDIO Approach. New York: Springer https://link.springer.com/content/pdf/10.1007/978-0-387-38290-6.pdf?pdf=button

Delaney A. M. (2000). Voices of experience: renewing higher education with alumni studies. Tertiary Education and Management, 6, p. 137-156. https://link.springer.com/content/pdf/10.1023/A:1009621304934.pdf?pdf=button

Jollands M., Jolly L. and Molyneaux T. (2012). Project-based learning as a continuing factor to graduates' work readiness. European Journal of Engineering Education https://doi.org/10.1080/03043797.2012.665848

Junaid, S., Gwynne-Evans, A., Kovacs, H., Lönngren, J., Jimenez Mejia, J.F., Natsume, K., Polmear, M., Serreau, Y., Shaw, C., Tobosaru, M., Martin, D. (2022). What is the role of ethics in accreditation documentation from a global view? SEFI 50th Annual Conference Proceedings. doi:10.5821/conference-9788412322262.1336

Leslie C. (2016). Engineering Competency Model. ASEE 123th Annual Conference New Orleans, LA https://peer.asee.org/engineering-competency-model

Pike, G. (1994). The relationship between alumni satisfaction and work experiences. Research in Higher Education, Vol. 35, No.1, AIR Forum Issue, pp. 105-123 https://www.jstor.org/stable/40196062

Prifti, L., Knigge, M., Kienegger, H., Kremar, H. (2017). A Caompetency Model for “Industrie 4.0” Employees, in Leimeister, J.M., Brenner, W. (Hrsg.) Proceedings der 13. Internationalen Tagung Wirtschaftsinformatik (WI2017), St. Gallen, 46-60 https://www.wi2017.ch/images/wi2017-0262.pdf

Saunders-Smits, G. and de Graaff E. (2012). Assessment of curriculum quality through alumni research. European Journal of Engineering Education, Vol. 37, No. 2, 133-142 http://dx.doi.org/10.1080/03043797.2012.665847

Tevelyan J. (2010). Mind the Gaps: Engineering Education and Practice. Proceedings of the 2010 AaeE Conference, Sydney https://aaee.net.au/wp-content/uploads/2018/10/AAEE2010-Trevelyan-Engineering_education_and_practice_gaps.pdf

Weerts, D. J., Cabrera, A.F., & Vidal, J. (2003). Alumni surveys: Three conceptualizations to alumni research. In J. Vidal (Ed.), *Métodos de análisis de la inserción laboral de los universitarios* (pp. 55-80). Universidad de León Press

Wiklund, I., Linbald, E., and Gunnarsson, S. (2005). Using an alumni survey as a tool for program evaluation. *Proceedings of 1st Annual CDIO Conference, Queen’s University, Ontario, Canada, 7-8 June 2005*

Winterton J. & Turner J. (2019). Preparing graduates for work readiness: an overview and agenda. Education + Training, Vol. 61, No. 5, pp. 536-551 https://doi.org/10.1108/ET-03-2019-0044

BIOGRAPHICAL INFORMATION

Helena Kovacs is a researcher at the LEARN Centre for Learning Sciences at EPFL, Switzerland and her current work focuses on exploring a wide variety of topics in teaching and learning at the institutional level. Beyond this, she works on developing a better understanding of transversal skills and competencies in engineering education, with a particular interest in ethics. Helena holds a PhD in educational sciences obtained as a Marie Sklodowska-Curie fellow in European Doctorate in Teacher Education (EDiTE).

Iris Capdevila is a pedagogical advisor at the Teaching Support Center (CAPE) at EPFL, Switzerland. She has 15 years of experience in the education field, as a teacher, deputy principal and innovative pedagogies coordinator. Her work is now focused on active learning strategies, transversal skills and evaluation of quality systems. She is studying a CAS on *Engineering of evaluations* for trainings. She is the General Secretary for the Swiss Faculty Development Network (SFDN).

Isabelle Lermigeaux-Sarrade holds a PhD in educational sciences, and a master's degree in physics. Since 2019, she has been a pedagogical advisor at the Teaching Support Centre of EPFL, where her main mission is curriculum evaluation. Previously, after 15 years of teaching at the secondary level, she taught Educational Sciences and trained novice teachers in France, and had a "broker" role between teachers and researchers at the French Carnot Institute for Education (ICE-AuRA).

Patrick Jermann holds a PhD degree in Psychology. Since 2013, he has been leading the Center for Digital Education at EPFL, implementing and evaluating a broad range of learning technologies on campus. Before this, he conducted research in the field of computer-supported collaborative learning, applying methods like tangible computing and dual eye tracking.

Corresponding author
Iris Capdevila
EPFL Ecole Polytechnique Fédérale de Lausanne
CAPE, Teaching Support Center
Route Cantonale,
1015 Lausanne, SWITZERLAND
iris.capdevila@epfl.ch