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## Students' Experiences Of Reflecting On Their Development Of Professional Skills In An Engineering Programme.

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### **Cover Page Footnote**

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### **Abstract**

Engineers play a central role in addressing the challenges which face society, and recent literature highlights the need for emphasis on the development of professional skills in engineering programmes. This paper describes the outcomes of a study which investigated students' experiences of reflecting on the development of their professional skills using an ePortfolio in a pilot project. A focus group was used to capture students' experiences of the reflection process and the use of the ePortfolio. Transcripts were analysed thematically to draw out the key experiences and to provide feed-forward advice for the next iteration of the project. The findings show that students need support in the reflection process, and clearer signposting between each skill and the modules relevant to their development. Students also found it difficult to ascertain their competency levels and felt that industry experience was needed to help score themselves accurately. Feed-forward advice included incorporating an ePortfolio throughout all years of the programme which would track their improvement in a range of skills, and providing a rubric to help assess their competency. The outcome of this study can be used by educators who wish to incorporate a professional skills ePortfolio in their engineering programmes.

**Keywords:** professional skills; engineering skills; co-creation of curriculum; reflection; ePortfolio

## **Introduction**

The influence of globalisation, disruptive technological change and socially complex problems will greatly affect the way engineers work in the future (Morace et al., 2017; Zhangbao & Yang, 2019). As a result, industry and society will continue to look to Higher Education Institutions (HEIs) to better prepare engineering graduates with the new skills needed to face the challenges of the future. Notwithstanding the critical and valued role that technical engineering subjects have within an engineering programme, the literature suggests that there is a need for a greater focus on the development of professional skills (Winberg et al., 2020; Craps et al., 2017; Ramadi et al., 2016). This study emerged from a programme-team initiative to enhance the development of engineering students' professional skills within their programme of study. The initiative included a compilation of the skills required and a full programme review of module content and assessment to identify barriers and opportunities for students to develop these skills. The crux of the project however was the introduction of a reflection and ePortfolio exercise to emphasise the need for a student-centred approach to developing the professional skills needed to solve the challenges of future society. This paper reports on the outcomes of a focus group with the students involved in the pilot and describes the key themes which emerged from their experiences. The outputs are used to inform additional iterations of the project and to highlight initiatives which will support the students in creating high impact ePortfolios in the future.

## **Literature review**

Recent seminal reports and academic literature highlight the need for adequately trained engineers with a multitude of skills to prepare industry and society for the needs of the future (Winberg et al, 2020; Kolmos & Holgaard, 2019; Craps et al., 2017; Tabas et al., 2019).

Many terms are used to describe the list of skills that engineering graduates should have upon

graduation. These include: graduate attributes, soft skills, employability skills, key skills, transferable skills, generic competencies, generic skills, professional skills, non-technical skills and transversal skills. For the purposes of this paper, the term “professional skills” has been used holistically to include: technical skills, non-technical skills and attitudes (Miller, 2015; Beagon et al., 2020). Industry has a similar viewpoint to academic literature and several industry studies are also reported in the literature (Colman & Willmot, 2016; Kövesi & Csizmadia, 2016; IOT, 2011). In Ireland specifically, the Institutes of Technology commissioned a study to look at the strengths and weaknesses of engineering programmes using feedback from employers (IOT, 2011). The report recommends that: “The teaching of key non-technical skills such as oral and written communication should be enhanced and further integrated into the earlier years of the engineering programmes” (IOT, 2011, p.8).

Whilst this study originated from a focus on the future by the programme team of lecturing staff, the design of engineering programmes at TU Dublin is also influenced by the accreditation requirements of Engineers Ireland (Engineers Ireland, 2021) and a new University Strategic Plan (TU Dublin, 2020). Engineers Ireland is the accrediting body for engineering degree programmes in Ireland and launched a new set of accreditation criteria in January 2021. The programme outcomes have been broadened with a focus on sustainability and also include specific aspects of ethical use of technology and data, and equality, diversity and inclusion in professional practice.

The University Strategic Plan is based on the concept of three pillars (People, Planet and Partnerships) with some parallels to the three-pillar model of sustainable development: environmental impact, social impact and economic impact (Lozano et al., 2017). The plan commits us to developing responsible global citizens by facilitating learning and knowledge creation and instilling a sustainability mindset in our students and staff. Structural engineers as key drivers in the creation of our infrastructure are well placed to impact change, as long

as they have the correct set of skills. As Zhangbao and Yang (2019, p.468) attest “Without the involvement of engineering, it is impossible for human beings to implement sustainable development”. Therefore, it is clear that structural engineering students need to develop a broad range of professional skills: technical skills to design buildings, non-technical skills to work with people, but also attitudes in relation to sustainable development and societal issues (Beagon et al., 2020).

There is also a significant body of literature which proposes best-practice ways to expose students to opportunities to develop professional skills within their programme. These include; Problem Based Learning or Conceive Design Implement Operate (CDIO) approaches (Jollands et al., 2012; Warnock and Mohammadi-Aragh, 2016; Larsen et al., 2017), project work (Picard et al., 2021) and even extra-curricular activities such as Ambassadorship and Engineering Service (Community Based Projects) programmes (Anagnos et al., 2014; Litchfield et al., 2016). However, encouraging students to reflect on their competence, as a way to enhance the development of professional skills has also shown to be effective in a study of computing students undertaking weekly reflective blogs. Curtin University introduced an iportfolio [sic] for engineering students which was based on a STAR-L (Situation, Task, Action, Response, Lessons Learned) format to encourage students to reflect deeply on their experiences (Cajander et al., 2011).

### **ePortfolios**

ePortfolios can be used as way to record a learner’s development and they also serve as a stimulus to encourage students to reflect on their performance and to enable them to self-assess (Meeus et al., 2006). They have the potential to transform learning, teaching and assessment (Scully et al., 2018; Donaldson, 2018) and have been used in many educational settings such as healthcare (Peacock et al, 2018), psychology (Gaitán, 2012), higher

education training (O'Keeffe & Donnelly, 2013; Ciesielkiewicz, 2019) and engineering education (Alam et al., 2015).

ePortfolios are a useful tool in assisting students to reflect deeply, think critically and showcase their best work, but there are challenges associated with their implementation. Walland and Shaw (2020) identified several of the key challenges in a literature review of ePortfolio theory and praxis between 2000 and 2019. The literature review which focussed on the aspect of transversal skills, identified tensions which included not only the “product” versus “process” conceptualisation of ePortfolios, but also differences in ICT skills of students and teachers and the value of engagement versus the burden on students (Walland & Shaw, 2020).

The definitions of product and process relate to assumptions about an ePortfolio being a space where students can collate files showing evidence of their experiences and achievements and as a process where students are empowered to learn about their own personal learning process, developing skills in reflecting, collaborating and presenting (EUfolio, 2015; Poole et al., 2018). In fact, an ePortfolio can serve as both a product and a process by encouraging self-reflection, collating evidence of the development of skills which can be used in employment opportunities, and showcasing work for assessment purposes (Scully et al., 2018; Poole et al., 2018; Alam et al, 2015). Furthermore, over time and with instructor feedback, ePortfolios can show advancement in student learning, and the aspect of ongoing feedback is a key contributor to a high impact ePortfolio (Powell et al., 2019). This raises the question about the ability of academic staff to provide effective feedback for improved learning, not only in the reflection “process” but also in the formulation of the ePortfolio “product” (Powell et al., 2019; Alam et al, 2015).

The rapid move from paper based to electronic based technologies in education has highlighted a widening gap between students and educators. As a result, for successful implementation, it is recognised that lecturing staff need professional development and support to help students gain maximum impact from the use of an ePortfolio (EUFolio, 2015; Powell et al., 2019). This training coupled with additional time needed to modify their assessment practice and upskilling in ICT skills to effectively use the software have also been identified by Alam et al. (2015).

Students are also faced with challenges which include the additional time and workload in creating an ePortfolio, skills in selecting artefacts for inclusion and skills in reflecting on their learning (Alam et al., 2015). Gaitán (2012) reported similar key findings from students' experiences in using an ePortfolio as a Personal Development Tool. They included general attitudes towards reflecting, writing and ePortfolio use and, more specifically, issues relating to having a clear purpose for undertaking the task, technical aspects with the software, their willingness to disclose honestly and the guidance received from lecturers. These findings also resonate with student experiences of using an ePortfolio in a higher-education course which included concerns about the purpose, the requirements of what should be included for assessment, the use of technology and the time-consuming nature of the work (O'Keefe & Donnelly, 2013).

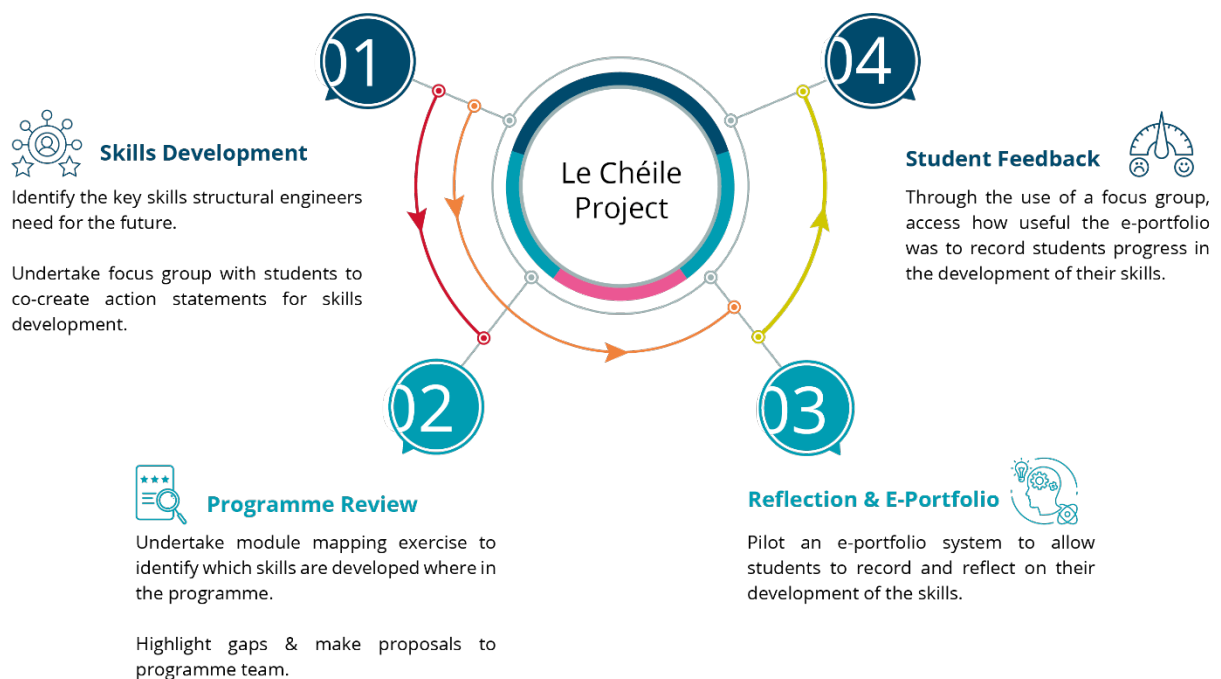
ePortfolios serve as a tool to encourage both reflection and self-assessment, in addition to creating a repository of evidence on development of specific skills. Hence ePortfolios provide an ideal opportunity for students to record their development of professional skills in particular. Nonetheless, their adoption in Ireland has been slow to emerge as a result of "a lack of government policy drivers; no distinct Irish ePortfolio community; and a scarcity of funding" (Farrell, 2019, p.154). However, the launch of a community of practice (initially called MaharaIrl and relaunched in 2018 as EPortfolio Ireland) indicates the emergence of a



group of academics interested in implementing learning opportunities through well-designed ePortfolio projects.

## Research design

This paper describes a pilot project as part of an educational reform effort in relation to integrating the use of an ePortfolio into a structural engineering programme to assist students in their development of professional skills. It is presented as a practice paper to describe an intervention and the experiences of the students. We intend to use the feedback from the students to inform the next iteration of the project. The project was awarded funding through the Le Chéile stream of the IMPACT project in TU Dublin (TU Dublin, 2019). Le Chéile is an Irish phrase meaning “together” and hence this was a programme-team effort undertaken by seven members of the School of Civil & Structural Engineering in TU Dublin, along with students in the structural engineering programme. The project was split into four research work packages as indicated in Figure 1.



**Figure 1: Work packages involved in overall project**

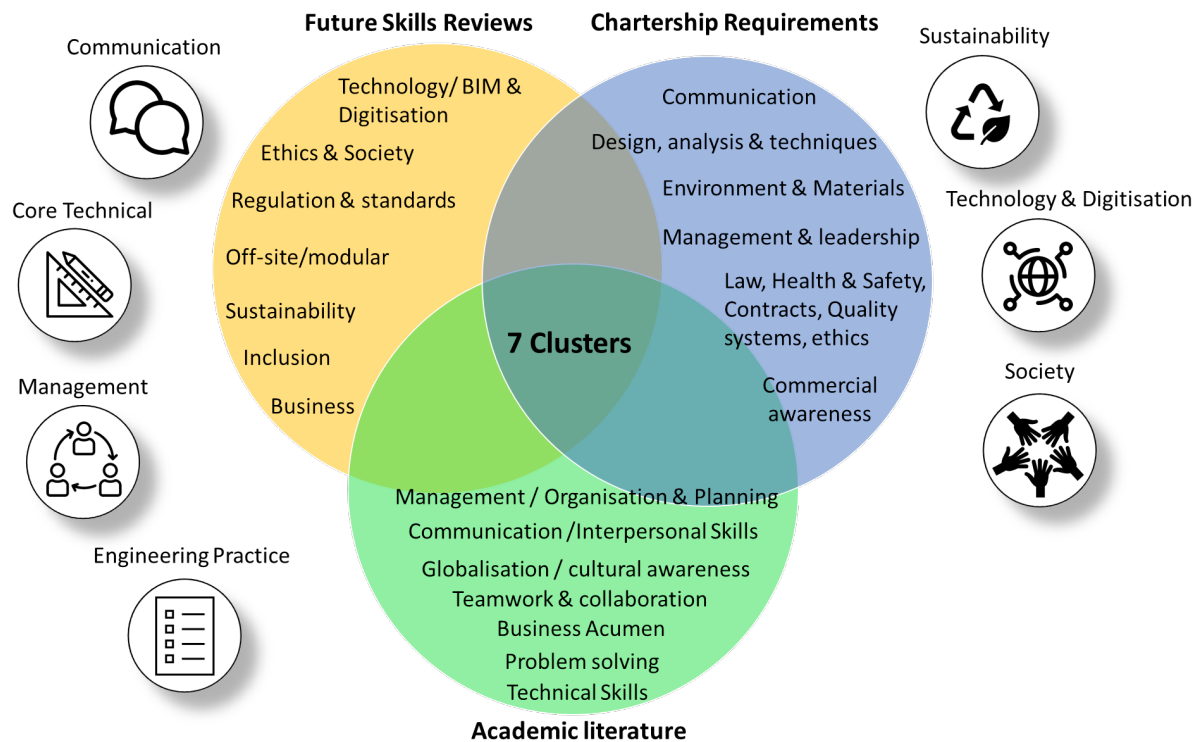
The first work package created a priority list of professional skills needed for structural engineering students which was distilled from a literature review. This skills list was then tested and definitions co-created with a student focus group so that action statements were provided for each skill (Byrne et al., 2021). Work Package Two comprised a programmatic review within which lecturing staff mapped the modules they teach in relation to the set of defined professional skills (Crean et al., 2021). In Work Package Three, third-year structural engineering students were invited to reflect on their skills development in a pilot ePortfolio project within a module (dePaor et al., 2021). The project closed with student focus groups to provide feedback on the reflection process and on the use of the ePortfolio, and finally to garner feed-forward advice on the next iteration of this exercise. The outputs from this final work package form the contents of this paper, where we aimed to investigate the student experiences of reflecting on their professional skills within an ePortfolio.

(Finally, it is important to note that Ireland was in lockdown as a result of the COVID-19 pandemic when this project took place. Students took classes online with no access to the university or opportunities to physically meet fellow group members.)

### **Professional skills list**

In order to provide a background for discussion of the student experiences, it is important to outlay the specific activity which was undertaken. In the first work package, the professional skills identified produced seven skill clusters, shown in Figure 2 (Byrne et al., 2021). These are the traditional, though evolving skills related to Communication, Core Technical Skills, Management and Engineering Practice, as well as emerging skills related to Sustainability, Technology and Digitisation and Society. These can also be categorised as Technical

(Technical Skills and Technology and Digitisation), Non-Technical (Communication, Management and Engineering Practice) and Attitudes (Sustainability and Societal).



**Figure 2: Clustering of Skills emerging from the literature (from Byrne et al., Sept 2021)**

The definitions of each of these skills along with action statements were co-created with structural engineering students in a focus group (Byrne et al., 2021) and are summarised and presented in Table 1. Full details of each skill definition and all action statements are described in detail in Byrne et al. (2021); however, as an example, the action list associated with “Society” included:

- The ability to engage with a community for the betterment of structural engineering or a structure.
- The ability to research and reduce the negative impact of a structure on a locality, including the local community, local services, traffic, and local businesses.
- The ability to be ethical in daily engineering practice.

**Table 1: Co-created definitions of skills for Structural Engineers from Work Package 1**

Technical
<ul style="list-style-type: none"> <li>• Core Technical: has a strong grounding in mathematics and science within structural engineering. This includes the fundamental principles of structural engineering, material behaviour, engineering equations and problem solving.</li> <li>• Technology and Digitisation: is able to learn and use new technologies and digital advancements in analysis, testing, communication and collaboration.</li> </ul>
Non-Technical
<ul style="list-style-type: none"> <li>• Communication: can effectively exchange information through a variety of diverse means and with diverse groups in various settings and circumstances.</li> <li>• Management: can manage themselves and others in keeping on track towards an end goal.</li> <li>• Engineering Practice: understands and follows the protocols, processes, rules and regulations of practicing within this field.</li> </ul>
Attitudes
<ul style="list-style-type: none"> <li>• Sustainability: has a working knowledge of the impact of design choices on sustainability and targets the reduction of impact on the planet and its natural resources.</li> <li>• Societal: has an understanding of how they can impact society either directly or indirectly, and makes efforts to give back to the community, understanding the inseparability of structure or structural engineering practices and people and place.</li> </ul>

### Reflection exercise

The reflection exercise was undertaken as part of a module which involved third-year structural engineering students in a six-week team project with architectural students. This was chosen to ensure that students would have an opportunity to develop teamwork skills and to work with a diverse team, in contrast to most student projects in the programme which although may include teamwork, are confined to structural engineering students working together. Students were provided with a list of the skills identified in Table 1 along with the action list statements and were asked to rate their confidence and then reflect on why they selected that particular rating for each skill. Rating options were “Completely Confident”, “Fairly Confident”, “Somewhat Confident” or “Not Confident at all”. Their ratings and

written reflections were then compiled and assessed by the authors and the outcomes are reported separately (De Paor et al., 2021). The focus group to which this paper relates took place six weeks after the completion of the reflection exercise and was hosted by two lecturers. (The questions asked in the focus group are included in Appendix A.)

### **Ethical approval**

As the research work involved human participants, ethical approval was required for the focus groups. Ethical approval was granted by the TU Dublin Research Ethics and Integrity Committee [Ref: REC-20-91]. A request for research participants was emailed to the third-year structural engineering class group who had trialled the ePortfolio exercise and all volunteers who had signed the ethical consent form were accepted. Focus groups were carried out remotely using Microsoft Teams and were recorded and fully transcribed.

### **Data analysis**

A General Inductive Approach (GIA) was used to analyse the transcripts which produces outcomes describing the most important themes uncovered. Thomas (2006) describes the following steps in the GIA process: 1) Data cleansing of raw files, 2) Close reading of text to gain an understanding of themes, 3) Creation of categories, 4) Overlapping coded and uncoded text and 5) Continuing revision and refinement of categories. In order to add validity to the analysis, the data was analysed independently by two researchers on the team, an example of independent parallel coding. They then discussed and debated their findings until they reached agreement. The findings are presented in two sections. The first is the primary themes (i.e. their outputs on the reflection and recording of their skills). Second, students were invited to give a commentary on how they would improve the process of both reflecting

on skills-development and recording their progress and their thoughts are summarised in the section entitled Feed Forward.

## **Findings – Themes**

### ***Lack of confidence in scoring ability***

The first theme which emerged from the focus group was the students' lack of confidence in their scoring ability. They were not sure how competent they were in specific skills or how to reflect on skills, because they did not have a clear picture on what competency in a particular skill meant. Their benchmark for what competency means is directed towards what is required of them in industry. They felt that having a work placement in the summer will highlight for them the level of competency required in each skill and therefore enable them to reflect and score their competency more accurately. There was no specific reference to assessing competency by examination scores; the focus was on what industry requires. For example, one student noted that they felt they were competent but realised very quickly once they undertook a task in a work placement that they were indeed not as competent as what was required:

It's kind of like hard to know if you have excelled in your skill, like at the best level in college... you think.... you know, I'm doing like six, seven out of 10, I'm actually doing pretty well. But then when you go into the working world, it's only like two out of 10. So it's, really hard to know how good you are. (M2)

I found it kinda difficult just to reflect on, because you don't really have a basis of what to go off. (M1)

I wouldn't be too sure on how much I know myself until you kind of get out into the working world and be able to apply everything that you've been studying for the last couple of years. I'm doing the XXX internship for the summer, so hopefully I'll be able to gauge a little bit more after that. (M1)

### ***Signposting towards specific modules***

Overall, the students found it difficult to link skills development with particular modules: they found it difficult to remember which modules had developed which skills. There was a reference made to developing skills such as communication and management not in relation to specific modules, but more generically through the use of project work, or the initial challenge of making friends in first year. However, when it related to other skills, the students appeared to associate skills development with what they were specifically taught in modules, what was on the curriculum rather than complementary skills developed alongside or outside of the university experience itself.

You know, first year, the first thing you got to do is make friends and that's a big aspect of how to get your skills going, communication, management, obviously. We have all the messaging apps and it takes two seconds to send somebody a message, you know? (M2)

I think in terms of the communication and management and stuff, we were able to reflect a bit more on that because we've done a lot of group projects and that involves a lot more of that side of things than the societal and sustainability impacts. (M1)

I don't think I ran into any issues with any of them in terms of the definition. Maybe just trying to associate them with different aspects of the course...just linking it, or hinting back to a particular module that we've done or aspects of the course that would apply to different skillsets. In terms of technology and stuff, obviously there's modules that we did that looked a bit more at that side of things than we would have looked at the societal impacts and what not. (M1)

### ***Understanding of skills requirements***

Although students were provided with the definitions that they had co-created, along with action lists for each skill, they differentiated between skills which were easy to reflect upon and those that were more difficult. This appeared to stem from both an understanding of the extent to which they are or should be competent in this skill and also how this skill would relate to the work of a structural engineer. Overall, communication skills, management, core

technical skills and technology and digitisation were easily understood. Technology and digitisation skills were enhanced by the move to an online environment as a result of the COVID pandemic. The skills required in relation to Sustainability and Society and Engineering Practice proved more difficult to reflect upon as students acknowledged the breadth of knowledge required in these areas and their lack of appreciation (as yet) as to how much a structural engineer can contribute until they gain industry experience. They felt that there was a need to work on real-world problems to make sense of sustainability and societal skills development.

I think the communication, management and core technical ones is okay, they are the ones that we're kind of a bit more familiar with. (M1)

Technology and digitisation. I find it very easy. Obviously we've spent the whole year online, so, you know, sorting out your filing cabinet with your documents and so on isn't a problem. (M2)

When it came to the engineering practice and sustainability, societal impacts, those sort of skills were a little more difficult to gauge how much we actually really know about it again, without having done much in the real world kind of sense of things. (M1)

With respect to sustainability, I don't think any of us were really aware of the depth that we needed to go into regarding that, you know. (M3)

### **Findings – feed forward**

When students were invited to give commentary on advice they would give to the next generation of students to undertake the ePortfolio, several aspects emerged.

#### ***Ability to reflect***

The first was the ability to reflect. Students were unsure how to reflect or how appropriate or valuable their reflection was. As third-year students, they were also exposed to a short project in their first year which involved a reflective exercise and had provided an example of a



shallow and deep reflection. However, this is the only scaffolding they had received before this exercise. They requested that additional support be given for this project going forward to assist them in developing deeper reflections.

It was hard to understand how well you think you're doing at a reflection. I know we did do a reflection, on the first-year civil structure project in DT066 and they gave us like a sample answer so it was easy to understand.....like a sample answer always helps you know. (M2)

### ***Signposting to skills-development in modules and long-term mapping***

The students felt that clearer direction on the skills developed in each module would have assisted them in the reflective exercise. They found it difficult to remember which modules they had completed and which skills they felt they had developed in each module. Clearer mapping and signposting to individual modules would have assisted in this regard.

In addition to clearer mapping within each module, the students felt that the development of an ePortfolio through the whole programme from first year to fourth year would be beneficial not only in assessing competency more accurately but recognising and celebrating development of those skills over the course of the programme.

I think something like the reflection, it might not be a bad idea to do it at the start of the year and take note of what you know, and what you're not sure about and what you kind of aim to learn as such. It might make the reflection later on in the year, a little bit easier to kind of gauge how far along you've come. (M1)

Like you can sit there in third year and think you've struggled for the last three years, but when you can actually see how much you've progressed, it's a bit more of a motivating way to try and do better, you're not just sitting there thinking you've been struggling the whole time. (M3)

I think rolling it out from first year would probably be the most helpful aspect of it, but maybe a bit more regular than just once or twice a year. (M1)

### **Viability of self-sustaining ePortfolio without academic credit**

Students discussed the incorporation of reflection tasks in several modules or over several years as a way to encourage students to reflect and build on their skills. Despite their best intentions, they felt that unless there is a requirement to undertake the reflection exercise, that students would not be motivated to reflect and in all likelihood would fail to maintain a portfolio. One student in particular noted how they had good intentions to continue with a reflective exercise in first year, but without motivation, it did not happen. Furthermore, students noted the importance of allowing sufficient time for students to reflect within the timetabled class.

You know, we had to do the WordPress [reflection] for the electrical project and then I said to myself, oh, you know, I'm going to use that blog and that is something I can use for the rest of my career. And I was like, oh, I'll, put up the civil and structural project. But you see, I was a first year and my mind was blown, like the whole college aspect of life and I haven't gone back to it since! (M2)

If there's not really an incentive for people in their late teens, early twenties to do it sometimes it's unlikely that are going to do it. (M3)

I think maybe sometimes in an individual module, maybe having some time .....I think people aren't really good, especially students and especially outside of classroom time to do those types of reflections. (M3)

### ***Using an ePortfolio for job applications***

The use of an ePortfolio as a way to showcase skills development and project work was also highlighted as an opportunity when applying for jobs and student placements. It was recognised that an ePortfolio should show growth, i.e. honesty about where things went wrong (the ups and downs) but with an acknowledgement of what was learned as a result.

It's good to be able to reflect and actually have something to show a company like that. You can start a project and follow through and finish it at the end and stay with it the whole time, show the ups and the downs, then all the way to the finish line, I suppose. (M3)

I think it would be pretty good idea in terms of when it comes to apply for jobs. I know your CV can list out the facts and skills and all the rest of it, but

it doesn't really tell you a whole lot about the person from an employer's view that you're going to be interviewing. But I think something like that, an ePortfolio can speak a lot more to somebody's character ..... You can show where your interests lie. (M1)

I think it really helps your growth as a person too.....it shows the progression to an employer, how well you've completed your four years. You know in first year I didn't have a clue. (M2)

## **Discussion**

This pilot project was used to better understand the student experience of reflecting in an ePortfolio so that the programme team could revisit the project before the next iteration of roll out. The students provided useful feedback and feed forward advice which will assist us in supporting a longer and more impactful programme to help students develop the professional skills needed for the future. Several key issues were brought out to assist in this ambition.

Students had some difficulty not only in the reflection process but also in understanding their own competency in specific skills. This can be ameliorated by providing them with several supports. The first is a model of reflection such as Gibbs (1998) or the STAR-L model used in Curtin University (Cajander et al., 2011) which can enhance the reflective process, enabling students to learn how to reflect more deeply. Furthermore, a more detailed rubric to show competency levels in each skill would permit students to more accurately assess their competence at certain stages throughout the four-year programme. For example, rather than use terms such as “Completely Confident”, “Fairly Confident” etc., terms such as “Appreciation”, “Knowledge”, “Experience” and “Ability” could be used which align with the Institution of Structural Engineer’s (2019) Core Objectives rubric, facilitating a clear pathway to this training scheme upon graduation. Examples of how structural engineers

specifically use these skills in practice can also enhance the link between theory and practice, specifically in relation to lesser-known skills such as Sustainability and Societal.

There was also a call to assist students in signposting within which modules specific skills were being developed. Rather than looking to the overall curriculum components or modules, it may be helpful to highlight these skills within each individual assessment. This type of signposting may also help students become more aware of the type of skills they are developing (or are supposed to be developing) with a particular assignment. As a simple example, a chemistry laboratory report could include aspects of Core Technical (solving equations), Communication (writing a lab report), Engineering Practice (following procedures) and Sustainability (disposing of the chemicals used in the experiment).

Furthermore, students did not appear to highlight any skills developed outside of the programme, through committees, clubs and societies, work placements or hobbies. The signposting exercise can also direct students' attention to the skills developed in these activities as they have been proved to be effective in developing professional skills (Anagnos et al., 2014; Litchfield et al., 2016). The signposting exercise would also align with a key component of high impact ePortfolios as espoused by Powell et al. (2019) where the assessment would be integral with learning outcomes for multiple courses and experiences.

Students indicated the benefits of showing progression over the degree programme and the incorporation of the reflection and ePortfolio exercise over multiple modules and multiple years. Our findings suggest that there is value in extending the use of this ePortfolio allowing students to keep track of their development of skills over time. This year-on-year ePortfolio can then be used as a basis of applying for work-placement and graduate jobs showing growth through their degree programme. However, students noted the importance of allowing class time to complete the reflective exercises and making it a requirement of an academic module, without which they were unlikely to engage. This finding emphasises the challenge

of balancing the benefits associated with the use of an ePortfolio against the additional time burden placed on students, and highlights the need to integrate it within the programme (Alam et al., 2015; O'Keefe & Donnelly, 2013; Walland & Shaw, 2020).

Finally, it is notable that the students did not experience that a lack of ICT skills was an impediment to engaging with the ePortfolio; however this may be because they had upskilled rapidly as a result of learning online during the COVID-19 pandemic.

### **Limitations**

It is important to note the limitations of this pilot study. Firstly the list of skills provided to students was specifically generated in relation to structural engineering in particular, and specifically with regard to Irish future skills reports and chartership requirements for structural engineers. The skills definitions and action statements were co-created with a small group of structural engineering students and hence may be specifically relevant to the structural engineering profession. The pilot study was carried out with only one student group in one module in a structural engineering programme in Ireland.

### **Conclusions and recommendations for practice**

Overall, this study proved to be an excellent pilot exercise and demonstrated to us how important it is to be explicit about which skills students are given opportunities to develop within each module. In order to sustain this initiative, future plans of the project team include opening up the reflection and ePortfolio exercise across the entire programme in several modules, encouraging students to reflect from their first to final years of study. Furthermore, additional scaffolding in the form of a reflection model, a detailed rubric and examples of

how structural engineers apply skills in practice will be provided. From the initial stages, students will be encouraged to set up the ePortfolio as an outward-facing profile which can be used for job applications in the form of work placement and graduate recruitment.

Our work raises several additional research questions which we hope to pursue, including investigating the effectiveness of the ePortfolio in developing specific skills (rather than relying on self-reported perceptions) and to analyse and implement relevant training for academic staff in assisting students to reflect and in providing relevant feedback. We hope our efforts will go some way to helping students to recognise the importance of the development of the professional skills structural engineers need for the future.

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## Appendix A: Focus Group Protocol

### *Sample identification*

The sample of students for the study will be drawn from the classes which have used an ePortfolio as part of the module to reflection on their skills development.

The researchers will strive for representation for both male & female and national & international students alike.

### *Focus group protocol*

Request for research participants.

Researcher will email students with an invite to the focus group and will include the questionnaire for ethical approval. Only students who have signed the ethical approval will be able to contribute.

Activity	Description	Time
Introductions	Provide an overview of who the researchers are.	15 minutes
Rationale for the research	Outline to the students in broad terms the purpose of the research and let them know that their feedback today will impact the introduction of e-portfolios on the programme.	
Outline student activity	Outline the activity for the focus groups.	
Student activity	Students will be prompted to discuss the following themes: <ul style="list-style-type: none"> <li>• Difficulty and value on Reflection on Skills Development</li> <li>• Difficulty of use of e-portfolio</li> <li>• Feedback for future implementation of e-portfolios</li> </ul>	45 minutes
Wrap up	Thank students for their time, offer to share the outcome of their input by circulating any reports and papers.	

### *Prompting questions*

To encourage students' to actively engage in the process of giving feedback on the reflection on skills and the use of e-portfolios, the researcher can ask prompting questions.

Difficulty and value on Reflection on Skills Development

- In general how did find the process of reflecting on skills?
- Which were easy to reflect upon, which were difficult?
- On a scale of 1-10 how much did you engage with the reflection process?
- What stopped you from engaging 100%
- Was there any confusion over what they meant? (Which ones?)

- Did you feel you had sufficient knowledge to rate yourself?
- For each skill mentioned: Can you give examples of where you reflected on this skill?

#### Difficulty of use of e-portfolio

- On a scale 1-10, how easy did you find the e-portfolio to use?
- With regard to the user interface - What was easy, what was difficult?

#### Feedback for future implementation of e-portfolios

- What advice would you give to the next students to use it?
- What would you do differently next time?
- What should we do differently?