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## Euniwell: Maximising Academic And Social Outcomes In Engineering Education

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# **EUNIWELL: MAXIMISING ACADEMIC AND SOCIAL OUTCOMES IN ENGINEERING EDUCATION**

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## **ABSTRACT**

The ERASMUS+ European University for Well-Being (EUniWell) alliance's mission aims to resolve the paradox of Europeans' relative prosperity against the global security and sustainability challenge. "Maximising Academic and Social Outcomes in Engineering Education" is a project which interprets this contradiction for engineering

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educators; how to best teach non-technical skills to ensure engineers make the utmost contribution to societal wellbeing? Appreciably, the social outcome for the person who becomes an engineer is positive because the profession is relatively well-paid. Therefore, engineering education is good for social mobility providing the learning environment narrows attainment gaps between disadvantaged and mainstream cohorts. Accordingly, our strategy is to bring together the expertise of the British, French, Italian and Swedish faculties to transfer best practice for professional, business and sustainability skill teaching, while contrasting how their disadvantaged cohorts present. The project has two primary objectives: To understand how partners differ in terms of skill teaching, and how students from disadvantaged backgrounds are accommodated. The paper describes the background and rationale of the project, and its research design and methodology. Although the project is still in progress and data collection is still underway, this paper provides insights and perspectives for engineering educators looking to design similar collaborations to share best practice, while considering engineering identities and their underlying competencies.

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## **1 INTRODUCTION**

Engineering is known to have a distinct cultural identity, which encompasses solving well-defined problems through the development of products, processes, and services. This identity is formed throughout the student's period of study. However, if the focus is solely on developing more practical skills, the question arises as to whether the students are developing holistically; What role do other professional skills have in developing students as engineers? It is our position that currently professional skills, such as innovation, enterprise, and creativity; communication and networking; and social, environment, and technical responsibility, are more subjective and subsequently are not taught as well by faculty. As a result, there are negative social outcomes in terms of satisfaction and wellbeing, despite the student successfully meeting any programme's learning outcomes.

The broader EUniWell alliance mission is to resolve the paradox of Europeans' relative levels of prosperity against the global challenges in society they face: health, environment, political instability, and defence. Maximising Academic and Social Outcomes in Engineering Education (MASOEE) interprets this contradiction for the engineering profession as how to best teach the non-technical skills to ensure engineers make their utmost contributions to societal wellbeing. Our strategy is to bring together the expertise of Birmingham, Florence, Linnaeus, and Nantes engineering faculties to share and develop expertise to improve the social outcomes of engineering students.

The cultural identity of professional engineers is often dominated by practical skills. Therefore, a key aim of the project is to explore ways in which we can 'rebalance' the education of engineering students, ensuring that there is as much emphasis on

professional skills as there is on practical. The rest of this paper is as follows. Section 2 provides some theoretical background behind the project; section 3 describes the research methodology; section 4 some preliminary results and section 5 a summary.

## **2 BACKGROUND**

Engineering culture has traditionally focused on technical competence, such as the basics of science and mathematics, design, and analysis skills, as well as the use of engineering tools and methods, which produces a 'traditional technologist' (Berge, Silfver, and Danielsson 2019). However, as these authors note, most contemporary faculties dealing with the education of engineers have moved away from this narrow focus and towards incorporating other skills such as professional skills, enterprise, and sustainability and ethics. It is because of this shift to a more contemporary approach, that they suggest that three new engineering identities have emerged: 'Self-made engineer', 'Contemporary technologist', and 'Responsible engineer'.

'Social-technical' dualism (Faulkner 2015) is the separation of 'technical' skills and 'social' competencies. It can often be reinforced through both the design and delivery of the curriculum and can subsequently lead to a 'hidden curriculum' (Tormey et al. 2015), typically comprising separate learning units for skills which are delivered by non-engineering experts. This results in non-technical competencies being duly taught and learned, but not widely thought of as an engineer's problem, and thus not fully integrated into day-to-day engineering habits. Our project is designed to not only understand both staff and student attitudes to these skills, but also to identify how this hidden curriculum manifests.

The global marketplace in higher education and its neoliberal trends, where students are customers, and where higher education is expected to produce employment-ready graduates, leads to social outcomes in education being considered chiefly through graduate destinations and earning potential (Berg, Huijbens, and Larsen 2016). As engineering is a relatively well-paid profession, the ultimate social outcome of studying engineering and then entering its profession for the individual can be considered net positive. For this reason, engineering education can be a force for social mobility, especially when faculty make a conscious effort to widen access for disadvantaged students. Consequently, once they arrive on campus, the learning environment delivers and equitable education which narrows any attainment gaps between disadvantaged groups and the mainstream cohorts. MASOEE partners have different definitions for what is considered a disadvantaged student in this context, and consequently what interventions they practice to narrow attainment. Therefore, understanding these differences and how students from these backgrounds experience the process of becoming an engineer and the types of intervention that make a difference is a valuable knowledge exchange.

### 3 METHODOLOGY

#### 3.1 Research questions

Reflecting on this background, we have formulated the following research questions:

- What are the similarities and differences between engineering partners, their student bodies, teaching, programme structures, and institution culture?
- How are the skills currently taught and embedded in programmes? What are student attitudes to learning these? How do we currently define and measure social outcomes?
- Which new approaches can we employ to better teach these skills that deliver better social and academic outcomes?

Fig. 1 provides an overview of the project, illustrating how the different components contribute to developing a comprehensive understanding of the teaching of professional skills within the partner universities, as well as how the partners are widening participation of disadvantaged students, ultimately narrowing any potential attainment gaps. The project is comprised of four 'Work Packages' (WP1, WP2, WP3, and WP4). WP1, WP2, and WP3 are designed to collect data, offering practitioner workshops and general data collection opportunities. WP1 concerns innovation, enterprise, and creativity; WP2 concerns communication and networking; WP3 concerns social, environment, and technical responsibility. WP4 is utilised to co-ordinate overall engineering education research approaches and research questions, as well as general project management.

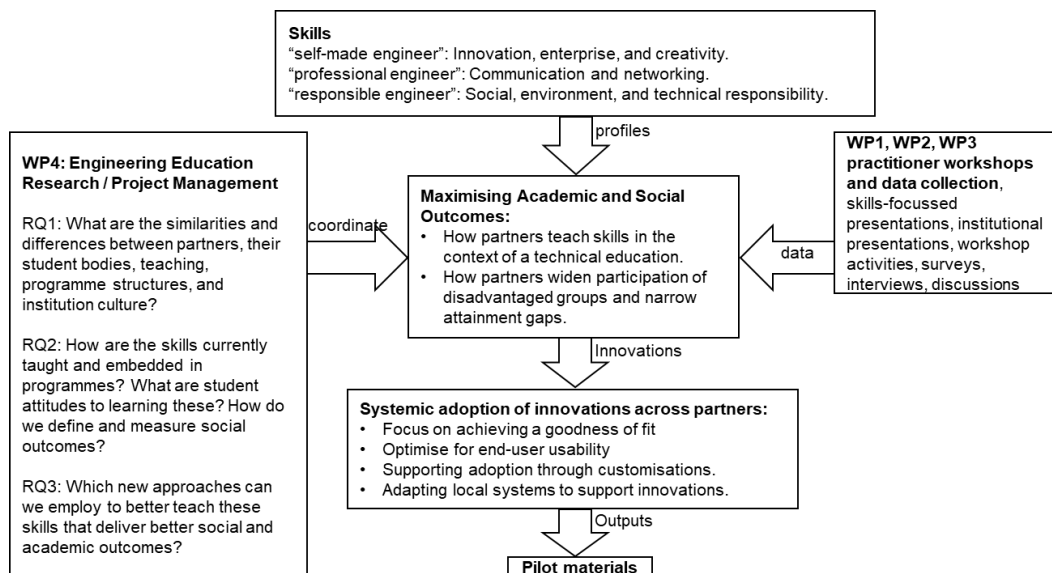


Fig. 1. Project workflow.

#### 3.2 Mapping engineering identities to skill taxonomies

So that all partners share a common definition for discussing the skills sets, the project will draw on existing skill inventories and taxonomies and map them to the 3

engineering cultures defined by (Berge, Silfver, and Danielsson 2019) as shown in Table 1.

*Table 1. Engineering identities mapped to MASOEE skill mappings*

<b>Engineering identity as defined by</b> (Berge, Silfver, and Danielsson 2019)	<b>MASOEE skill mappings to frameworks</b>
Traditional technologist (status-quo)	Science and maths, design, analysis, engineering tools and methods.
Self-made engineer (neoliberal trends)	WP1 Entrepreneurship: Innovation, enterprise & creativity Entercomp (Bacigalupo et al. 2016)
Contemporary technologist (progressive trends)	WP2 Solving complex challenges: Communication & networking. WEF 21 <sup>st</sup> Century Skills (Soffel 2016)
Responsible engineer (sustainability trends)	WP3: Sustainability competence: Technical, social & environment responsibility. EU GreenComp (Bianchi, Pisiotis, and Cabrera Giraldez 2022)

### 3.3 Mixed methods

(Johnson and Onwuegbuzie 2004a) argue that it is the diverse nature of mixed methods that results in higher quality research. The MASOEE project strategy is to examine the similarities and differences between institutions in terms of student bodies, teaching, programme structures, and institutional culture. Whilst it is possible to gather some of this data within a quantitative manner, exploring student attitudes needs a more qualitative approach, leading to the decision to adopt a mixed method research design. To help understand how this mixed method research has been structured, the research questions were broken down into each method used to help answer it and whether it is qualitative or quantitative (Table 2).

### 3.4 Survey

The survey was designed to obtain an overview of current professional skills teaching practices, similarities and differences between the different partner universities, and demographics (current year of study, foundation/pre-year, discipline, University, country of birth, country they attended secondary school in, measure of disadvantaged status). Each partner shared how disadvantage was monitored within their own country. Whilst there was some crossover between the partners in terms of how they monitor disadvantaged status, there are also some differences (Fig. 2).

### 3.5 Documentation, interviews, and focus groups

The qualitative aspect of the research encompasses documentation, interviews, and focus groups, which explore attitudes and approaches, and will build on information found within the survey phase. Interview and focus group schedules were developed

to guide the process. In terms of document analysis, the team created a curriculum grid, entering information on modules that are running at each institute.

Table 2. Research methods identified to answer research questions

Documentation (Qualitative)	Student Survey (Quantitative/Qualitative)	Interviews (Qualitative)	Focus Groups (Qualitative)	Case Studies (Qualitative)
<b>University college/school websites (RQ1/2):</b> Teaching, Programme structures, Institution culture, How skills are taught, access to scholarships (identifying support for disadvantaged)	<b>Demographic (RQ2):</b> Disadvantaged (e.g. Sutton Trust, UK), Free school meals, first in family to go to university, postcode. <b>Similarities and differences (RQ1):</b> Engineering partners, Student bodies, teaching, Programme structures	<b>Attitudes (RQ2):</b> Student attitudes to learning these skills <b>Approaches (RQ3):</b> Which new approaches to better teach these skills to deliver better social and academic outcomes.	<b>Approaches (RQ3):</b> Which new approaches can we employ to better teach these skills that deliver better social and academic outcomes.	<b>Similarities and Differences (RQ1):</b> How skills are taught <b>Similarities and Differences (RQ1):</b> How skills gaps are partners closed <b>Approaches (RQ3):</b> transfer best practice.

Measure of disadvantage	UK	SWEDEN	ITALY	FRANCE
Free School Meals (FSM) at secondary school	✓			
Home postcode	✓		✓	
Parents attended university	✓		✓	
First Language		✓	✓	
Government Scholarship			✓	✓
Paid employment whilst studying				✓

Fig. 2: Measurement of disadvantaged students in the four partner countries



### 3.6 Case study documentation: best practice adoption across partners

MASOEE partners exchange best practice through sharing case studies. Moreover, to facilitate integration of new practice into their institutions, the case studies are structured drawing on the literature of diffusion of innovations – notably the propagation paradigm (Froyd et al. 2017) where the key object is to maximise the efficacy and the fit to the partner to allow for meaningful adoption. The characteristics of this propagation paradigm include: The focus being fit rather than evidence of efficacy. This requires dialogue with partners for how to adapt an innovation at a partner; The innovations should be characterised by usability to provide generalisation to other settings, rather than strong data; Partner interactions through case study presentations ought to support adoption rather than raise awareness; The different instructional systems of the partners e.g., Canvas, Moodle, must be considered as part of the case study so that technical frictions can be reduced.

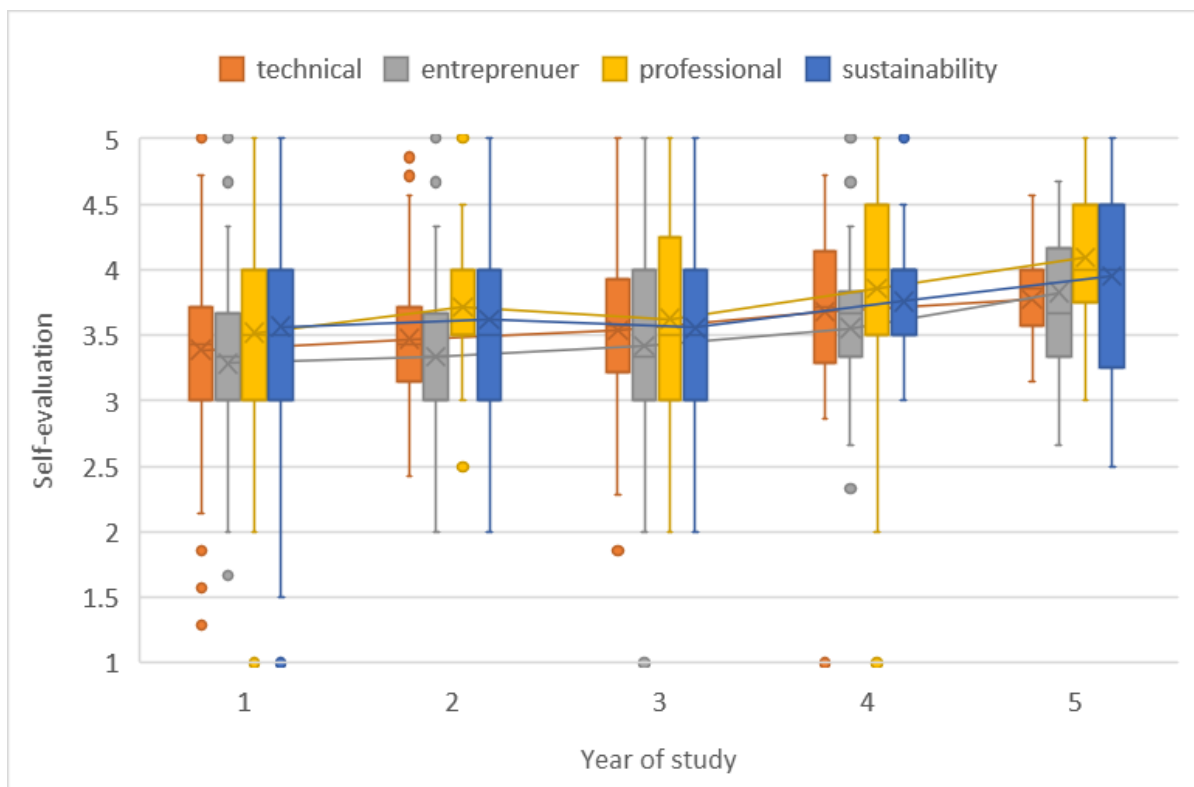


Fig. 2 Self-evaluation of MASOEE skill mappings against year of study (n=535)

## 4 PRELIMINARY RESULTS FROM SURVEY

As outlined in Table 2, a student survey is being conducted by all partners. The survey has been translated into the language of each partner's country and captures demographic information as well as attitudes to teaching skills and student self-rating of abilities in each of the skill sets outlined in Table 1. Early results highlight differences in students' self-evaluation of the MASOEE skills mapping they are learning; e.g. for one partner's cohort (Fig. 2) where we compared skills against year

of study, we observe that there is a gradual upward trend in most skill levels with some difference in variances between year. Although further analysis is needed, there are a couple of stand-out results that are driving our focus group and interview discussions: Sustainability skills (blue) are fairly consistent from years 1-3 but increase in years 4-5. Entrepreneurship skills (grey) follow a similar trajectory although in the first 2 years there is a greater concentration of students rating themselves as lower, resulting in a smaller variance. Going forward, it will be interesting to compare institution's cohorts and differences and relate these to their curriculum and culture.

## 5. SUMMARY

Accreditation standards and a globalised engineering educator profession can bring about harmonization of European engineering degrees. However, we enjoy different cultures and contexts, including student and staff diversity, language, national priorities, facilities, exchange opportunities, and industry collaborations. The MASOEE project is a creative learning process to share this knowledge and expertise.

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