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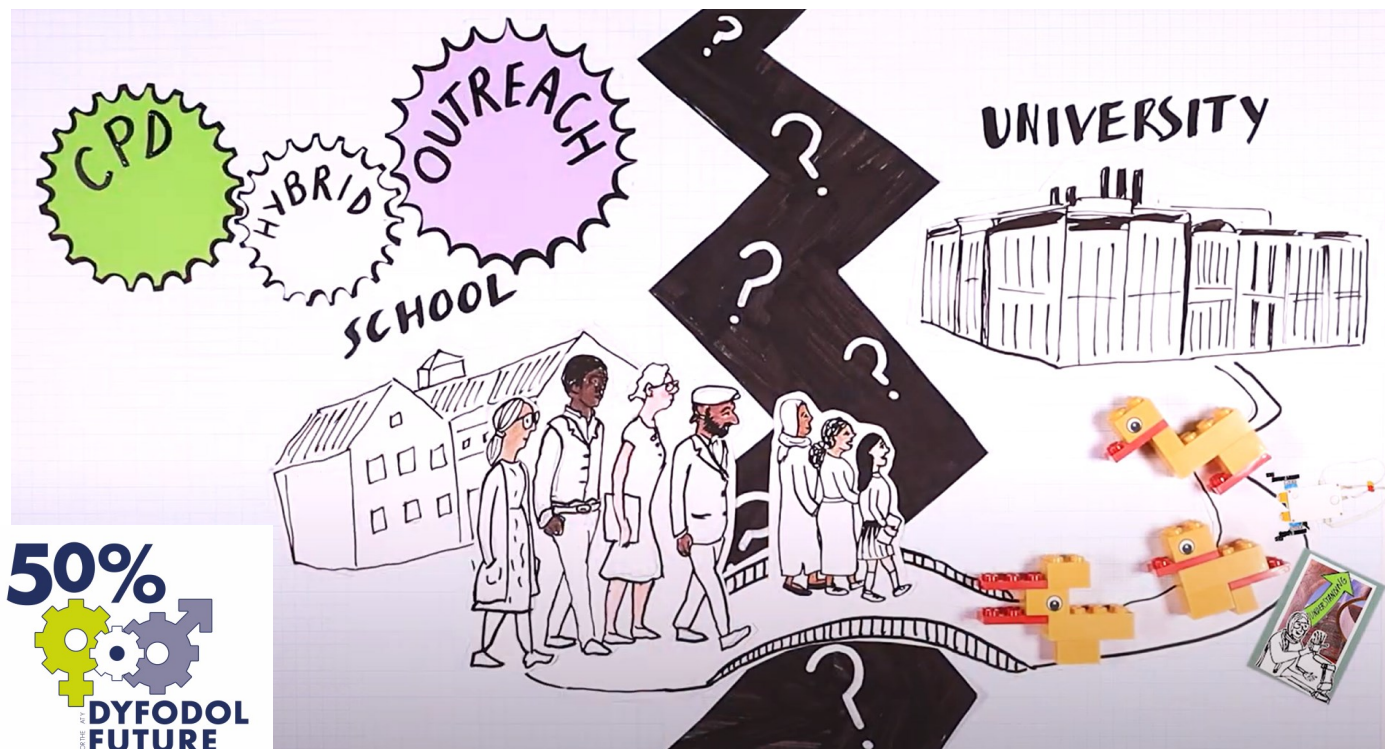
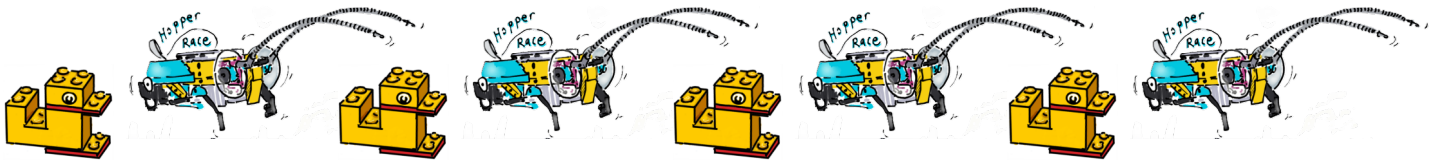
Royal Academy of Engineering

50% for the Future

A Guide to a Hybrid Outreach Approach

Dr Jennifer Thompson

Department of Mechanical Engineering, Swansea University



50forthefuture@swansea.ac.uk

Executive summary

The 50% for the Future (50%FTF) project at Swansea University's Department of Mechanical Engineering (DoME) aims to improve female representation and experiences studying and working in Mechanical Engineering. Launched in August 2022, it has worked to address the low female student representation within the DoME undergraduate courses (8.5% in a ~500 student cohort, below the then national average of 11.2%).

Female Mechanical Engineering students reported challenges in the male-dominated environment, including low self-confidence, self-efficacy, and a lack of relatable role models. Consequently, the long-term goal has been to increase female representation, whilst in the interim working to improve their current higher education (HE) study experience, to better support and inspire their ongoing careers in Mechanical Engineering.

The project has worked to address three key issues around females becoming a professional Mechanical Engineer:

- **Problem 1** – “*The Before*”: Misconceptions about Mechanical Engineering.
- **Problem 2** – “*The Now*”: The male-dominated HE environment.
- **Problem 3** – “*The Future*”: The leaky pipeline effect.

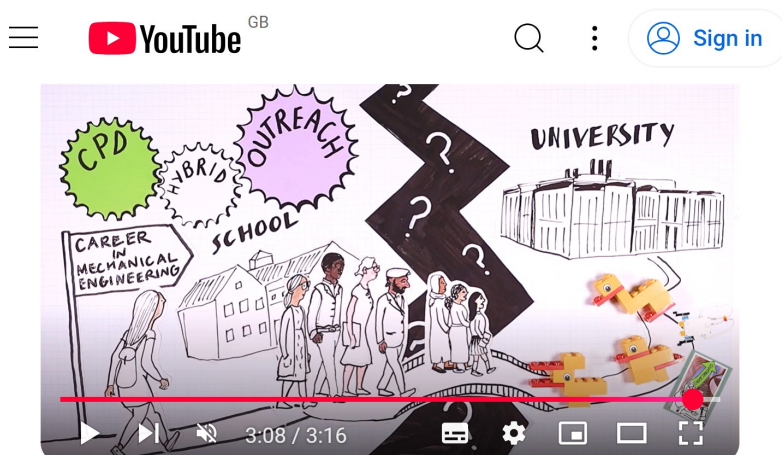
Interventions to address the three main problems were developed through data collection, including surveys of students, focus groups with female students, and surveys of schoolchildren and schoolteachers/college lecturers (i.e. educators).

Focusing on **Problem 1**, three successful Outreach Interventions were developed, and tested forming an impactful “*Hybrid Outreach*” Approach to address the “*Knowledge, Awareness, and Role Model Void*” females were found to experience around careers in Mechanical Engineering.

This “How to Guide” focuses on providing you with the background to the development of the Hybrid Outreach Approach, as well as details on how to set up your own outreach initiative and, if of interest, we invite you to join a regional **50% for the Future Outreach Hub**.

We believe that the Hybrid Outreach Approach can be applied for all Engineering-related degrees, to address misconceptions and, hopefully, increase the diversity of the UK Engineering workforce through a collaborative effort among HE institutions.

To accompany this How to Guide, we have produced a supporting short animation.



Please contact us at 50forthefuture@swansea.ac.uk for material in an alternative format for greater accessibility.

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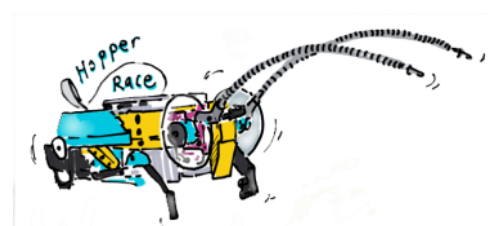
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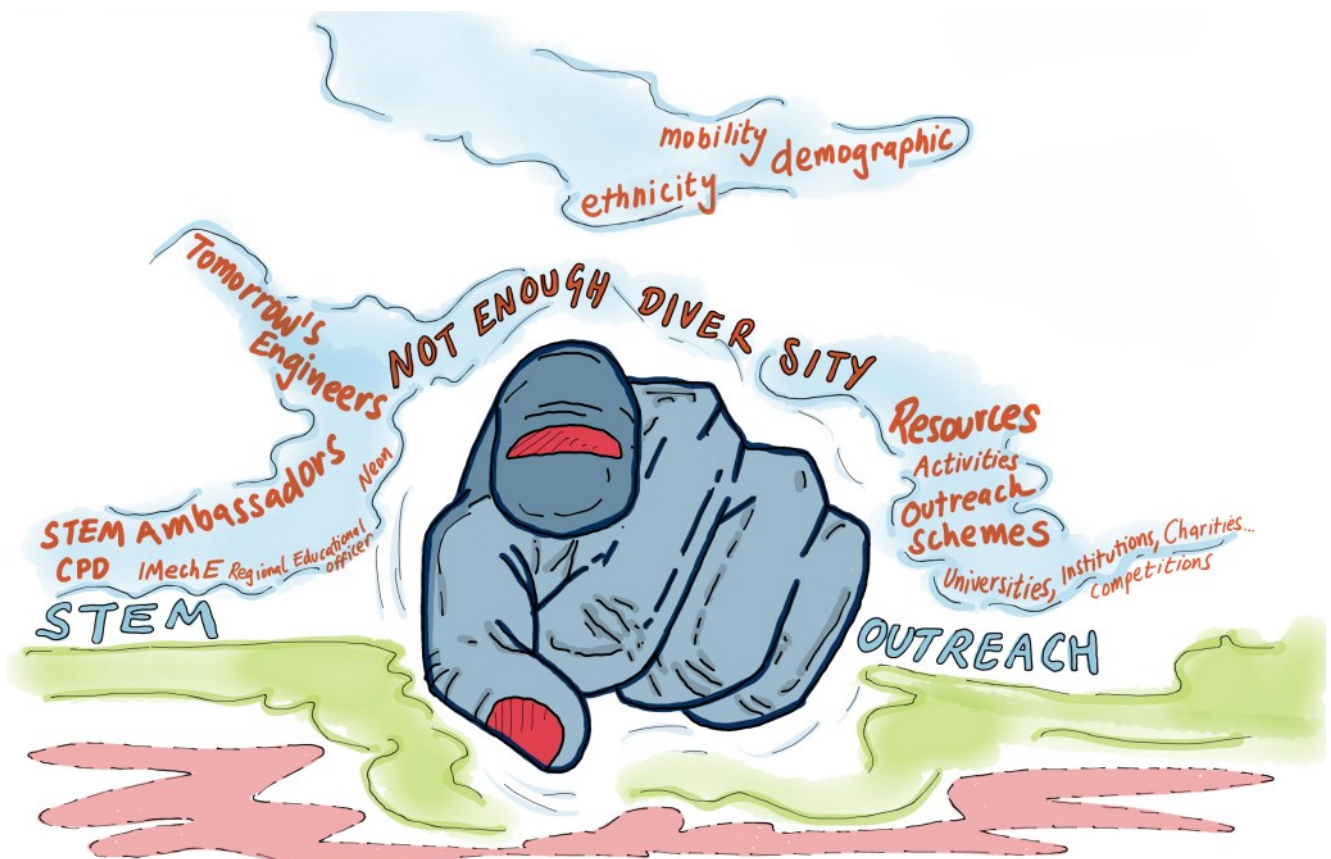
Introduction

The Royal Academy of Engineering Diversity Impact Programme-funded 50% for the Future project, at Swansea University, tackled three problem areas contributing to female under-representation in the study for and pursuit of a Mechanical Engineering career. As part of this project, a “Hybrid Outreach Approach” was developed, which focused on impacting under-represented groups within the demographic of working engineers in the UK. The provision of an effective, national outreach scheme will enhance understanding of the engineering disciplines for all young persons for whom the “full picture” of a career in engineering is not readily communicated, understood or available.

University departments engaged in school outreach will find in this How to Guide advice on delivering impactful outreach interventions to schools and educators, along with templates for questionnaires and surveys to use in measuring the impact of your outreach.

Why does under-representation matter?

Key elements of Mechanical Engineering and other engineering disciplines include problem-solving and product design. Increasing diversity in the student population and subsequent workforce fosters innovation and ensures that products and infrastructure are designed with a diverse cross-section of society in mind, as well as opening up career opportunities for more sectors of society.



“Not Enough Diversity”. Illustration by Ralph Mann, purpleheron.co.uk

Defining the problems

The issue of limited representation of women in the Engineering sector is well-documented. According to EngineeringUK (2024), the number of women working in engineering and tech dropped from 16.5% of the 2022 workforce to 15.7% of the 2023 workforce.

The national average percentage of women among Mechanical Engineering students in the UK was 11.8% in 2021. Competitor universities were matching or surpassing that national average (2016–2021, HESA data), but Swansea University was seeing persistent under-representation at 8.5%. Consequently, scoping work was started to better understand the issues of female under-representation and the concept for the “50% for the Future” project was formed. The project had two clear aims: to increase female student numbers in the Department of Mechanical Engineering to the national average within five years and, more ambitiously, to achieve female:male parity by 2050.

Various studies offered insight into motivating factors for female engineering students in the USA, Taiwan and European countries outside the UK (e.g. Dos Santos 2020, 2022, 2023, Kolmos et al. 2013, Wentling & Camacho 2008). Dos Santos applies Social Cognitive Career Theory (SCCT) to argue that motivations, career decisions and decision-making processes of individuals and groups can be understood as arising out of a combination of internal factors and external environmental impacts. Experiences in the school environment such as encouragement from teachers and enjoyment of and achievement in subjects studied are reported to strongly impact and influence decision-making, as do societal factors such as the range of job opportunities and salaries.



Figure 1: The SCCT connections (Dos Santos 2020, 2022, 2023).

We had anecdotal evidence that female students at Swansea University were negatively impacted by an environment of dominant masculinity and lacked relatable role models. But we needed more than anecdotal evidence to establish the reasons and develop interventions, so in 2021 we set up a working group bringing together academics, industry and IMechE representatives, along with a diverse representation of Mechanical Engineering students.

From these discussions, three clear problems were identified that the Department of Mechanical Engineering at Swansea wanted to better understand and work towards improving. These problems correlate to important stages in the process of becoming a professional Mechanical Engineer, and are summarised as:

- **Problem 1** – “*The Before*”: Misconceptions about Mechanical Engineering. What is it and what do Mechanical Engineers do?
- **Problem 2** – “*The Now*”: The male-dominated higher education (HE) environment. Being the odd one out as a female Mechanical Engineer.
- **Problem 3** – “*The Future*”: The leaky pipeline effect.

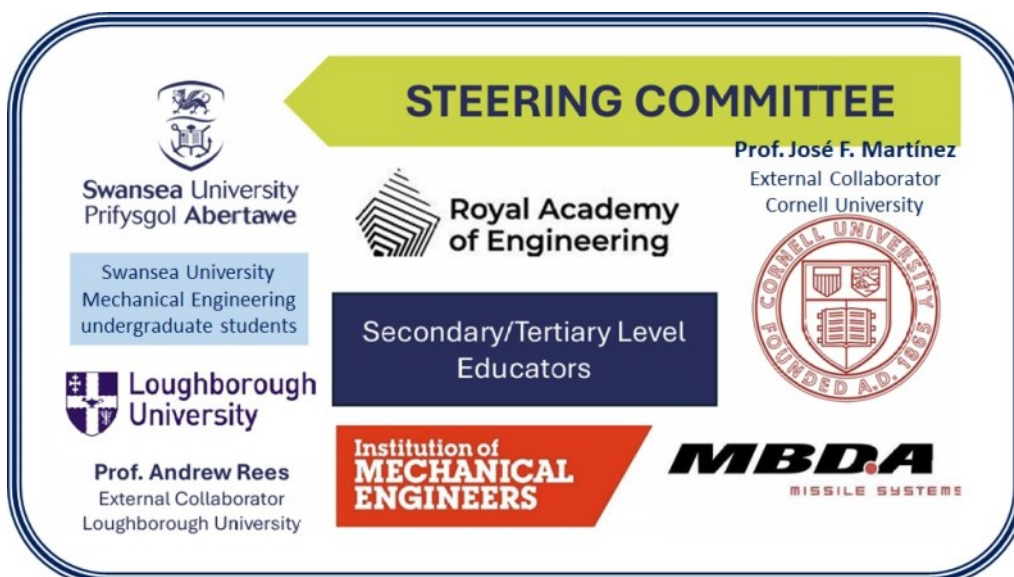
In March 2022, we secured funding from the Royal Academy of Engineering Diversity Impact Programme (DIP) to investigate these problems and develop a strategy to tackle them. This was the “50% for the Future” project.

The 50% for the Future team

The project team for 50% for the Future consists of Swansea University (SU) staff, led by Dr Jennifer Thompson, and student-led sub-teams responsible for facilitating aspects of the project interventions. The success of the project to date can be attributed to the development of a clear vision around addressing the problems and issues identified via the acquisition of survey and focus group data. In the development of all interventions throughout the project, the voices and skills of the project team have been harnessed and, most importantly, our beneficiaries – current and future female Mechanical Engineering students – have been heard.

50% for the Future has been built on collaborative working, within the main SU-based project team and with external experts and beneficiaries, through the utilisation of effective Steering Committees. Steering Committee compositions have been created through careful consideration, with representatives from:

- industry/employers;
- national and international HE institutional peers;
- the engineering accrediting body IMechE and
- educators from the secondary and tertiary level.



The 50% for the Future project approach

The 50% for the Future project used a data-driven approach to develop a deeper understanding around the three defined problem areas (page 3). We were focused on better understanding what influenced our female students' decision-making process around subject and career choice. In addition, we gathered viewpoints from schoolteachers and college lecturers. The following data-gathering exercises were undertaken:

- A student survey with our entire undergraduate Mechanical Engineering cohort.
- Focus groups with our female Mechanical Engineering students.
- A World Café-style event with our Mechanical Engineering students, to brainstorm outreach activities.
- A survey sent to teachers and tertiary educators within our locality.

Figure 2 shows the sequential nature of the data-driven approach, where questions that arose were addressed through further targeted surveys and focus groups.

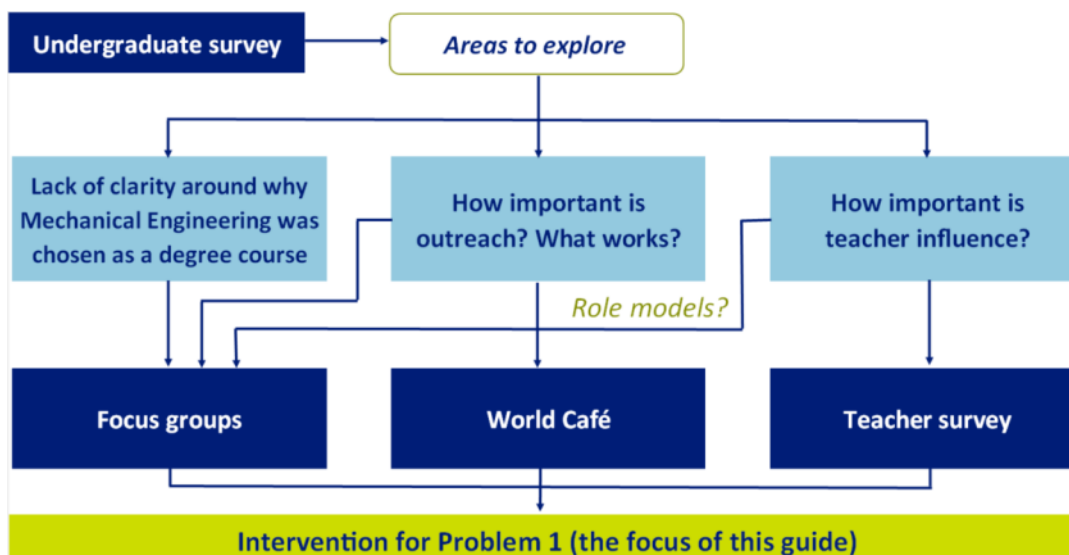


Figure 2: Our sequential data-driven approach to designing interventions.

The undergraduate survey

We sent out a survey to more than 480 undergraduate students across all year groups within the Department of Mechanical Engineering. The completion rate was 50.6% overall, with nearly 100% from female respondents studying the course (see Table 1).

The survey asked about:

- the age at which the students showed interest or intent to study or pursue a career in Mechanical Engineering
- the internal and external motivating factors at key subject selection milestones (GCSE, A level, degree)
- the effectiveness of outreach activities in the decision process
- preferences for Mechanical Engineering applications (industrial sectors).

The full survey, which was developed to gain information for Problems 1–3 (defined on page 3), is reproduced in Appendix 1. The focus of this guide is on the outputs of Problem 1 only.

Age of interest

We found that girls were generally slightly older than boys when they became interested in Mechanical Engineering. See findings in Table 2.

Table 1: Sex of survey participants

	Number	%
Female	44	18.1
Male	196	80.7
Prefer not to say	1	0.4
Total	243	100.0

Table 2: Summary of findings from the student survey showing age at which an interest in Engineering and Mechanical Engineering was established.

	Age (years) interested in Engineering		Age (years) interested in Mechanical Engineering (specifically)	
	FEMALE	MALE	FEMALE	MALE
Min	5	0	10	5
Max	19	22	22	25
Average	13.9	13.7	16.5	15.9

Motivating factors

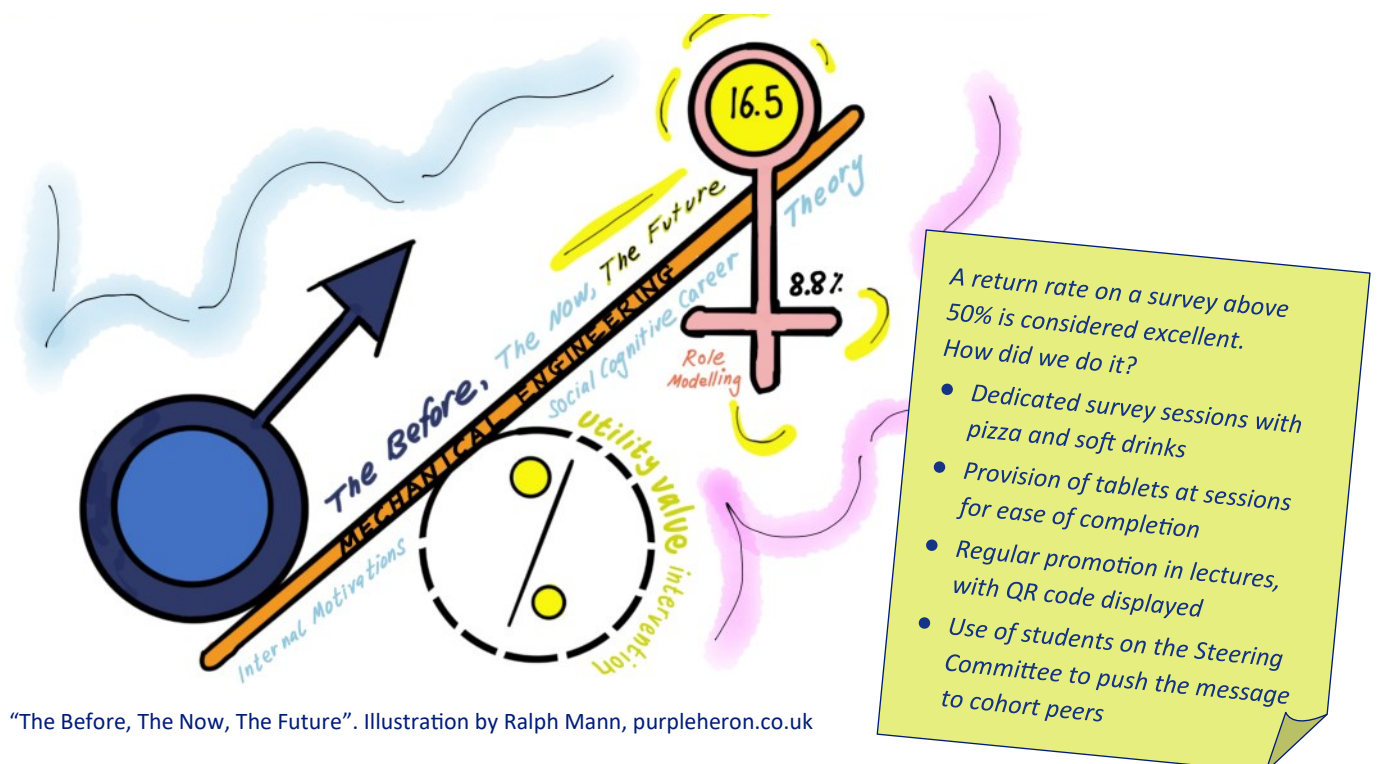
We split motivating factors for subject and degree choices into External and Internal factors. Survey respondents were asked to score these motivating factors on a scale of 0 to 5, with 0 for no influence/not relevant and 5 for great influence/critical in decision making. Multiple statements could have the same score for each question.

External motivating factors

- Friends/peers
- Teachers
- Parents
- Career advisors
- Outreach activity

Internal motivating factors

- Just “knew” I wanted to be a Mechanical Engineer
- Wanted a job in STEM
- High salary/earning potential
- Job with a positive impact on society
- Enjoyed/good at the topics
- Prestige



External motivating factors

When considering the selection of GCSE and A level subjects, female respondents scored all external motivating factors lower than male respondents. A larger percentage of male respondents scored parents at 3 or above. Career advisors were the least important external factor for both female and male respondents.

When considering degree selection, a much higher percentage of female respondents than male respondents scored teachers, friends and career advisors at 0 (i.e. of no influence). Male respondents were still more likely to be influenced by their parents than female respondents. Outreach scored similarly for both female and male respondents, and is the second highest scoring external influencer (behind parents). See Figures 3–5.

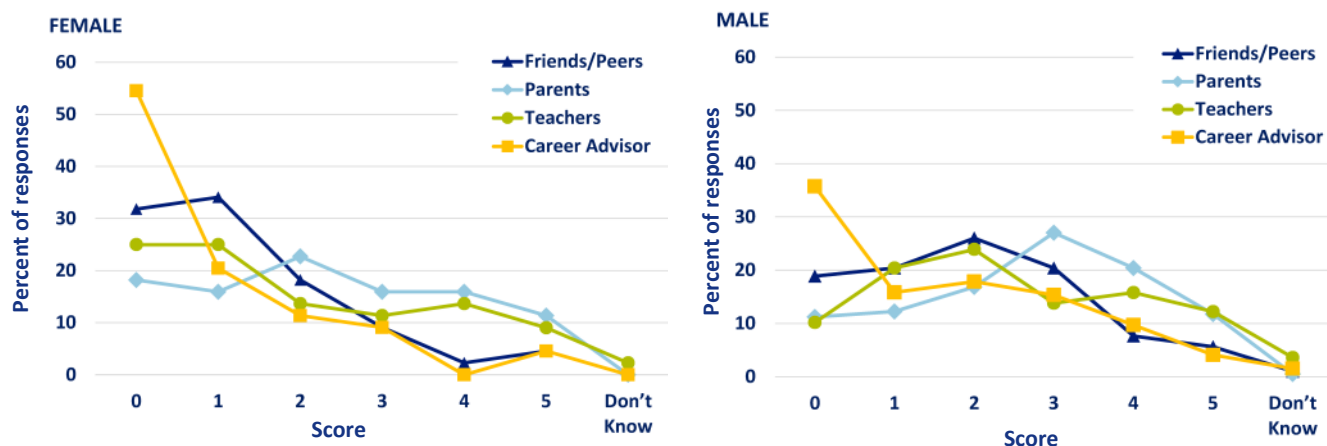


Figure 3: External motivating factors in selecting subjects at **GCSE level**.

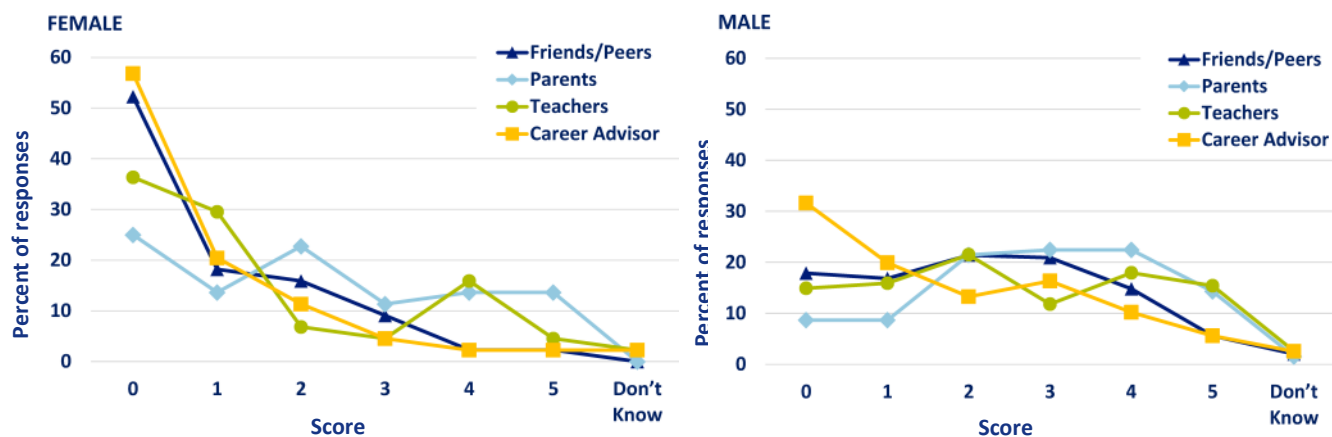


Figure 4: External motivating factors in selecting subjects at **A level**.

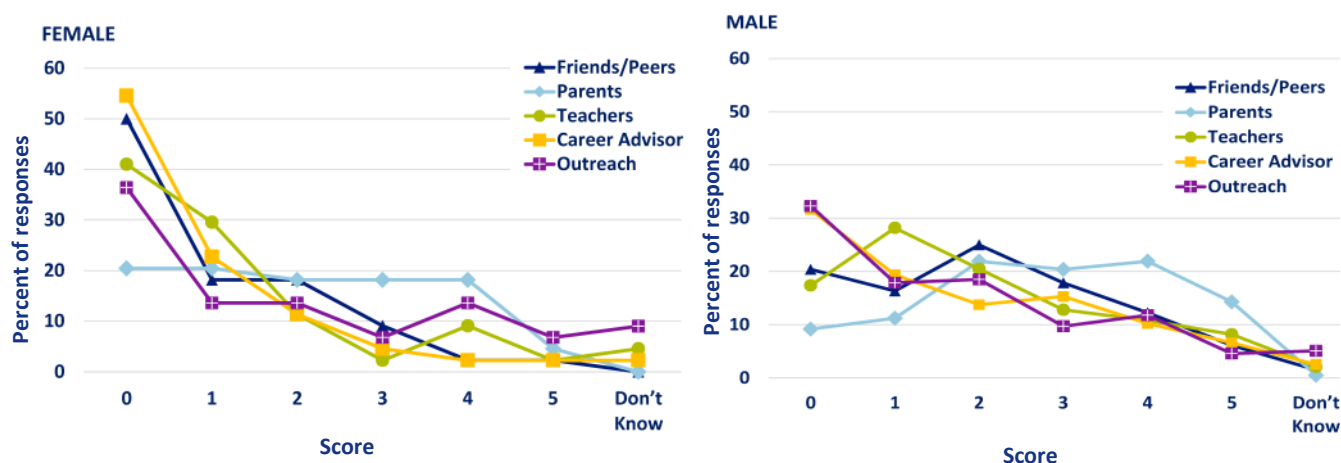


Figure 5: External motivating factors in selecting subjects at **degree level**.

Internal motivating factors

When considering their selection of subjects at GCSE and A level, female and male respondents both scored salary and positive impact of career choice similarly. Male respondents scored “just knowing” that they wanted to study Mechanical Engineering higher than female respondents, although female respondents showed higher motivation around knowing they wanted STEM-focused careers. More than 50% of female respondents scored achievement/enjoyment of their chosen subjects at 5, which fits well with Dos Santos’s SCCT findings (see page 2). This enjoyment and efficacy in subjects was not found to be such a motivating factor for male respondents.

When considering selection at degree level, male respondents showed more consistent scoring curves for all factors. Female respondents scored positive societal impact and prestige lower than male respondents. Most interestingly, the high scores for expected enjoyment/efficacy at the subject that female respondents awarded at school level were found to decrease sharply. See Figures 6–8.

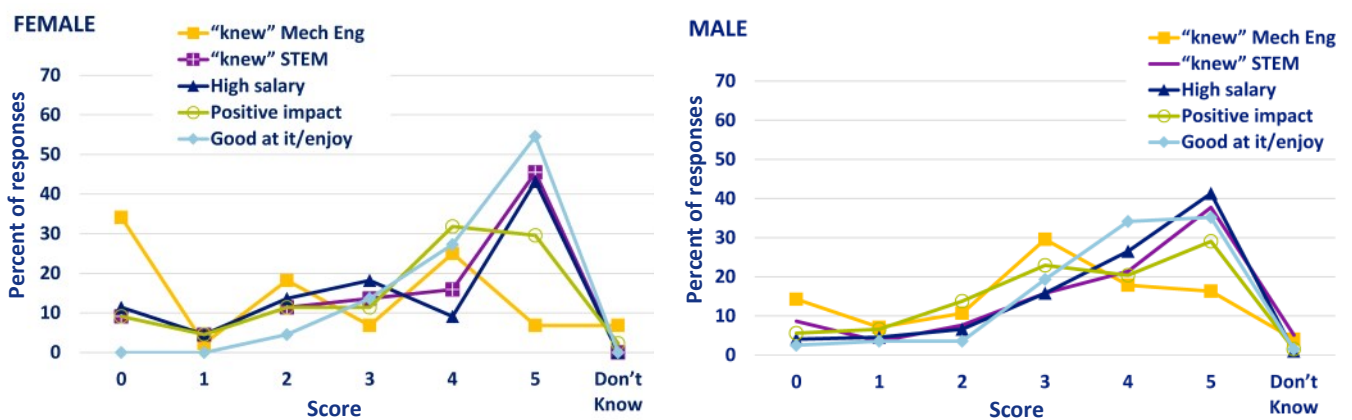


Figure 6: Internal motivating factors in selecting subjects at **GCSE level**.

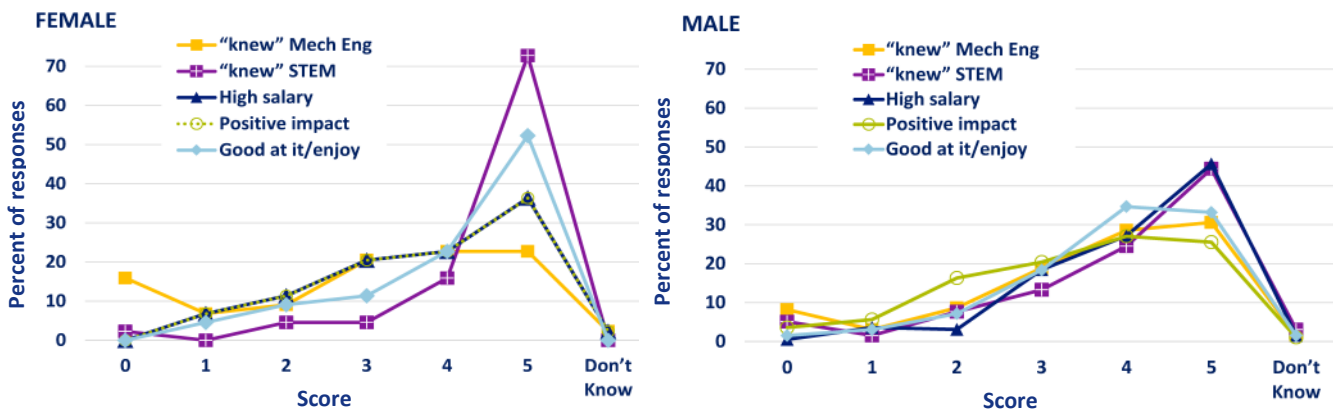


Figure 7: Internal motivating factors in selecting subjects at **A level**.

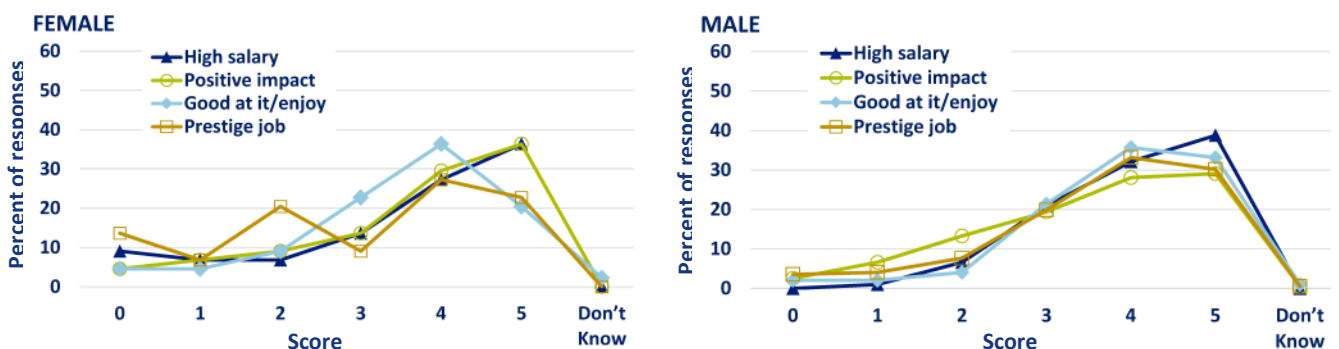


Figure 8: Internal motivating factors in selecting subjects at **degree level**.

Sectors of interest

Both female and male respondents scored Design and Automotive sectors the highest. Renewable energy was of similar interest to both groups (Figure 9).

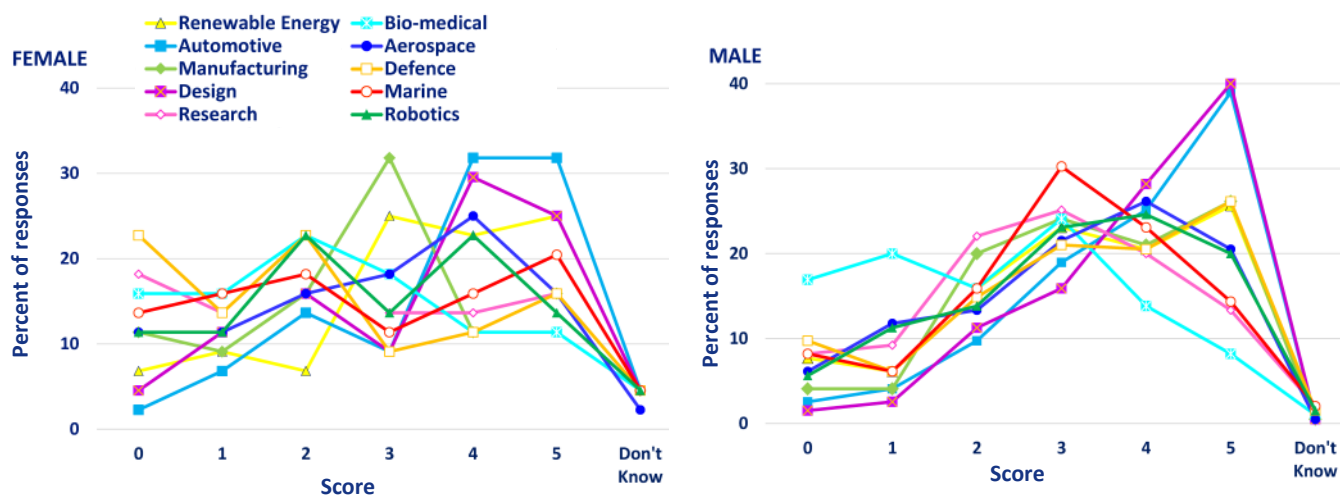


Figure 9: Sectors of interest for female and male respondents, once qualified as a Mechanical Engineer

Key findings around teachers' influence

The respondents were asked to give free-text comments when providing survey responses around the decision stages for GCSE, A level and degree subject selection. We received more free-text responses from female respondents than male. In the free-text responses respondents supplied the subjects taught by influencing teachers, where it was seen that the most influential teachers taught **Physics**, followed by **Maths**. Female respondents also identified Product Design teachers as influential during A level and in degree selection. Could *this be due to the dual aspect of product design, involving both creativity and technical ability?* It was also noted that two female respondents had been actively discouraged from pursuing Engineering by teachers. This discouragement was not reported by any male respondents.

I was discouraged by teachers from selecting STEM topics as I had "previously achieved better grades in humanities". However, one Product Design (DT) teacher encouraged me to pursue STEM so I selected this subject to get more of an idea of the field.

[My teachers] discouraged me from going into STEM, I got told repeatedly ... I should just stick to what I was best at and what would be an easy route — art, never felt like I was welcomed or supported by my STEM teachers and they never believed in me because I studied art as well.

Areas to explore

In our survey the female respondents indicated a stronger leaning towards motivation from internal factors than their male counterparts. At degree entry, enjoyment or perceived efficacy in the subject became less of a motivating factor, indicating a lack of certainty about what the degree entails, highlighting a knowledge void about what Mechanical Engineering involves. It was positive that impactful and effective outreach was an influential external factor for both female and male respondents, and there seemed to be an opportunity to further leverage the relationship between student and teacher to help address the identified knowledge void around engineering.

The focus group

Following analysis of the student survey data, we still lacked clarity around why females were selecting Mechanical Engineering at degree level. The drive of enjoyment and perceived or expected efficacy in the subject had been lost. In order to gain clarity, we set up an all-female focus group to discuss their personal experiences and journeys. From the focus group data we identified three key themes and several interconnecting subthemes, which helped us gain a deeper understanding of our female undergraduates' motivations around a career in Mechanical Engineering (see Figure 10).

The questions addressed by the focus group are in Appendix 2.

Key findings from the focus group

Discussions around role models in the focus group highlighted that the participants could see the merit of suitable role models, but also emphasised the lack of relatable role models in their personal experience. Outside a few participants who mentioned family members and work experience placements, the focus group participants in the main were not able to identify role models. They were, however, clear about what they wanted to see in role models (Figure 11, page 10).

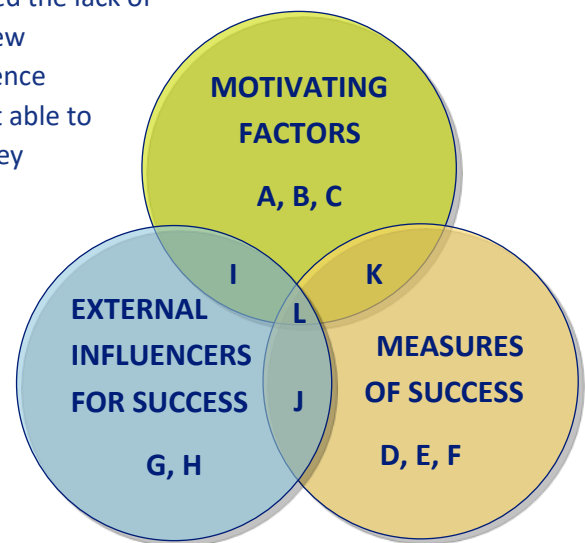


Figure 10: Key themes in participant responses in our focus group

A	Thriving in career Desire to push boundaries in the field and to make positive contributions while enjoying their career	G	Attributes of role model Belief that role models need to be motivating, relatable and inspiring
B	Wanting to be challenged Wanting to push themselves, be hands on, learn more and take on difficult tasks	H	Study requirements Desires in university such as more feedback, variation in groups and a more personal approach through socials and smaller groups
C	Expectations of the field Choosing the field for the broad range of opportunities and the competition with themselves and others	I	Consequences of positive working environment Ability for a positive environment to have a positive impact and allow individuals to feel reassured, comfortable, and supported
D	Academic results The view that success will be reflected by good grades	J	Negative/ harmful behaviour Experiences of being intimidated, humiliated, and
E	Personal development Being able to prove themselves, develop their skills	K	Perceptions/ assumptions of females The impact of sexism, stereotypes, prejudice and
F	Stability Being both emotionally and financially stable	L	Pressures placed on females Impact of the field being male dominated, politics in the workplace, amplification of errors made and being made to feel like a burden



Figure 11: Qualitative responses on role models from the Focus Group

In our focus group, being challenged and thriving in a career were clear strong internal motivations, together with being successful (academically and through personal development) and so facilitating a stable future (financially and in contentment). There is a strong theme of efficacy in career/role as a motivator for females. It became clear that in addition to needing more role models (ideally female) outside familial and friend relationships and work experience, there was also a lack of support and encouragement for their ongoing development as Mechanical Engineers. As in the survey, a participant raised the experience of being actively deterred from engineering by a teacher, further highlighting the need to engage with teachers as part of this project.

World Café event

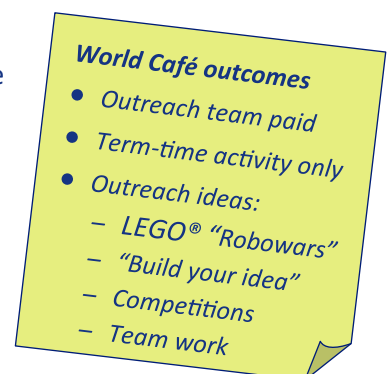
The World Café methodology is a format for hosting a large group dialogue in a relaxed format, where paper is laid out on tables for brainstorming and attendees can move around discussions. We used this structure to ask participants to:

- devise a specific outreach activity
- advise on the role of undergraduate students in delivering outreach.

Appendix 3 has the discussion topics used in the World Café event.

For the outreach activity, we asked them to think carefully about how to address misconceptions of Mechanical Engineering and reflect on outreach that had been delivered to them along with other influential activities or experiences. They were asked to write down ideas for outreach, thinking about the target age, level of accessibility, likely cost, facilitator requirements, duration, diversity of appeal, inclusivity, and so on.

In asking about the role of undergraduate students in delivering outreach, we asked about whether they envisaged running activities themselves, whether in term-time, paid, or whether they thought it was not their role.



The teacher survey

It was clear from our student survey responses that teachers had some impact on decision making, and there were examples of them discouraging female students from pursuing careers in Mechanical Engineering. Consequently, we wanted to further investigate teachers' perspectives, so our third data-gathering exercise was a survey sent to local secondary and tertiary educators. We had 63 responses from teachers across a range of disciplines: 40% humanities and 60% STEM.

Teachers were generally positive about highlighting engineering career options, but identify a number of constraints, including time pressures, lack of knowledge and insufficient resources

See Appendix 4 for the full questionnaire sent to secondary and tertiary educators.

From the teacher survey results it was clear that there was high interest in discussing engineering in a wider context with their students, but a lack of comfort or confidence (see Figures 12–16). It is essential that this lack of knowledge around the subject matter is addressed, so that teachers can help to fill the knowledge/awareness void about what Mechanical Engineering is, that was established from the student survey findings.

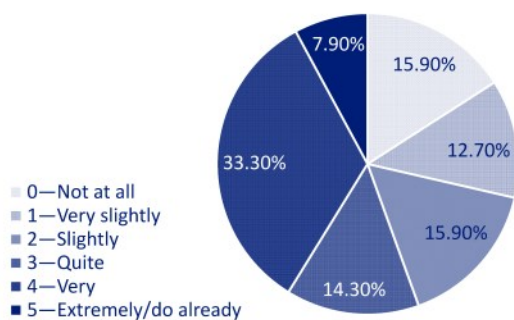


Figure 12: Teacher responses: **interest** in discussing Engineering.

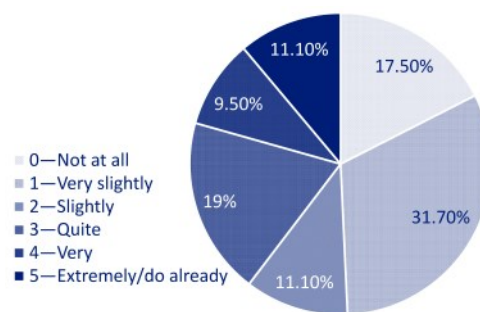


Figure 13: Teacher responses: **comfort** discussing Engineering.

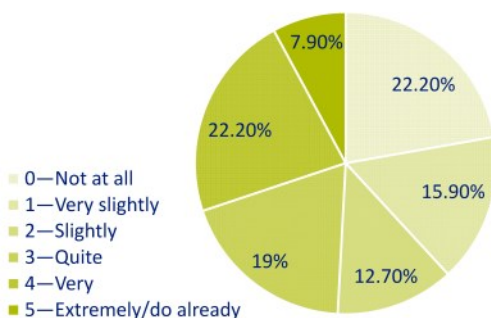


Figure 14: Teacher responses: **interest** in discussing Mechanical Engineering.

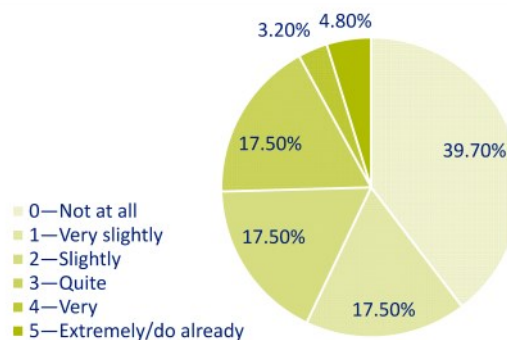


Figure 15: Teacher responses: **comfort** discussing Mechanical Engineering.

I would love to know more about what these subjects are about

If you talk about engineering in wider terms you might be able to engage a wider audience of people

I'm a Humanities teacher. I would be happy to link Engineering to the societal need during the war

This doesn't happen enough. That's why we are not inspiring our pupils into these careers

I would be really interested in broadening my knowledge of these areas as then I would be better equipped to advise my students

I don't consider myself qualified enough to discuss these areas with any authority

Figure 16: Qualitative teacher responses on their interest and comfort discussing Engineering and Mechanical Engineering.

Building on the data: creating our Hybrid Outreach Approach

The “Information and Role Model void”

From the research undertaken, an overview of which we have provided on pages 1–11, it became evident to us that young people are experiencing a void of information and understanding around what a degree and careers in Mechanical Engineering involve. We believe that the impact of this is more detrimental for females than their male counterparts because many of the misconceptions that develop from the information void present Engineering as a “male” vocation, with outdated ideas about the topics it covers and the career options available. Consequently, it is easier for males to “fall into” an engineering degree or be guided by family members or peers who have the same limited understanding of what the career can involve. Therefore, providing consistent, good-quality outreach to help fill the information void is essential in providing young females with the necessary guidance, support and encouragement to make informed decisions around degree/career selection.

However, whilst the delivery of outreach activities engaging schoolchildren over a range of ages is essential, it has also been established that the student–teacher relationship, pre-HE, needs to be better leveraged to provide a consistent source of informed knowledge around career options in Mechanical Engineering. Our survey responses highlight that at present, teachers have a strong interest in being able to discuss engineering with their students but do not have the knowledge to be comfortable doing this. So, outreach targeted at teachers and educators pre-HE is required.

Additionally, it is essential to attempt to address the lack of relatable role models for females considering a career in Mechanical Engineering. It was evident from our Focus Group sessions with our female undergraduates that this was an issue that had impacted them throughout their decision-making processes around careers and in their studies to date.

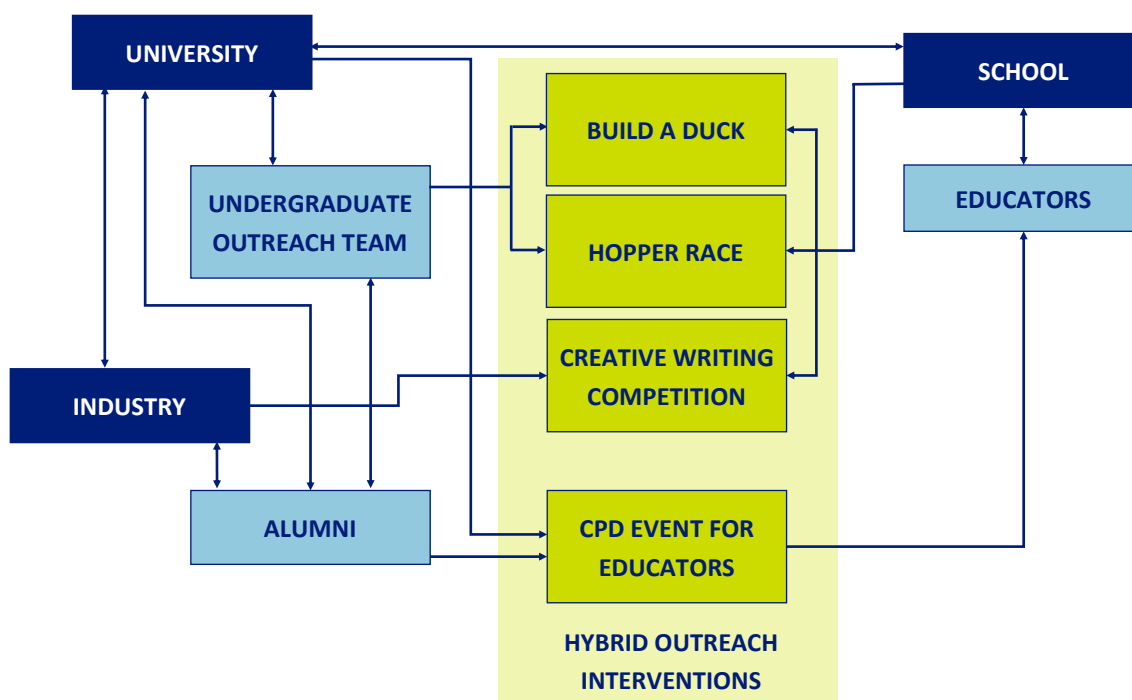


Figure 17: Intervention for Problem 1. The Hybrid Outreach Approach

Consequently, in designing the interventions based on our data, we adopted a **Hybrid Outreach Approach** involving outreach with schoolchildren *and* educators, and incorporating our own undergraduates, industry and alumni to provide access to role models.

The Hybrid Outreach approach summarised in Figure 17 consists of:

- **Outreach Intervention 1** – Holistic Learning – “Ducks and Hoppers”
- **Outreach Intervention 2** – Creative Writing Competition - “Finding out for myself”
- **Outreach Intervention 3** – Educating the Educators - “Mechanical Engineering Today”

Further details of these Interventions are provided over the following pages.

Outreach Intervention 1 – Holistic learning: *Ducks and Hoppers*

Outreach Intervention 1 is what could be termed a “traditional” outreach activity, focussed on engaging schoolchildren across a range of ages through hands-on activities using LEGO®, undertaken in an intensive session of 1 to 3 hours in duration, that showcases aspects of Mechanical Engineering in practice. The intention of this activity is to elicit excitement on the subject matter and to leave the participants with a positive core memory around the experience. A fundamental aspect of our Outreach Intervention 1 is **employing our own undergraduates to run these sessions**. The two key motivations for this were to provide:

- relatable role models to the outreach participants
- developmental opportunities for the undergraduate outreach team members.

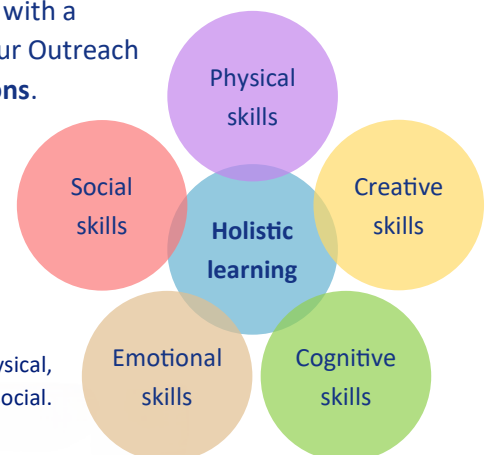
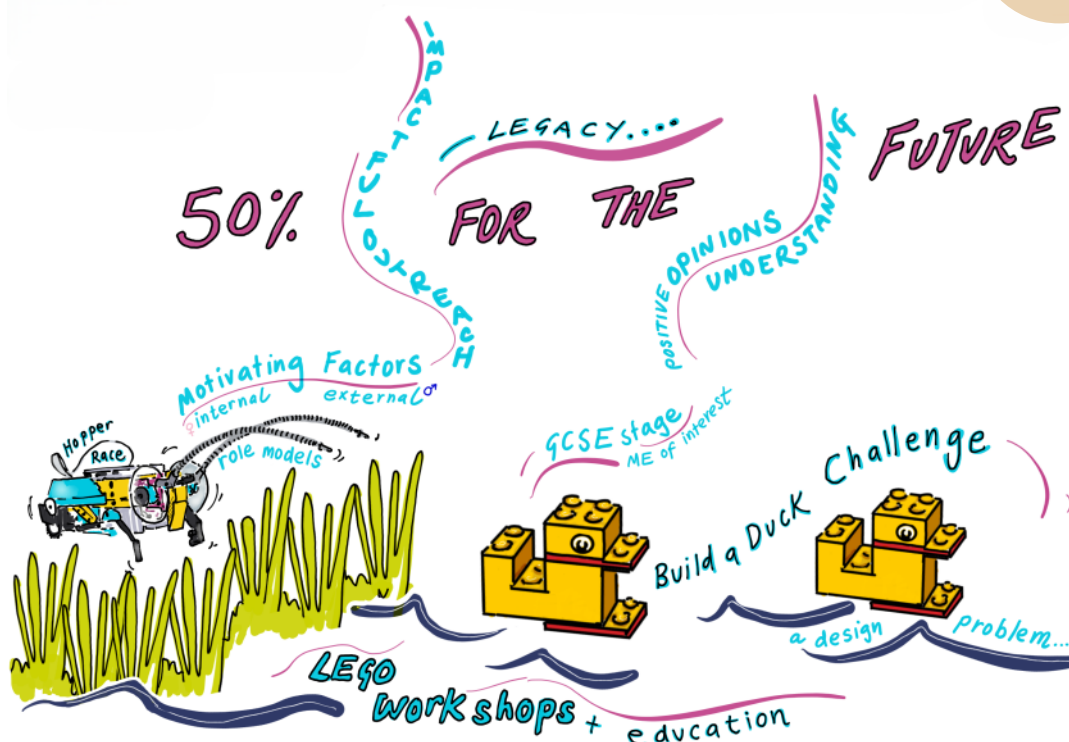


Figure 18: Holistic learning engages multiple skills: physical, creative, cognitive, emotional and social.



“50% for the Future”. Illustration by Ralph Mann, purpleheron.co.uk

Forming your undergraduate outreach team

In order to form our undergraduate outreach team we undertook the following steps:

1. Promotion of the opportunity to join the undergraduate outreach team during Induction week to all of our Mechanical Engineering students; we also highlighted the work of the outreach team at Recruitment Open Days for the course, so that our joining students were already aware of the project. In our promotion we emphasised the benefits of being part of the outreach team.
2. Asked any undergraduates interested in joining the outreach team to write a short email/letter of application.

1. Benefits of being in the outreach team:

- *gaining valuable teamwork experience and developing transferable and career-enhancing skills such as public speaking and time-management*
- *becoming role models and inspiring the next generation of mechanical engineers*
- *paid for their time*

2. Applying to be in the outreach team:

- *reason for wanting to be part of the team?*
- *experience of outreach?*
- *how they would balance the outreach activities with their studies?*

Once you have recruited your outreach team members, you will need to ensure they have DBS checks in place. Typically your university HR/admin teams will be able to help you organise this. Be aware that it can take several weeks for DBS checks to come through and that there will be an initial cost per person (currently £21.50) and subsequent annual update charges to maintain the DBS-checked status.

Our team at Swansea University has around 20 members from across all years of the Mechanical Engineering degree course, with recruitment of new members to replace leavers undertaken at the beginning of each academic year. They require only light-touch management from an academic member of staff, with MS Teams used for all organisation and communication. We did schedule initial training sessions for the new outreach team, but following this we encouraged an ethos within the team of peer-to-peer learning and sharing of experiences.

Ducks and Hoppers

Our student-led outreach team delivered twenty-three workshops using LEGO® Creator six-piece brick sets and LEGO® Education SPIKE™ Prime kits supplied by Getech Ltd, reaching ~650 school/college pupils across South/West Wales over an 18-month period.

The LEGO® activities were developed around the concept of "holistic learning", embodying Physical, Creative, Cognitive, Emotional and Social skills and used the LEGO® Education SPIKE™ series supported by "LEGO® Invention Squad" resources. These introduce children to the concept of the engineering design process (i.e. the iterative approach required and the consideration of user/end requirements) as well as promoting the teamwork aspect of engineering and allowing a competitive element to be included.

50% for the Future added to this, with an emphasis on the idea that **diversity in teams of engineers** results in a design that considers the needs of a diverse population. Our resources emphasised issues in design over the years that have overlooked demographics of the population e.g. crash-test dummies only being more representative of women's bodies since 2022 (www.bbc.co.uk/news/technology-62877930)

Prifysgol Abertaweili
Swansea University
Y Gyfadrn Gwyddoniaeth a Pheirianteg
Faculty of Science and Engineering

All of those devices are used by individuals/society as a whole...

Therefore...

- ❖ When designing things, we need to think about all the different end user needs e.g. young/old, male/female, different cultures, disabilities etc...
- ❖ Having a diverse workforce of engineers is SO important, to make sure the designs created consider all of the perspectives of the end user and meet everyone's needs.

Real World Example:
Until fairly recently, crash test dummies (that all car safety ratings were designed to and measured from) were modelled on the average male... not women, let alone pregnant women... meaning there was bias in the design, whereby the needs and protection of women in the design of cars had not been considered.



Figure 19: Our slide presenting the need for diversity in a design team, in the context of crash-test dummies not representing female bodies.

Outreach Intervention 2 – creative writing competition: “Finding out for myself”

Schoolchildren were asked to produce a creative writing piece (e.g. poem, short story, zine) using the title “**Mechanical Engineering Through My Eyes**”. The intervention attempted to facilitate the concept of SCCT (see page 2), with pupils encouraged to realise their own efficacy and aptitude for a potential career in Mechanical Engineering through personal research combined with their own imagination.

The activity was also devised to engage students who enjoyed or felt more capable at artistic and creative activities; removing any internalised resistance to the activity from perceiving themselves as not interested or capable in STEM subjects. To-date, one competition has been run, with ninety-two entries received, 53% of which were from female students.



Figure 20: Our flier for the creative writing competition (here for illustration)

Outreach Intervention 3 – Continual Professional Development (CPD) conference for educators: “Educating the Educators”

From our initial surveys it was clear that secondary and tertiary educators have an important role to play in inspiring, informing and encouraging young people to pursue Mechanical Engineering. However, from our teacher survey findings (see page 11) it was established that very few teachers felt comfortable in discussing Mechanical Engineering with their students. Consequently, the CPD conference was developed to “**educate the educators**” about what Mechanical Engineering looks like today. The CPD conference included a combination of lab tours, presentations on Mechanical Engineering research, career options and talks from female alumni, followed by workshop activities on the STEM landscape and approaches to outreach.



Figure 21: Images from our animation illustrating the CPD conference

Data collection: assessing the impact of your outreach

Before undertaking any surveys, we advise that you engage with your university's Research Ethics Governance. Typically, if you are acquiring data on the protected characteristics of your survey respondents and intend to publish your findings, you will need ethics approval.

When undertaking any survey you must:

- Provide a participant information sheet that clearly lays out the purpose of the survey
- Acquire consent from the respondent to collect, store and publish their data. Note that when surveying respondents under the age of 18 you will need to acquire consent from the school and/or the appropriate parent or guardian.

We provide you with the consent form and participant information sheet that were supplied to parents/guardians for our under-18 participants in Appendix 5.

Protected characteristics

- Age
- Sex
- Disability
- Race
- Gender reassignment
- Religion/belief
- Sexual orientation
- Marriage/civil partnership
- Pregnancy/maternity

During 50% for the Future, we used a combination of paper-based and online questionnaire formats, using the GDPR-compliant "Online Surveys" platform. Completed paper-based questionnaires must be stored and disposed of in accordance with your university's guidelines.

For our Outreach Interventions 1 and 2, we surveyed the participating schoolchildren both pre- and post-intervention. For Outreach Intervention 3, we did the same for the educators attending the CPD conference. Below is an example of one of our paper questionnaires.

The questionnaires we used pre- and post-intervention are in Appendix 6 (Outreach Interventions 1 and 2) and Appendix 7 (Outreach Intervention 3). If you would like any of the materials provided in the Appendices in MS Word or PDF format, please contact 50forthefuture@swansea.ac.uk

POST-INTERVENTION QUESTIONNAIRE - consent

I have read the Student Information Sheet and understand that my participation is voluntary, and I can withdraw at any point without penalty. However, I'm aware that as the Questionnaire is anonymous, once I have submitted my response, this cannot be extracted from the dataset.

☐ I confirm

I am happy for the 50% For the Future project to use my Questionnaire responses as part of their research.

☐ I confirm

POST-INTERVENTION QUESTIONNAIRE

Please complete this questionnaire *after* participating in the activity

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50% for the FUTURE

Sex ☐ Male ☐ Female ☐ Other ☐ Prefer not to say

Age _____

School _____

Please select the option you feel most applies to you for each of these questions.

Question 1 – I understand what mechanical engineering is.

☐ Strongly Agree
☐ Agree
☐ Neither agree/disagree
☐ Disagree
☐ Strongly Disagree

Question 2 – I have a positive opinion of mechanical engineering.

☐ Strongly Agree
☐ Agree
☐ Neither agree/disagree
☐ Disagree
☐ Strongly Disagree

Figure 22: One of the pages from our pre- and post-intervention questionnaire for Outreach Interventions 1 and 2, used here for illustration. The full questionnaires are reproduced in Appendixes 6 and 7.

Implementation of the interventions

Outreach Intervention 1: planning

A major challenge in organising outreach is managing the scheduling conflicts between the university and schools. Our outreach is run by an undergraduate team, so it needs to be undertaken during university term time, which can cause problems in finding suitable lecture room space and times for on-site outreach sessions. When considering outreach with children who are preparing or sitting assessments (i.e. GCSEs/A levels) there is very limited school availability at certain times of the year. Therefore, it is essential that **schools are contacted early** to find suitable dates. It is good practice to send an email in June or July (i.e. before the school summer break) in order to plan events later in the following academic year.

Teachers are very busy and are not readily available via email through the working day. Therefore, prepare a short “pitch” (i.e. one or two PowerPoint slides) outlining your outreach activity, highlighting the learning outcomes and benefits to them in participating. We have provided you with the “hopper challenge” as an example outreach activity, but you could offer to create a LEGO® design activity or equivalent aligned to STEM topics relevant to the school’s curriculum. For example, the 50% for the Future team have run a design challenge for wind turbines using LEGO® Education SPIKE™ kits.

Although general contact emails for schools are available online, this did not prove to be an effective means of contact to offer outreach during the 50% for the Future project. You need to try to **establish a contact within the school**, ideally a STEM teacher.

Once you have made that contact, you will find that the schools are very engaged and are looking for suitable outreach opportunities for their students.

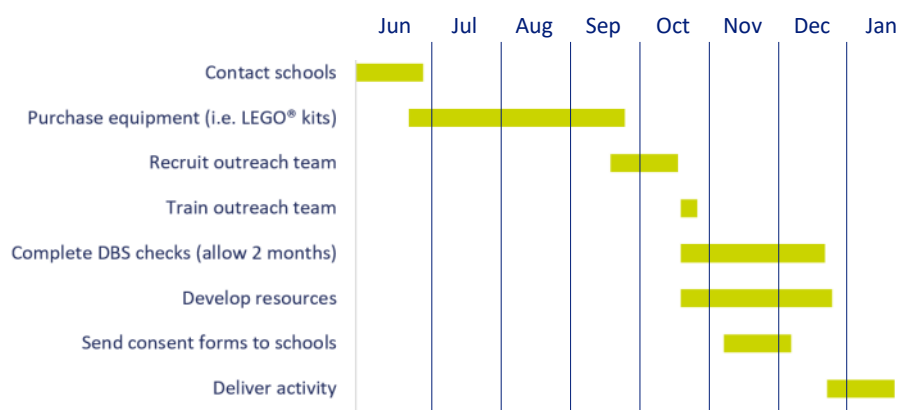


Figure 23: A Gantt chart showing an example of the timeline for preparation ahead of delivering outreach. You may find it useful to produce something similar in your outreach planning.

Outreach Intervention 1: resources

A key aspect of the 50% for the Future project at Swansea University was the recruitment of a diverse student outreach team to act as relatable role models to the outreach participants, at the same time providing a development opportunity for the students and the chance to build community with their teammates through shared experience and purpose.

We purchased our LEGO® Education SPIKE™ kits and LEGO® Creator 6-piece (duck) brick sets from Getech Ltd Education Specialist (www.getech.co.uk/edu/). They were also able to provide training and advise on the activities. After Getech Ltd provided the initial training sessions, subsequent training was undertaken within the outreach team, with older members mentoring new members. In total we purchased 10 SPIKE™ kits;

we have found that this is a suitable number of kits to meet the requirements of most class sizes that we have been asked to cater to, with typically around 2 to 4 pupils assigned to one kit for an activity.

The complexity of the activities undertaken with the LEGO® Education SPIKE™ kits can be easily tailored to the age-group undertaking the session. For younger groups free-rein and imaginative designs can be encouraged, whilst for A-Level students, gearing can be included and further explanation around Mechanical Engineering design principles provided. If you decide to use LEGO® Education SPIKE™ kits, you will also need available one laptop/tablet per kit in order to run the app/Scratch code needed. We also recommend that you purchase a fold-up trolley to assist in moving the outreach equipment around schools.

Aside from the initial outlay for the LEGO® activity equipment, there are ongoing costs to run Outreach Intervention 1:

- Hourly payment for outreach members' time when running activities. We think this is essential in order to demonstrate to the team that their commitment and skills are recognised.
- Any travel costs incurred when travelling to schools. We do recommend that you ensure that several of your outreach team hold valid, clean, driving licences. Your university will have its own policies around car hire/expenses.
- Cost of DBS checks, required annually.

Prior to running any activity, whether on your campus or at a school, you will also require a risk assessment. Most schools will request this in the planning stage. In Figure 24 we provide you with example entries in a risk assessment. However, we strongly recommend that you review your own assessment with your university's Health and Safety Officer.

Hazards associated with the activity	Individuals at risk from harm by the hazards	Risk Reduction and Control: Measures put in place to reduce the risks of hazards occurring	Is anything else needed to manage the risks?	Person responsible for managing concerns
Children's behaviour	Children, School Staff, University Staff, Undergraduate Outreach Team	• Safety instructions are given to the children before the activity starts and must be adhered to. • The number of participants will determine the appropriate staff and helper-to-child ratio and must be adhered to. • Remind the children of the rules to ensure they behave appropriately throughout the activity. • Inappropriate behaviour will be accordingly dealt with by University and School Staff. • Children will be removed from the activity by the School Staff if necessary	No	School Staff/University Staff
Equipment: Faulty, misuse, slips, trips and falls	Children, School Staff, University Staff, Undergraduate Outreach Team	• Check and assess all equipment before use to ensure it is well-maintained and in working order. • Equipment is stored safely and out of the way during the activity to reduce the risk of a slip or trip hazard.	No	University Staff, Undergraduate Outreach Team
Small items: Swallowing and choking	Children	Supervise the group constantly throughout the activity.	No	University Staff, Undergraduate Outreach Team, School Staff

Figure 24: An example of entries in a risk table for Outreach Intervention 1.

Outreach Intervention 1: on the day

Collecting data

If you have planned to acquire data to assess your outreach's impact, ensure you have acquired all necessary consents. Remember to run the questionnaire both pre- and post-activity. Many schools have tablets available, so if you provide the questionnaires to teachers in advance, they can have them loaded and ready to be completed.

Alternatively, be sure to bring sufficient paper copies. Please refer to page 16 for more details.

The activities

For Intervention 1 there are two LEGO®-based activities, both focused around design and the iterative approach needed, as well as the benefit of having different viewpoints and perspectives brought to the process i.e. diversity within the design team.

To focus participants during the activities **each activity or part of an activity was timed**. The time provided for an activity can be varied depending on the complexity of task, age-group or ability of the outreach participants.

The two activities we typically undertake at a 50% for the Future outreach session are “Build a Duck” and “Hopper Race”.

Build a Duck

An introductory/ice-breaker activity undertaken as individuals. Every participant is given the same set of six LEGO® pieces and given 30 seconds to create a duck using all six pieces. This challenge is designed to demonstrate that despite the simplicity of the task everyone will approach it differently. At the end of the 30 seconds it is important to ask everyone to hold up their ducks and to look around the room at the diversity in the designs produced. The emphasis of this task is that more design perspectives are considered with a diverse workforce.

For younger age groups you can also ask them to name their ducks. All participants get to keep their ducks, which is a useful reminder of the day and the message around diversity that they have received.



Figure 25: Diversity in duck design.

Hopper Race

This simple robotics challenge demonstrates prototyping and teamwork. The instructions to build the simple hopper along with the pre-programmed Scratch code is provided with the LEGO® Invention Squad resources (www.education.lego.com/en-us/lessons/prime-invention-squad/hopper-race/). Once this initial build is complete you can ask participants to modify the “hopper”/propulsion part of their design, and/or the code. For older age groups, you can encourage them to use gearing and/or ban them from using wheels. With more time available you can ask the students to brainstorm/design on paper before building.

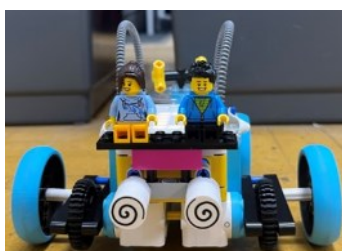
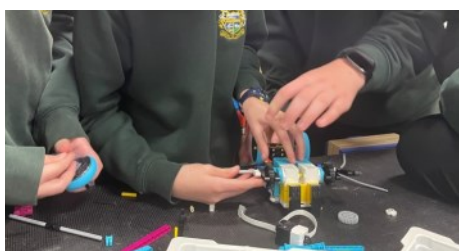


Figure 26: LEGO® hopper design.

You want them to meet two design goals:

- The hopper is fast
- The hopper moves in a straight line

But you add time restrictions and possibly part restrictions to replicate real-world engineering tasks. The teams are asked to race their designs, and this always induces a great deal of excitement!

Please note, whilst we have used LEGO® Education SPIKE™ kits, Outreach Intervention 1 can use any resources, provided the key aspects are incorporated:

- Design something – emphasising the importance of diversity in thought/experience/background
- Improve something, i.e. design iterations and optimisation
- Teamwork
- Competition

Outreach Intervention 2: creative writing competition – “I need to find out for myself”

An overview

This intervention was designed to help promote and raise awareness of Mechanical Engineering by utilising the concepts of Social Cognitive Career Theory and Utility Value Theory (see page 2) to address misconceptions around the subject area, particularly with females. The aim was for entrants to undertake their own research, and through doing this spend more time reflecting on their own potential efficacy in the subject or career options offered in Mechanical Engineering.

The task set was for entrants to express their vision/ideas under the title of **“Mechanical Engineering Through my Eyes”** in their own chosen creative written or drawn form. The emphasis for this intervention was self-reflection and pupil research, so we wanted to give the entrants free rein with the format of their competition entry. We suggested some formats (e.g. essay, poem, poster) and in an effort to demonstrate creative mediums our outreach team delivered workshops on zine (mini magazine) creation (see Figure 27). We made it clear that spelling and grammar were of less concern than the motivation and content of the entries.

The task was an extra-curricular activity promoted within the school, and English lessons, specifically. A slide deck was developed and given to the schools to present in lessons when introducing the competition to the pupils (Figure 28). Schools were also sent posters with a QR code that provided details of the competition (Figure 19, page 15). You may want to consider providing some resources of case studies around Engineering with suitable role models (see “Results”, page 27).

Based on the survey feedback and the ages at which students started to become interested in Engineering/Mechanical Engineering, it was decided to target both KS3 and KS4 education levels. Consequently, entries were accepted from 11–13 and 14–16 age categories, with winner and runner-up prizes offered to both, to incentivise participation. You have the opportunity here to involve an industry sponsor to fund prizes.

The prizes offered were related to the design element of Mechanical Engineering: a VR headset and a 3D printer. In the first iteration of the competition, the participating schools were asked to collect and send through entries, which were then scored anonymously by a team of academics within the Department of Mechanical Engineering at Swansea University. A scoring rubric was utilised for consistency (see Appendix 8).



Figure 27: Example zines.



On selection of the winning entries the schools were contacted, and the prizes and a certificate were awarded within a school assembly. Schools had the option to have the winner or a member of the 50% for the Future team read out the winning entry (if a written entry won). An example of a winning entry is given on page 22.

You may want to collect data in order to assess the benefits of the activities and determine whether they have the expected outcomes. Don't forget to get consent to collect and store the data, and make sure you run your surveys pre- and post- the activity. See page 16 for more information.

- Find the funding for prizes – try to secure some industry sponsorship
- Decide on a title or theme for the competition – you may want to engage with industry for ideas
- Decide how you want to accept entries i.e. ask for school to organise and send on.
- Advertise the competition to schools and select suitable dates.
- Attend schools to provide an overview of the activity with presentations/resources.
- If suitable/needed the outreach team can run a Zine workshop.
- Ensure DBS checks are in place for outreach team running workshops
- Create a scoring rubric (or use the one provided)
- Set up a team to read and score the entries
- Decide on how you will acknowledge the winners and award the prizes

This intervention is low-cost but you may need to consider the following:

When I was a Fairy

My strongest memory from being small
Is a little bit whimsical and certainly airy
But according to all I used to recall
All the times "When I was a Fairy".

They were dreams I believed in
To treasure and hold
The wings on my back
Were turquoise and gold.

Now that I'm older
I've decided to apply
The rules of physics
To make me fly.

The first step in my engineering plan
Is to refine a strategy
For making a flying machine
To bend the laws of gravity.

I need materials to reduce drag
So will research aerodynamics
To reach the kind of heights
Where the views will be panoramic.

Thanks to the power of memory cloth
The wings are taking shape
With the help of aluminum tubing
And probably a bit of tape.

I've got to consider how to get lift
So must think about weight
A quick study of the force of inertia
To help me go straight.

I probably need a bit of propulsion
So must think about thrust
Acceleration and smooth landing
Is also a must.

It's time to put these wings on my back
And soar across the sky
Thanks to mechanical engineering
I'm finally high and dry.



Illustration by Ralph Mann, purpleheron.co.uk



Outreach Intervention 3 – teacher CPD conference:

“Educating the educators”

An overview

In December 2023 we ran a teacher CPD event, with a focus on “**educating the educators**” about Mechanical Engineering. Participants were invited from secondary schools and tertiary colleges from South and West Wales; additionally, social media was used to advertise the event more widely (see Figure 29) and a teacher from Oxfordshire did join the event.

In total, eighteen STEM Teachers attended, from 10 different schools and colleges. There were two key factors in achieving this turnout:

1. Timing is everything. Towards the end of term in December proved to be a very popular time for the event.
2. Funding – We were able to fund the cost of supply cover for teachers attending the event; this was in the region of ~£250 per teacher. With a restricted budget we recommend that this subsidy is offered to teachers from schools based in more socioeconomically deprived areas, as typically we found these schools to have less flexibility in covering for any teacher absences. You may want to consider inviting industry to sponsor your event.

The focus of the day was the enhancement of teachers’ understanding and awareness of Mechanical Engineering, with the aim of achieving more consistent dissemination of learning around Mechanical Engineering. We included several different kinds of activities:

- Presentations and tours of laboratories on the theme “Mechanical Engineering Today”, including topics such as Industry 4.0, marine energy and additive layer manufacturing. The aim of this was to provide examples of the breadth of Mechanical Engineering and to widen awareness of subjects outside what are thought of as traditional Mechanical Engineering applications.
- Talks from female alumni working within the Engineering sector – to provide tangible examples of what our female graduates have gone on to achieve.
- Presentation on careers in engineering to provide teachers with information such as typical starting salary of a graduate engineer, etc.
- Talks on the landscape of STEM outreach and introductions to Swansea University’s outreach offerings. This set the scene for the afternoon’s workshop sessions, which focussed on getting teachers to think about problems with outreach and what they wanted to see from outreach provision.

The workshop sessions were timetabled to last for about an hour. The activities we ran are summarised in Figure 30.

A particularly effective part of the CPD event was the use of a graphic illustrator (www.purpleheron.co.uk), who summarised the day into a series of images. All of these images were then sent to the participants after the day, as a reminder of **key themes and ideas around Mechanical Engineering**. A number of the attendees stated that they would be printing and displaying these resources in staff rooms and classrooms. The illustrations have featured throughout this guide.



Figure 29: Our flier for the teacher CPD conference.

Workshop Session – The Future of Outreach

Individual exercise: Traffic lights exercise

(10 minutes)

Fill in as many sticky notes as possible within the time, with ideas/statements for:

- What **Doesn't work or is holding back?** (PINK sticky notes)
- What **Does Work?** (YELLOW sticky notes)
- What are the **Opportunities/ways to improve and widen impact?** (GREEN sticky notes)



Sticky notes are then displayed on a pin-board for all participants to view.

Group exercise: The 5-Whys?

(10 minutes)

The 5 Why's is an easy exercise out of the Design Thinking toolbox. It is great for exploring the cause and effect of a problem and getting to the core of the issue you're working on. The exercise is as simple as starting with the most obvious effect of your problem, and asking "why" five times, until you get to the ultimate cause."

Outreach delivery doesn't have enough impact: Why? Why? Why? Why? Why?

A Worksheet is provided to record the group's ideas and displayed alongside the sticky notes

Group exercise: Mind-map/brainstorm Session

(up to 25 minutes)

Reflecting on the previous activities, your own experiences, and today's event, please use the large paper provided to brainstorm and as a group create a mind-map around the topic of:

"Improving the uptake and equality of Outreach Activities for Engineering in Welsh Schools"

You might like to consider as some of your points:

- Types of activities
- Mode of delivery
- Engagement (students and schools)
- Widening participation (ED&I)

These mind-maps are then presented by each group, to allow all participants to share ideas.

Figure 30: Our workshop activities.

Outreach Intervention 3: Planning

- Establish budget and whether there is any resource to fund teacher cover for attendees: try to acquire industry sponsorship.
- Select a suitable date. It would be a good idea to talk to schools and alumni early for guidance on dates. We found that December and late in the Summer term were times of year that teachers had more flexibility
- Design a flyer and send invitations to school head teachers and STEM contacts in schools; depending on budget use social media to advertise the event wider.
- Decide on the themes and topics for the day and plan a timetable (see Figure 31).
- Confirm any external speakers and requirements of presentations.

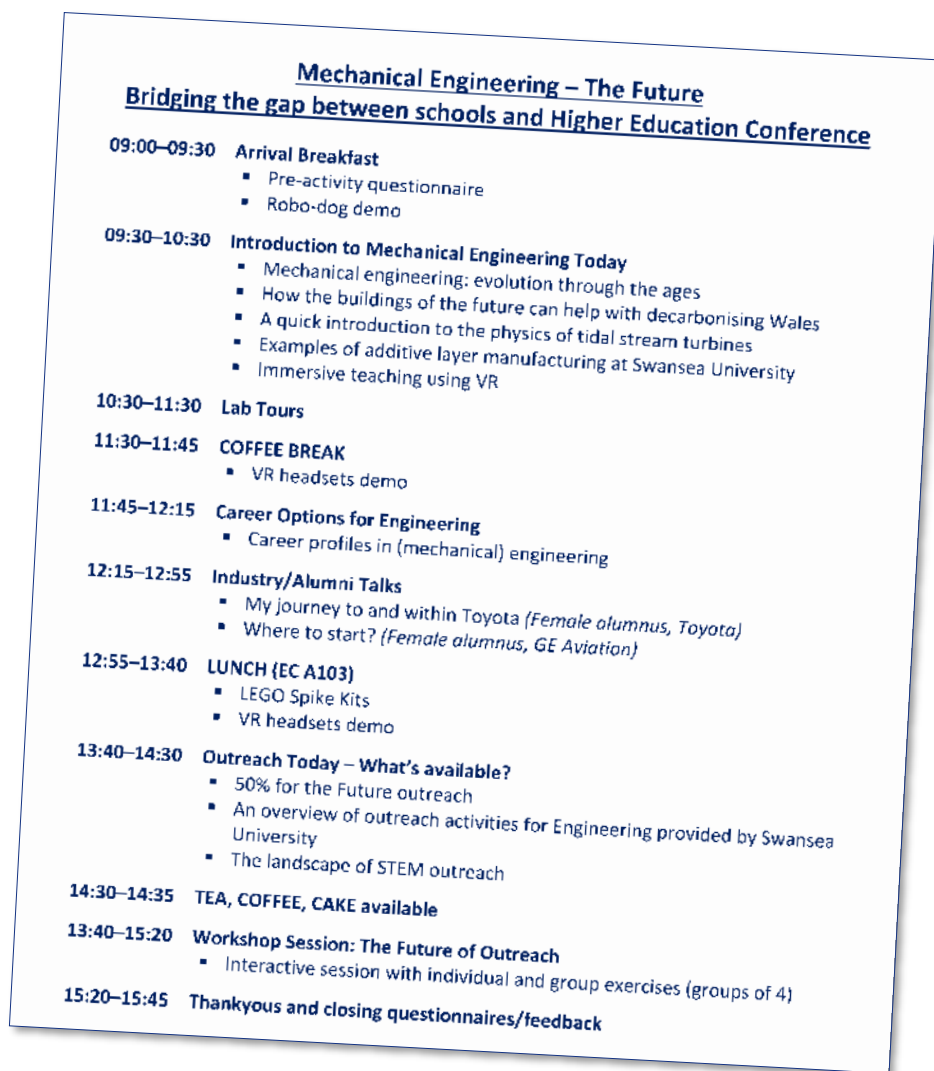


Figure 31: Our agenda for Outreach Intervention 3, the teacher CPD event.

- Book a venue and catering for the day, along with any audiovisual support necessary
- Complete risk assessments as required by the venue/your institution
- Prepare presentations and acquire presentations from all attendees at least 48 hours in advance of the event.
- Develop a suitable pre- and post-event questionnaire to gauge attitudes (see page 16 for details).

Outreach Intervention 3: Resources

- Workshops will require paper, sticky notes, and some means of displaying them.
- Pens
- Catering
- Budget to cover teacher costs (if possible)
- Depending on external speakers budget to cover expenses.
- Budget for a graphic illustrator to leverage maximum output from the event.
- A pre- and post-intervention questionnaire (see page 16 for data collection guidance).

Checklists for the Hybrid Outreach Approach

Outreach Intervention 1 Checklist

- ☐ *Appoint an academic to lead on planning the outreach and liaising with schools*
- ☐ *Consider how you will fund the resources needed for your activities (Internal, external, industry funding?)*
- ☐ *Set up outreach team and complete DBS checks*
- ☐ *Purchase LEGO® Creator 10-piece brick sets and LEGO® Education SPIKE™ Prime kits or equivalent resources for your activity (plan this with your outreach team)*
- ☐ *Contact schools for interest and dates*
- ☐ *Develop your questionnaires—DON'T FORGET YOUR ETHICS PROCESS!*
- ☐ *Create a presentation outlining the outreach activity*
- ☐ *Train outreach team to run activity and deliver the questionnaires, ensuring collection of consent*
- ☐ *Complete risk assessment for activity*
- ☐ *Post-activity, consider lessons learnt: What worked? What didn't? What should we do differently? Did the activity have the desired outcome?*

Outreach Intervention 2 Checklist

- ☐ *Engage local industry for prize sponsorship and tailoring of title for entries*
- ☐ *Design and produce flier and distribute it to local schools*
- ☐ *Advertise on social media*
- ☐ *Make sure everyone working with pupils has the necessary DBS checks*
- ☐ *If acquiring survey data ensure consent is acquired - you will need to work with the school for this – and ensure the questionnaire is run before and after the activity.*
- ☐ *Run workshops in schools (poster design, zines, etc.) if required*
- ☐ *Create scoring rubric and set up panel to score entries*
- ☐ *Award prizes and publicise on social media*

Outreach Intervention 3 Checklist

- ☐ *Consult with schools, alumni and the venue to choose a suitable date*
- ☐ *Decide on the themes for the day and plan a timetable, checking availability (presenters, lab techs, etc.)*
- ☐ *Book the venue, catering, audiovisual support, graphic illustrator (if using)*
- ☐ *Design a flyer and send invitations to school head teachers*
- ☐ *Complete risk assessments as required by the venue/your institution*
- ☐ *Prepare presentations and acquire external speakers' presentations*
- ☐ *Have your questionnaires ready, with consent forms and participant information sheets*
- ☐ *Confirm timetable and be prepared for late adjustments*
- ☐ *Thank presenters and follow up with schools (e.g. distribute graphic illustrations)*

Results: the impact of the Hybrid Outreach

Approach

The questionnaires we used are shown in the Appendices and explained on page 16. If you would like MS Word or PDF versions of the questionnaires, contact 50forthefuture@swansea.ac.uk

Questionnaire findings for Intervention 1: Ducks and Hoppers

During 2023/24 (i.e. the funded duration of the 50% for the Future project), Outreach Intervention 1 was undertaken for 15 schools, with 23 sessions run.

From those sessions, three schools in South West Wales, of varying socioeconomic backgrounds, participated in pre- and post-activity questionnaires. We received questionnaires from 136 pupils across both KS3 and KS4 levels of education, 51% of which were female.

Results for Outreach Intervention 1 (Figures 32–34) clearly illustrated a marked increase in participants' understanding, positive opinion and interest in pursuing Mechanical Engineering at degree level or as a career. This improvement was seen across both the female and male participants.

Feedback provided by teachers present at the outreach sessions was also overwhelmingly positive around the experience provided for the students:

"The Lego workshop proved to be an enriching and impactful experience for the students involved, providing a unique, engaging and fun learning opportunity. Please can we make this an annual event?! ... [The students] experienced the joy of problem-solving as a team. The innovative and enjoyable nature of the activity not only captured their attention but also fueled their curiosity and creativity. This was a dynamic and fun-filled morning that allowed pupils to apply theoretical knowledge to a practical context, enhancing their understanding of engineering concepts."

Questionnaire findings for Intervention 2: creative writing competition

During the funded period of 50% for the Future, in the Winter term of 2023, the creative writing competition was run with three schools of varying socioeconomic backgrounds, with participants asked to complete a pre- and post-intervention questionnaire.

Ninety-two pupils across the two age-range categories (KS3 and KS4 levels) completed the questionnaire; 53% were completed by female pupils.

The results showed that understanding, and positive opinion of Mechanical Engineering both improved with increases in the categories of Agree and Strongly Agree for both male and female respondents (Figures 35–37).

However, considering the results for interest in pursuing Mechanical Engineering as a degree/career there was a marked increase in the Agree category, but a decrease in the strongly agree and an increase in the neither agree/disagree category. This result was not observed for Outreach Intervention 1. We propose that this could be caused by the lack of resources available on a general internet search showing role models in engaging Mechanical Engineering careers.

We recommend providing your own case studies of women in engineering and/or a list of relevant websites to help guide the initial internet searches undertaken by the schoolchildren.

Table 3: Questionnaire responses before and after Outreach Intervention 1 – Ducks and Hoppers

	Question 1: understand				Question 2: opinion				Question 3: pursue			
	Female		Male		Female		Male		Female		Male	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Strongly Agree	9%	23%	12%	37%	7%	19%	15%	45%	1%	7%	7%	22%
Agree	40%	66%	51%	52%	39%	53%	49%	40%	10%	26%	35%	48%
Neither Agree/ Disagree	33%	10%	29%	12%	45%	24%	31%	15%	47%	40%	45%	22%
Disagree	15%	1%	8%	0%	6%	1%	2%	0%	30%	21%	8%	8%
Strongly Disagree	3%	0%	0%	0%	3%	3%	2%	0%	13%	6%	5%	0%

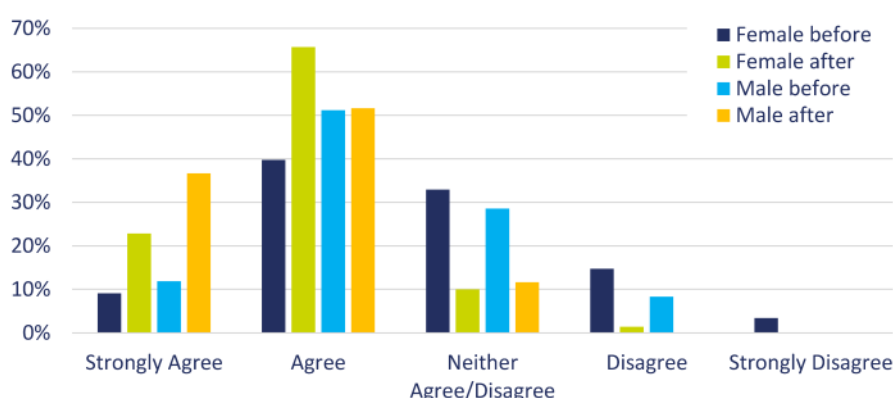


Figure 32: Female and male questionnaire responses to the statement **I understand what Mechanical Engineering is** before and after Intervention 1 (ducks and hoppers).

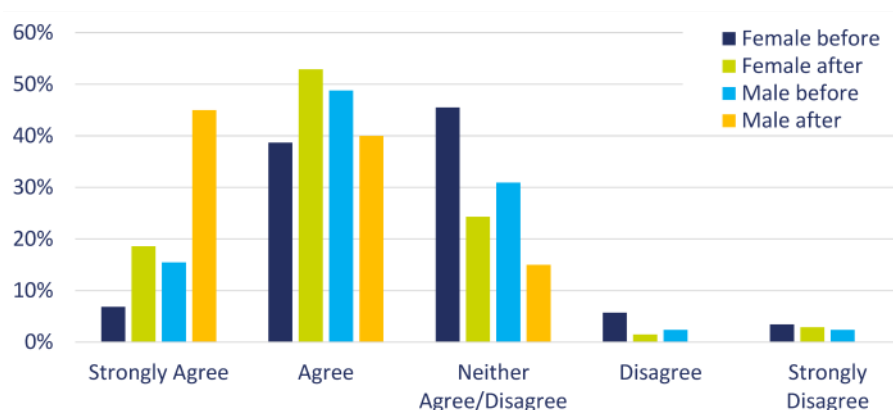


Figure 33: Female and male questionnaire responses to the statement **I have a positive opinion of Mechanical Engineering** before and after Intervention 1 (ducks and hoppers).

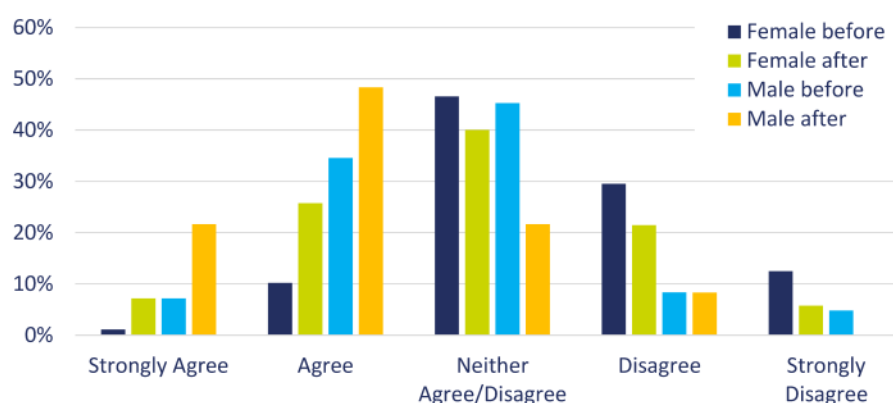


Figure 34: Female and male questionnaire responses to the statement **I am interested in pursuing Mechanical Engineering** before and after Intervention 1 (ducks and hoppers).

Table 4: Questionnaire responses before and after Outreach Intervention 2 – creative writing competition

	Question 1: understand				Question 2: opinion				Question 3: pursue			
	Female		Male		Female		Male		Female		Male	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Strongly Agree	6%	18%	8%	16%	17%	24%	19%	28%	8%	6%	14%	9%
Agree	38%	59%	46%	65%	29%	53%	40%	63%	26%	50%	28%	37%
Neither Agree/ Disagree	27%	20%	26%	14%	46%	18%	34%	7%	34%	45%	34%	42%
Disagree	23%	4%	15%	5%	6%	2%	5%	2%	22%	22%	17%	7%
Strongly Disagree	6%	0%	5%	0%	3%	4%	1%	0%	11%	8%	7%	5%

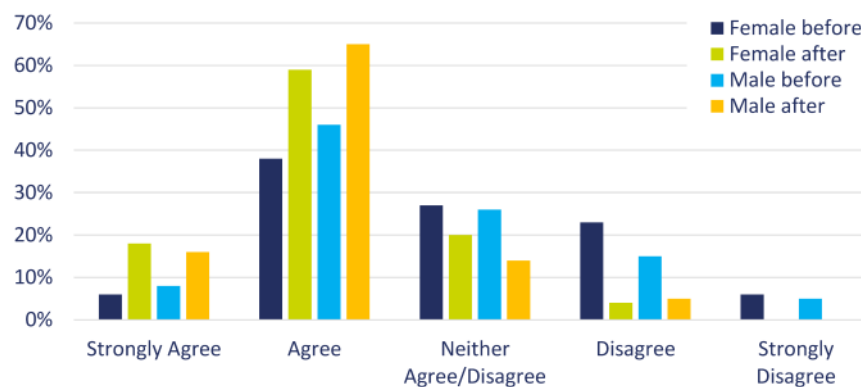


Figure 35: Female and male questionnaire responses to the statement **I understand what Mechanical Engineering is** before and after Intervention 2 (creative writing).

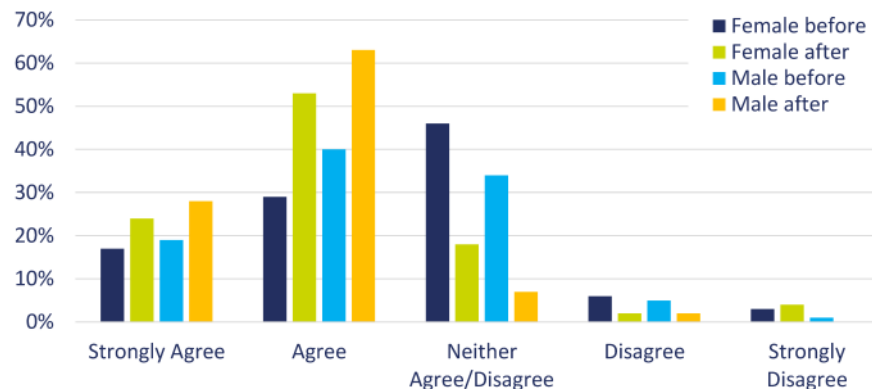


Figure 36: Female and male questionnaire responses to the statement **I have a positive opinion of Mechanical Engineering** before and after Intervention 2 (creative writing).

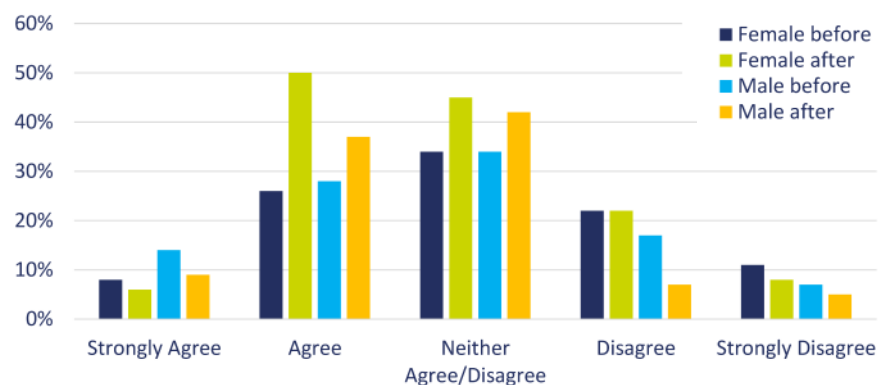


Figure 37: Female and male questionnaire responses to the statement **I am interested in pursuing Mechanical Engineering** before and after Intervention 2 (creative writing).

Table 5: Questionnaire responses before and after Outreach Intervention 3 – Teacher CPD Conference.

	Question 1: understand				Question 2: opinion				Question 3: confidence			
	Female		Male		Female		Male		Female		Male	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Strongly Agree	33%	83%	8%	75%	67%	100%	42%	92%	50%	83%	25%	75%
Agree	33%	17%	75%	25%	33%	0%	50%	8%	17%	17%	50%	25%
Neither Agree/Disagree	0%	0%	8%	0%	0%	0%	8%	0%	0%	0%	17%	0%
Disagree	33%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Strongly Disagree	0%	0%	8%	0%	0%	0%	0%	0%	33%	0%	8%	0%

All teachers completing the survey after the intervention taught STEM subjects, which may account for the high initial understanding of Mechanical Engineering.

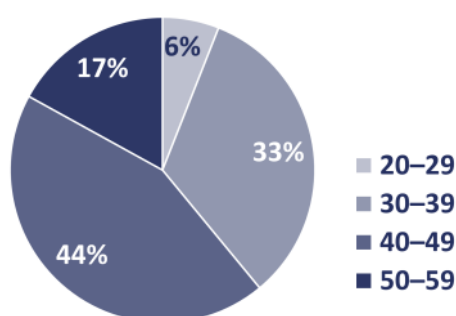


Figure 38: Breakdown by age of the teacher CPD conference attendees.

Questionnaire findings for Intervention 3: teacher CPD conference

Eighteen STEM Teachers from 10 different secondary schools and tertiary colleges attended the CPD event in December 2023, and 33% of the attendees were female. The age range of participants is summarised in Figure 38. The questionnaire findings clearly highlighted that understanding and opinion of Mechanical Engineering improved and most importantly there was a strong increase in confidence to discuss Mechanical Engineering with their students. With this being the key driver for undertaking the CPD event, it was a positive outcome of the intervention. Some examples of qualitative teacher feedback on the event are provided.

Really informative day, can now make clear links between the subjects I teach and Mech Eng and also have lots of ideas brimming for ways to incorporate it into my Biology and Welsh Bacc lessons!

Presentations had so much quality information ... Hospitality and tour was amazing and being able see different research and facilities ... Tasks at the end were provoking and were very useful to hear similar experiences with STEM outreach

Reflections on the 50% for the Future

Hybrid Outreach Approach

What went well?

- The data-informed (both quantitative and qualitative), sequential development of our Hybrid Outreach Approach; this data-driven approach helped us to create a well-informed method that has focussed on addressing specific identified issues in the process of females selecting Mechanical Engineering at degree-level.
- Females responded well to both the Outreach 1 and Outreach 2 Interventions with clear improvement in understanding and opinion of Mechanical Engineering after participating.
- Females won in both age categories of Outreach Intervention 2 after the blind-scoring of submissions, producing thoughtful and impactful pieces of work.
- Pre- and post-intervention questionnaire survey data taken from school children participating in both Outreach Interventions 1 and 2 showed positive outcomes for both male and female participants. The activities were purposefully undertaken in schools from socioeconomically deprived areas of the South Wales Valleys and so it can be extrapolated that the outreach approaches are applicable across differing under-represented demographics at HE-Level in Mechanical Engineering i.e. it is known that white British males from low socioeconomic status groups have the lowest progression rates to HE (OFFA: <https://shorturl.at/cVOue>).
- A clear outcome from Outreach Intervention 3, the Teacher CPD Conference, was that educators felt more confidence around discussing Mechanical Engineering with the students. This is critical in bridging the knowledge void that students are currently facing around Mechanical Engineering and probably Engineering in general.
- By involving our cohort in the process (i.e. surveying and recruiting into the outreach team), we have found that we've improved relationships with our current student cohort; raising their awareness of research undertaken to support them and improve their HE- learning environment.
- Overall, we've developed tangible outputs with longevity, that are engaging and motivating our current students and steadily increasing our recruitment of female students. The impact of the funding has and will continue to be transformative for the Department of Mechanical Engineering at Swansea University.

Recommendations

- If you want to better understand the issues experienced by your student cohort/ recruitment demographic, use a varied and tailored approach to dig into problems because this will provide greater granularity of the complex and multifaceted issues (e.g. make use of surveys, focus groups, interviews, World Café events, and so on).
- It is important to listen to and use information from beneficiaries and stakeholders (i.e. students and teachers); for us it was key in driving the direction of the project in a productive way to create impactful interventions.
- Planning ahead is essential in order to get teachers on board; they have very restrictive timetabling and need plenty of warning in order to be able to attend events during term time.

- If possible try to contribute to teacher cover costs, to free up teachers to attend your conference, with priority given to teachers from socioeconomically deprived schools.
- It's important to build relationships with schools and return regularly to run outreach activities: keep those lines of communication open!
- Be adaptable. Ask schools/teachers whether there are curriculum areas that they would like supported/reinforced through the outreach activities that you are offering. This can increase uptake. For example, we were asked by a school to adapt the Outreach Intervention 1 Hopper challenge, to look at the design and building of a wind turbine to tie in with their classroom activities around renewable energy.
- Ensure you promote your outreach work to improve diversity of your cohort and the benefits of joining the undergraduate outreach team at Open Days for your Department/University. We have seen the outreach team specifically mentioned in UCAS personal statements and in Induction Week we have a number of new students very eager to join the team.

Lessons learnt

- Don't underestimate the time involved in acquiring data around your intervention implementation. You will need to factor in your University's ethics approval process for running surveys and securing prior consent when working with minors. For over-18s it is possible to embed consent into the survey, but you will need to have provided sufficient and detailed participant information to allow informed consent to be acquired.
- Consider more fully the impact of term times on ability to interact and test interventions.
- Try to acquire specific teacher contacts within schools; using general school email contacts is not always successful in opening lines of communication to run outreach.
- When running the teacher CPD conference we found that all of our attendees were STEM teachers; in hindsight we should have been more proactive in encouraging non-STEM teachers and support staff to the conference to widen the potential impact of the event. As was clear from the Teacher Survey results (pages 10–11), there is an interest from all teachers to find out more about Mechanical Engineering/Engineering, to support their students' understanding/awareness.

50% for the Future: success and risks

Our biggest success

The intention of the 50% for the Future project was to improve experiences of females studying Mechanical Engineering at HE-Level, which we knew from previously published work and our own anecdotal experiences at Swansea University was impacted by the male-dominated environment. We believed that if we could improve females' experiences whilst studying it would also have the positive outcome that they would feel more motivated and positive around going on to pursue their career goals within the Mechanical Engineering/Engineering sector. Therefore, a critical output for the 50% for the Future project had to be finding a way to increase the number of

females choosing Mechanical Engineering as a degree choice. This was why our Hybrid Outreach Approach was developed.

We deem our Hybrid Outreach Approach to be a **success** for the following reasons:

1. It has been developed to target the issues highlighted from our survey and focus group work (see Figure 39).
2. From qualitative and quantitative data acquired from schoolchildren and teacher participants we have seen clear increases in understanding and positive opinion around Mechanical Engineering; with female schoolchildren clearly positively impacted by both Outreach Interventions 1 and 2 (see results on pages 28–29).
3. We have seen a marked increase in our female enrolment in Mechanical Engineering. The average female representation across the Mechanical Engineering cohort in 2021 was 8.8%, whereas in our 2024/25 entry we saw 14.9% female representation. This is around a 70% increase, and is against the backdrop of ~10% female intake into UK HE Mechanical Engineering courses (www.engineeringuk.com/research-and-insights/our-research-and-evaluation-reports/engineering-and-technology-workforce-may-2025-update/). Whilst we cannot definitively state that this increase is attributable to the 50% for the Future Hybrid Outreach Approach, we do actively promote the work at our Open Days and have had positive feedback from prospective female students and their parents about the initiative.

PROBLEMS IDENTIFIED		
A <i>Selection of Mechanical Engineering at degree level by females wasn't driven by perceived (potential) efficacy and/or enjoyment of the subject, which had been a clear driver for GCSE and A-Level selection. Qualitative and Focus Group findings highlighted that Mechanical Engineering had been selected <u>in-spite</u> of a lack of real clarity over what it could involve.</i>	B <i>Evidence that teachers had been influential in both a positive and negative manner in the selection of degree choices; but that teacher–student guidance was not a relationship being fully leveraged. Survey results from teachers found a general lack of knowledge and confidence in discussing engineering and Mechanical Engineering with their students.</i>	C <i>Our female undergraduate students felt that they had not had clear relatable role-models within Mechanical Engineering/Engineering available throughout their education pathway to date</i>
SOLUTIONS		
A <i>Providing two different types of outreach interventions – one showcasing more of the hands-on design and problem-solving attributes of the subject and another that is encouraging personal research to be undertaken to gain a deeper understanding of the subject.</i>	B <i>The CPD conference is better informing educators so that the teacher–student guidance relationship can be fully leveraged.</i>	C <i>Our outreach team is assembled from undergraduates with a diverse demographic with a strong representation of females; additionally, the Creative Writing Competition can be supplemented with targeted research information i.e. providing case studies of inspirational females in Mechanical Engineering, etc.</i>

Figure 39: The problems identified and the solutions in our Hybrid Outreach approach.

What else success looks like

Alongside the proven effectiveness of the Hybrid Outreach Approach; the following can also be deemed successful outputs of the 50% for the Future project and the outreach work:

- Within Swansea University we are working to embed the findings of the project and to widen the application of the Hybrid Outreach Approach, i.e. to highlight different engineering topics/applications.
- We have been able to share our findings across the UK HE pedagogy community via presentations and posters at 11 national conferences over the project duration, and we have established that there is interest from other HE institutions across the UK to partner and collaborate with the outreach approach we have developed.
- The activities themselves are low-cost and high-impact, but key to delivering them successfully is the buy-in from our university, local schools, industry partners, and most importantly the continuous student engagement from our undergraduate outreach team.

Another potential success of the 50% for the Future Hybrid Outreach Approach is the development of **Regional Outreach Hubs**. This will be discussed further in “Replication and scalability” (pages 36–37).

Risks to successful implementation of the Hybrid Outreach Approach

The following have been identified as potential risks when implementing the Hybrid Outreach Approach that could jeopardise its success:

- Low uptake from schools would be particularly detrimental to the success of this approach. Following the guidance given in this document should help in avoiding this (i.e. management of ongoing engagement with schools, use of existing partnering and networking arrangements, and forward planning for timetabling).
- Lack of interest or engagement from undergraduates to participate in the outreach team (although we haven’t found this to be an issue).
- No funding. There are a number of costs for activities covered in this How to Guide:
 - The purchase of the LEGO® Education SPIKE™ kits and associated equipment.
 - Supply teacher cover to encourage attendance at the teacher CPD event
 - Prizes for the Creative Writing Competition
 - Payment of undergraduate outreach team members for their time running outreach sessions, and costs for travel and DBS checks.

We were lucky and extremely grateful to have received the initial project funding from the Academy’s Diversity Impact Programme for the 50% for the Future project, which covered the LEGO® purchase, supply teacher costs and prizes, and we have the support of the Department of Mechanical Engineering and Swansea University in covering the ongoing costs for the outreach team. However, we will discuss alternatives to these costs or ways to share across the HE community in the section “Replication and scalability” (pages 36–37). We also recommend that to mitigate against these costs you plan ahead to determine what you can deliver with the funding available from external funding bodies, university funding or industry sponsorship, and engage as early as possible with participating schools and teachers.

COSTS

The extra-curricular creative writing activity will see higher engagement if you are able to offer prizes. You will have higher attendance at the teacher CPD event if you are able to cover the costs of supply teachers. You may also need to pay for DBS checks and travel costs, and for catering costs at any CPD event.

We were able to cover the initial outlay required for the LEGO® Education SPIKE™ kits and dedicated laptop for each kit to run the associated app. However, the specific activity that is undertaken for Outreach Intervention 1 **does not** have to utilise this kit; any activity that requires consideration of diversity of design and problem-solving would be suitable.

What success could look like for you?

As has been showcased in this How to Guide, the three outreach interventions each delivered positive outcomes. Therefore, whether you undertake one or the combined “Hybrid Outreach Approach” and take care to avoid the risks highlighted previously, you can expect to see:

- Improvement in understanding and opinion of Mechanical Engineering of your targeted discipline of Engineering with pupils and/or teachers at schools/colleges you work with.
- Improved legacy relationships with the schools/colleges you target with your outreach.
- An opportunity to engage your undergraduate cohort around EDI, along with provision of an extra-curricular activity that develops essential skills for their ongoing development i.e. management, teamwork, public-speaking, etc.
- With consistent implementation of your outreach, an increase in percentage representation of the under-represented demographic your outreach has targeted.

This could be further enhanced through the suggestions made in the following section, “Replication and scalability” (pages 36–37).



Figure 40: LEGO® duck and hopper illustrated by Ralph Mann, and an image from our animation, illustrating the Hybrid Outreach approach.

Replication and scalability

The justification for the Hybrid Outreach Approach is that separately the interventions are impactful, but together their effectiveness is enhanced, with the different activities targeting specific issues identified around the knowledge and role model void, and designed to have wide appeal and impact. Each of the outreach activities can be scaled, with the size of outreach events and conference determined by budget and staff limitations only.

It should be highlighted that although we are recommending the hybrid approach of the three interventions, we have proven that each separately has a positive impact on the participants. It is therefore possible to move forward with only one of the interventions for lower initial outlay while funding is secured or planning undertaken for the others.

The extent of outreach undertaken can be managed and targeted to align with individual university/departmental requirements.

Reflecting on Outreach Intervention 1, any university could facilitate the formation of their own undergraduate outreach team. The outreach activity offered is then only dependent on the budget available. The purchasing of LEGO® Education SPIKE™ kits is not a requirement; other no/low cost ideas for outreach activities are readily available (e.g. www.sciencebuddies.org/stem-activities/subjects/mechanical-engineering) and the outreach activity can be tailored to the participating school's specific learning requirements for the session, to enhance appeal and usefulness. We have hopefully provided you with sufficient information in this How to Guide to be able to plan and implement these sorts of activities as well as acquire data to assess effectiveness.

We believe that Outreach Intervention 2, the creative writing competition provides the greatest opportunity for large-scale implementation at relatively low cost. And the “creative” aspect can take a variety of forms: poster, essay, poem, short story, zine.

Outreach Intervention 3, the CPD conference for Educators can be kept small and focussed on a specific school or feeder schools for your University/Department; but, as for Outreach Intervention 2 the conference can be scaled up and run as a large, flagship annual event.

With this in mind, we would like to highlight the next planned steps for 50% for the Future: regional 50% for the Future Outreach Hubs formed by HE institutions.

Regional 50% for the Future Outreach Hubs

The effectiveness of the Hybrid Outreach Approach raises the opportunity to widen the implementation of the interventions. In particular, Outreach Interventions 2 and 3 lend themselves very well to being run **collaboratively by a network of universities**. The creative writing competition run at a large scale across a region of the UK could have the potential to impact thousands of school-age children, providing an exciting opportunity to begin addressing the misconceptions around Engineering as an inclusive career.

Similarly, the teacher CPD conference could be run annually as a national event, with 100-plus teachers in attendance, with a different university taking the lead each year on organising, theming and accommodating the event. The scaled effect of such events could make a meaningful impact on raising the profile and overall understanding of the Engineering specialities.

There is also the possibility that costs of purchasing a large number of LEGO® Education SPIKE™ kits could be shared amongst the partners in the regional hubs, and

cross-university outreach teams formed. This would also provide a great opportunity for networking between undergraduate students within Engineering courses at different UK universities.

Consequently, we would like to invite other HE institutions in the UK to join one of the proposed Regional 50% for the Future Outreach Hubs: South Wales and the South West; North Wales and the North West; the Midlands; North East; London and the South East; Scotland; and Northern Ireland.

If you would be interested in forming or joining one of these regional hubs or require any further information then please contact 50forthefuture@swansea.ac.uk.



Figure 41: Suggested Regional Hub areas

Not just Mechanical Engineering, not just girls

The Hybrid Outreach Approach was developed around promotion of Mechanical Engineering to females, but it can be easily adapted to any of the other Engineering disciplines. National levels of recruitment of females into HE degrees in Mechanical Engineering sit at around 12%. But from the HESA data, the figure is similarly low across a number of Engineering disciplines: Aerospace at around ~15%; Electrical ~14%; and Civil ~22%. The Hybrid Outreach Approach is equally applicable across all disciplines, the only requirement is to change the focus of the content to the necessary engineering application.

Additionally, the Hybrid Outreach Approach is developed to address the knowledge and role model void that our survey data highlighted (see page 8); it has not necessarily been designed in a way that specifically appeals to females. This is reinforced by the pre- and post-intervention questionnaire responses following Interventions 1 and 2 (pages 28–29), which showed that males also responded favourably to the activities. Therefore, we believe that the approach will be impactful in raising awareness of Mechanical Engineering or any of the other Engineering disciplines to other under-represented demographics within the HE Engineering sector. You would only need to consider ensuring that the make-up of the outreach team and any supporting material provided around the creative writing competition provide suitable examples of role models in the targeted under-represented demographic group.

Final thoughts

We can reflect on the success at Swansea University since the inception of the 50% for the Future project in 2021/22. We have seen an increase in the female first-year intake for Mechanical Engineering to 14.9% in 2024/25, which compares favourably with the average female representation in Mechanical Engineering degrees in the UK in the 2024/25 entry, which was 10% (www.engineeringuk.com/research-and-insights/our-research-and-evaluation-reports/engineering-and-technology-workforce-may-2025-update/).

With a wider embedding of this approach across HE institutions in the UK, through the proposed formation of the Regional 50% for the Future Outreach Hubs, there is the potential for a step increase in female representation in the typically more male-dominated Engineering disciplines and the possibility to widen that impact to other under-represented demographic groups within the sector. Filling the information and awareness void around engineering disciplines with accurate details, relevant examples, and suitable role models, all supported by more informed teachers at secondary and tertiary level, will enhance the appeal of engineering with all school-age children impacted by the Hybrid Outreach Approach, helping to diversify representation within UK-engineers that reflects wider society.

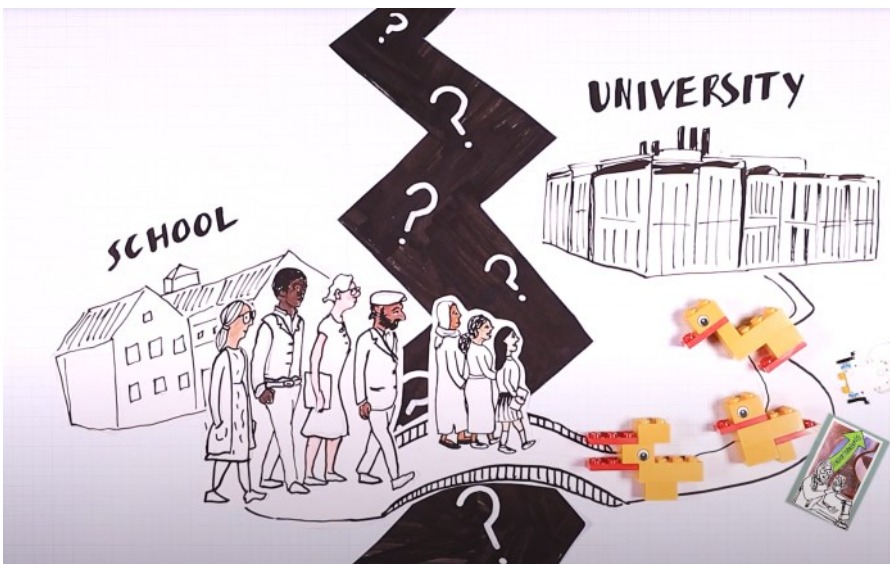


Figure 42: Crossing the knowledge void. An image from our animation.

Appendix 1: 50% for the Future undergraduate survey

This questionnaire aims to find out more information about the three problems outlined on page 3. We use the findings from the Problem 1 questions to inform the hybrid outreach development. The full questionnaire might be helpful in discovering the experiences and intentions of your undergraduates.

Problem 1 – Why am I Studying Mechanical Engineering?

This Section of the Survey is helping to establish information to remedy our Problem 1; misconception of Mechanical Engineering, preventing its selection as a degree/career by females. By surveying a cohort of students already studying Mechanical Engineering, data will be attained to gain deeper understanding around the following:

- The age-range that students who selected Mechanical Engineering showed interest or intent to study or pursue it as a career.
- The motivating factors at key decision milestones i.e. pre-GCSE, pre-A-Level, pre-degree; in particular, discerning between internal and external motivating factors.
- With specific attention given to the effectiveness of outreach activities in the decision process.
- Difference in preference for applications (i.e. industrial sectors) of Mechanical Engineering.

Utilising the quantitative and qualitative data from the responses, with particular focus on any gender divide in the responses; it is the intention to devise a more impactful, timely and gender sensitive outreach/ education campaign around Mechanical Engineering.

Question 1.1

How old were you when you first became interested in Engineering/Mechanical Engineering as a topic/ potential career? Age = _____ (could also accept an age range)

Question 1.2

For each of the following parts i, ii & iii; please score each statement from 0 to 5; with 0 being of no influence/ not relevant and 5 being of great influence/critical in decision making:

(i) What/who most influenced your selection of GCSE subjects?

- ☐ You knew you wanted to be a Mechanical Engineer
- ☐ You knew you wanted a job in STEM
- ☐ You wanted a job with high salary/earning potential
- ☐ You wanted a job which would have a positive impact on society/environment
- ☐ Your friend/peers
- ☐ Your teacher(s) *if score above 2 please state which subject this/these teacher(s) taught?*

-
- ☐ Your parent(s)
 - ☐ Your career advisor
 - ☐ You just enjoyed/good at studying the topics
 - ☐ You don't know

Please add any other not listed and score:

(ii) What/who most influenced your selection of A-Level subjects?

- ☐ You knew you wanted to be a Mechanical Engineer
- ☐ You knew you wanted a job in STEM
- ☐ You wanted a job with high salary/earning potential
- ☐ You wanted a job which would have a positive impact on society/environment
- ☐ Your friend/peers
- ☐ Your teacher(s) *if score above 2 please state which subject this/these teacher(s) taught?*

-
- ☐ Your parent(s)
 - ☐ Your career advisor
 - ☐ You just enjoyed/good at studying the topics
 - ☐ You don't know

Please add any other not listed and score.

(iii) What/who most influenced your decision to study for a degree in Mechanical Engineering?

- ☐ You wanted a job with high salary/earning potential
- ☐ You wanted a job with prestige
- ☐ You wanted a job which would have a positive impact on society/environment
- ☐ Your friend/peers
- ☐ Your teacher(s) *if score above 2 please state which subject this/these teacher(s) taught?*

-
- ☐ Your parent(s)
 - ☐ Your career advisor
 - ☐ You thought you'd excel at/enjoy it
 - ☐ You don't know?

Please add any other not listed and score.

Question 1.3

(i) Did you participate in any outreach activities before selecting your degree?

If yes, score its effectiveness out of 10 and briefly describe the activity. _____

(ii) Would you be interested in assisting in outreach activities to promote Mechanical Engineering?

Please tick appropriate Response: ☐ Yes ☐ No ☐ Unsure

Question 1.4

What Mechanical Engineering sector would you prefer to work in once graduated? Please rank in order of preference (1 most preferred to 10 least preferred):

- ☐ Renewable Energy
- ☐ Automotive
- ☐ Manufacturing
- ☐ Design
- ☐ Research

- ☐ Bio-medical
- ☐ Aerospace
- ☐ Defence
- ☐ Marine
- ☐ Robotics

Problem 2 – Now I’m studying Mechanical Engineering?

This section of the survey is helping to gain deeper awareness around Problem 2: we anticipate that our female students, as a minority, will be negatively impacted by the male-dominated learning environment. By surveying our Mechanical Engineering undergraduates, we will assess:

- whether our curriculum is male-biased i.e. establish if our female students are impacted by a “hidden curriculum”;
- with, particular focus given to establishing any preference for type and form of learning/assessment activities; and, motivating factors behind study.
- The extent and frequency of discriminatory behaviour (towards female students).

By quantifying and better qualifying the issues and by using follow-on Focus Group Session to dig deeper into identified problems, it will be possible to develop targeted interventions in teaching approach and curriculum content to ensure gender-sensitivity. Suitable approaches will also be brought in, to better educate around problematic discriminatory behaviour and a more robust reporting and support system can be developed.

Question 2.1

Please score the following degree-related activities in terms of personal preference/enjoyment of activity. Score each from 1 to 5; with 1 being the lowest preference of subject and 5 being the highest preference of subject:

- ☐ creative problem-solving
- ☐ design and prototyping
- ☐ simulation
- ☐ CAD
- ☐ solving mathematical problems
- ☐ group work
- ☐ individual work
- ☐ open-book assessment
- ☐ closed-book assessment
- ☐ viva/presentations
- ☐ experimental work
- ☐ construction/fabrication
- ☐ 3D-printing
- ☐ Coding

Question 2.2

When I’m studying what motivates me is:

- ☐ gaining the knowledge, I know I’ll need for my future career
- ☐ achieving the highest mark possible
- ☐ outperforming my peers
- ☐ praise from lecturer/mentor
- ☐ awards/prizes
- ☐ recognition from my peers

Please score each from 1 to 5; with 1 being a non-motivating factor and 5 being a highly motivating factor.

Question 2.3

Give yourself a mark out of 100 for your performance/abilities as a Mechanical Engineer: _____

Question 2.4

In your experience do you prefer to work in a team that is, not including yourself:

- ☐ All male;
- ☐ All female;
- ☐ Balanced between all genders;
- ☐ Have no preference.

Please score accordingly from 1 to 5; with 1 being least preferred and 5 being most preferred? If you have scored something 2 or lower could you briefly explain why? (please do NOT name any individuals in your explanation)

Question 2.5

Have you ever had to adapt your personality/behaviour to fit-in when studying at Swansea University? ☐ Yes

☐ No

If Yes, provide details (please, do NOT name any individuals in your answer).

Question 2.6

During my studies at Swansea University I feel I am treated equally/fairly by (answer Yes/No for each):

Peers ☐ Yes ☐ No

Lecturers ☐ Yes ☐ No

Mentors ☐ Yes ☐ No

Administrative staff ☐ Yes ☐ No

Technicians ☐ Yes ☐ No

Other (please specify) _____ ☐ Yes ☐ No

Question 2.7

Whilst studying at Swansea University or whilst on an industrial placement, considering your own experiences of discriminatory behaviour and/or language (e.g. you've been unfairly treated or excluded), please tick the appropriate description:

- ☐ I have both witnessed and experienced;
- ☐ I have witnessed but not experienced;
- ☐ I have experienced but not witnessed;
- ☐ I have neither witnessed nor experienced.

If you did not tick the fourth statement, then was your selection of experienced and/or witnessed behaviour (please tick one):

- ☐ A regular occurrence
- ☐ An infrequent occurrence
- ☐ A one-off

If you feel able to, please could you provide some details with regards to the behaviours experienced/witnessed; do NOT mention the name of any individuals.

Appendix 2: Focus group session

Opening remarks for Focus Group sessions

The lead researcher/interviewer will:

- introduce themselves and the other research team members in attendance
- thank the participants for agreeing to take part in the focus group
- go over the purpose of the focus group and answer any questions
- discuss the audio recording of the focus group and confirm that participants are still happy with being recorded and transcribed by a third-party provider
- discuss confidentiality and set ground rules and discuss how their data will be used and stored – including providing each participant with their pseudonym (pseudonym name tags will be handed out)
- advise participants that they are free to leave the focus group at any time; or ask for the recording to be paused
- provide signposting information for the University's Bullying and Harassment policies, and Support and Wellbeing services
- go through the consent form and confirm all participants have signed and submitted their Participant Consent Form before beginning the session

Focus Group 1: Decision Making and Motivating Factors for females studying Mechanical Engineering

Aims of focus group 1

The aim of this focus group is to develop insight of the decision-making process and motivations of females studying Mechanical Engineering at HE-Level; specifically, from the 50% for the Future survey results it appears that females are more influenced by internal motivating factors as opposed to their male counterparts, who rely more on external influences.

Topics for discussion

The following have been identified as areas of interest from the 50% for the Future survey results and will be discussed in the focus group. There will be scope for participants to discuss issues they feel are pertinent and relate to the main topics for discussion.

1. What is the internalised decision-making process that females undergo in their path to a degree in Mechanical Engineering?
 - a) Reflect on what it is that you wanted/want out of a career?
 - b) What was it particularly about Mechanical Engineering that appealed/appeals to you?
 - c) When you look to your future career what do you actually see yourself doing?
 - d) Has your viewpoint/perception of Mechanical Engineering changed since you started your degree?
2. Motivating factors for females when they study/prepare for a career?
 - a) What do you define as success in your study?
 - b) What would you define as success in your future career?
 - c) What do you think we could do with the course that would further motivate you?
3. The importance of Mentoring for you?
 - a) What do you think about the current Mentoring System?
 - b) Could you suggest how it could be improved, for example peer-to-peer mentoring?

4. The importance of Role Models for you?
 - a) What do you think about Role Models?
 - b) What do you see as the benefits of having a Role Model?
 - c) What makes a good Role Model?
 - d) Do you think there are Role Models for women in Mechanical Engineering generally?
 - e) Do you think there are Role Models for women in Mechanical Engineering at Swansea University?

Focus Group 2: Addressing the Culture within Mechanical Engineering

Aims of focus group 2

The aim of this focus group is to develop insight into the problems that females experience whilst studying in the dominant masculine culture of Mechanical Engineering. In particular, the 50% for the future survey results highlighted issues around Group Work and incidences of witnessing/experiencing inappropriate behaviour that need to be further discussed. Additionally, we would like to establish if the experiences that females have whilst studying in the HE-environment contribute/exacerbate the idea that their sex will be a barrier to their future success in the workplace?

Topics for discussion

The following have been identified as areas of interest from the 50% for the Future survey results and will be discussed in the focus group. There will be scope for participants to discuss issues they feel are pertinent and relate to the main topics for discussion.

1. Group work is a fundamental aspect of your degree, can we discuss your experiences of group work?
 - a) Do you feel that you are able to reach your full potential in group work i.e. be creative, innovative, etc.?
 - b) When you've worked in a mainly male v's mainly female group was there a difference in the quality of the work or productivity, of the group?
 - c) Have you ever had any negative/unpleasant experiences when working in a group?
How do you think we could improve the group work process for you i.e. composition of group? Types of tasks/problems set?
2. There are challenges to studying/working in an environment when you are the minority – can we discuss your experience of this and ideas for how things could be improved?
 - a) Can we talk about negative experiences/incidences that you've experienced whilst studying or on your placement year that you believe happened to you because of your sex?
 - b) Do you feel equipped to know how to handle these types of incidents?
 - c) How do you think we could improve things within the Department of Mechanical Engineering to:
 - (i) Improve the culture/environment
 - (ii) Better equip you to cope with such behaviours/incidences.
3. From the survey responses it seems that you believe your sex/gender will be a barrier to your success in the workplace, can we discuss this?
 - a) Firstly, what do you think generally are barriers to your future success?
 - b) What is it about being female do you think is going to affect your success in the workplace?
 - c) How can we overcome this attitude/feeling?

Appendix 3: World Café event to devise outreach activities

PART 1: Devise a specific Outreach Activity

Consider the following (@ that age):

- The hobbies you enjoyed?
- Topic areas you enjoyed?
- Did you prefer to work alone or in a group?
- Your attention span!
- What activities did/didn't work for you?

Specify the following in your idea:

- Target age category (Primary/Secondary – early/GCSE/A-Level)
- Level of accessibility
- Cost
- Level of teacher or university involvement needed
- Duration (happens in-School/After School?)
- The diversity of appeal
- Socioeconomically inclusive?

When you're devising your Outreach Activity you need to think carefully about how you're addressing the Misconception of Mechanical Engineering.

PART 2: What role/how much of a role do you think undergraduate students should play in the Department's Outreach Activities...?

For example...

- Do you envisage running activities?
- Helping to deliver during term or outside of term?
- Being a part of a paid outreach team?
- Not your responsibility

Appendix 4: 50% for the Future Educator Survey

Introduction

The information in the “Participant Information Sheet” Version 1.1 dated 31/05/23 (as uploaded along with this document), will provide an introduction and background to the project, as well as full details around GDPR; all of that content in pdf format will be given in the email invite along with the hyperlink to the Questionnaire, as well as embedded at the start of the Questionnaire.

The Online Surveys platform will be used.

Consent statement

Please refer to the Participant Consent Form V1.1, dated 31/05/23 uploaded along with this document, which demonstrates how the request for consent will be sought. The consent form will be embedded at the end of the Questionnaire, prior to the point of submission.

Question 1

In your own words, briefly describe (1-2 sentences) what you think Mechanical Engineering is/involves?

Question 2

(a) How often have you recommended/suggested the following as options for future careers for your STEM-capable male students? *(Score 0 to 5 with: 0 – never/discourage; 1 – very occasionally; 2 – occasionally; 3 – often; 4 – very often; 5- regularly/actively encourage)*

- ☐ Engineering (generally)
- ☐ Mechanical Engineering
- ☐ Civil Engineering
- ☐ Electrical/Electronic Engineering
- ☐ Chemical Engineering
- ☐ Aeronautical/Aerospace Engineering
- ☐ Medicine/Medical professions
- ☐ Law
- ☐ Maths (Statistician, etc.)
- ☐ Physicist
- ☐ Chemist
- ☐ Accountant
- ☐ Arts/Humanities
- ☐ Languages

(b) How often have you recommended/suggested the following as options for future careers for your STEM-capable female students? *(Score 0 to 5 with: 0 – never/discourage; 1 – very occasionally; 2 – occasionally; 3 – often; 4 – very often; 5- regularly/actively encourage)*

- ☐ Engineering (generally)
- ☐ Mechanical Engineering
- ☐ Civil Engineering
- ☐ Electrical/Electronic Engineering
- ☐ Chemical Engineering

- ___ Aeronautical/Aerospace Engineering
- ___ Medicine/Medical professions
- ___ Law
- ___ Maths (Statistician, etc.)
- ___ Physicist
- ___ Chemist
- ___ Accountant
- ___ Arts/Humanities
- ___ Languages

Please provide free-text comments about your scores; particularly consider your motivations/reasoning for scores around the Engineering-based careers.

- (c) Would you/have you actively encourage(d) students to go into Engineering (who have shown an interest), regardless of their academic ability in STEM-based subjects? ☐ Yes ☐ No
Please provide further details around your response:

Question 3

- (a) Which of these subjects do you consider as a potential deterrent/barrier to male students pursuing a career in Engineering? (Please score 0 to 5; 0 is none; 1 – very little, to 5 - very much)
- ___ Physics
 - ___ Maths
 - ___ D&T
- (b) Which of these subjects do you consider as a potential deterrent/barrier to female students pursuing a career in Engineering? (Please score 0 to 5; 0 is none; 1 – very little to 5 - very much)
- ___ Physics
 - ___ Maths
 - ___ D&T

Please provide any further thoughts around your scores:

Question 4

- (a) How comfortable based on your awareness/knowledge, would you be in discussing the following subject areas as part of your teaching? (please score 0 to 5: 0 – not at all/not relevant; 1 – very slightly; 2 – slightly; 3 – quite; 4 – very; 5 – extremely/already do this)
- ___ Engineering in a wider context
 - ___ Mechanical Engineering specifically
- (b) How interested are you to discuss the following subject areas as part of your teaching? (please score 0 to 5: 0 – not at all/not interested; 1 – very slightly; 2 – slightly; 3 – quite; 4 – very; 5 – extremely and do already do this)

- ☐ Engineering in a wider context
- ☐ Mechanical Engineering specifically

Please provide any further thoughts around your scores:

Question 5

If we were to run outreach activities with your School/College, what do you think would work best? *Please score the following options from 0 to 5 (0 – wouldn't work/not suitable; 1=least preferred to 5=most preferred)*

(a) Length/frequency of Session

- ☐ Short, one-off, during term time – School day
- ☐ Short, regular, during term-time – School day
- ☐ Short, one-off, afterschool session
- ☐ Short, regular, afterschool session
- ☐ Summer/half-term School

For your most preferred approach(es), please provide further details/suggestions i.e. how regularly, time of year, duration, etc.:

(b) Year groups to target for most impact w.r.t career selection

- ☐ Y7–Y9
- ☐ Y10–Y11
- ☐ Y12–Y13

Any further comment/details:

(c) Location

- ☐ On Swansea Uni Campus
- ☐ At your school/college
- ☐ At another location (please specify below)

Any further comment/details:

(d) Level of participation required from yourself

- ☐ None
- ☐ Some
- ☐ Moderate
- ☐ High

Any further comment/details:

Please provide any specific suggestions for Outreach Activities that you know work or would like to see for the promotion of Engineering/STEM:

Question 6

If we were to develop and run an annual event which helped to highlight developments in Mechanical Engineering/Engineering, with ideas for how it could be incorporated into the Secondary/Tertiary Education environment, to raise awareness and support career advice, would you be interested in attending such an event? (please select)

☐ Yes ☐ No

Please provide any suggestions or issues that you would like us to consider in developing such an event:

Demographic Questions

Age category:

- ☐ 21–29;
- ☐ 30–39;
- ☐ 40–49;
- ☐ 50–59;
- ☐ 60 and over.

Sex:

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to say

Age-range you typically teach:

- ☐ Year 7–9
- ☐ Year 10–11
- ☐ Year 12–13
- ☐ Year 13+

Subjects you typically teach: (free-text response)

School/College name: (free-text response)

Appendix 5: Sample consent form text and information sheet

(These Questions are embedded into the Final Questionnaire on Online Survey platform)

(Version number ____, Date: __/__/__)

Project Title: 50% for the Future: securing a gender balanced future for the profession of Mechanical Engineering.

Contact Details:

The contact details of the main researcher:

Please initial box

I confirm that I have read and understood the Participant Information
(dated __/__/__ version number __) for this Questionnaire and have
had the opportunity to ask questions.

☐

I understand that the participation of my Child is voluntary and that I am free
to withdraw the participation of my Child (prior to completion of the Questionnaire)
at any time, without giving any reason, without any repercussions.

☐

Please note; once a Questionnaire has been submitted it will not be possible to
withdraw, as the Questionnaire submissions are anonymous.

I understand that sections of any of data obtained from the Questionnaire
responses may be looked at by responsible individuals from Swansea University or
from regulatory authorities where it is relevant. I give permission for this.

☐

I understand that data acquired from the Questionnaires may be used in reports
and academic publications in anonymous fashion.

☐

I agree for my child to take part in the above Project study.

☐

Date _____

Signed _____

Relationship to Child _____

Parent/Guardian Information Sheet

We would like to invite your child to take part in a research project which is trying to understand and address why so few females undertake Mechanical Engineering as a degree/career; the project is run by Swansea University. Before you decide whether you would like your child to take part, please take the time to read the following information.

If you would NOT like your child to participate, please complete the Opt-Out Form [link to online form]
Otherwise, if you are happy for your child to take part, you do not need to do anything.

PARENT INFORMATION SHEET

(Version __, Date __/__/____)

Project Title: _____

Contact Details: _____

1. Invitation Paragraph

In January of 2022 the Department of Mechanical Engineering at Swansea University secured a grant from the Royal Academy of Engineering to develop a Strategy that will address the current, below National Average representation of females on its undergraduate Mechanical Engineering degree course.

We are seeking participation of your Child to help us in developing Outreach Activities to promote Mechanical Engineering.

We will be undertaking various Outreach Activities related to Mechanical Engineering at a number of Local Schools; asking the participating students to undertake a brief anonymous Questionnaire (~5 minutes in duration) before and after the Outreach Activity, so that we can assess its effectiveness.

The same questionnaire will be used both before and after the outreach activity. If you would like to see the questionnaires, they can be found here:

- Pre activity: Link to online copy of questionnaire to be embedded.
- Post activity: Link to online copy of questionnaire to be embedded.

The findings from the Questionnaires will allow us to prove that Outreach activities of the formats tested work in appealing to all Children, regardless of sex.

2. What is the purpose of the study?

Currently, the Department of Mechanical Engineering's cohort consists of only 8.8% females; this is below the (already low) National average of ~12%. Engineers develop solutions to the problems of Society; therefore, it is essential that the demographic of trained engineers reflect the society that they work for. We are undertaking a study to gain deeper understanding around three problem areas in the journey to becoming a successful Mechanical Engineer (outlined below), around which we will develop an intervention-based Strategy.

The 3 Problems:

1. **“The Before”** - What are the motivating factors around the selection of STEM subjects, and subsequently *Mechanical Engineering*? *We need to improve our understanding of this and more generally the difference in perceptions around Mechanical Engineering for males versus females.*
2. **“The Now”** - Whilst our female students are a minority, they will be presented with barriers to their success and motivation whilst studying; we need to establish how we can reduce the negative impact of a male-dominated learning environment?
3. **“The Future”** – How can we better support our female students in their future career aspirations to mitigate against the “leaky pipeline” effect?

We require assistance in addressing our Problem 1: “The Before”. We are seeking to develop suitably engaging Outreach Activities that appeal to all Children and consequently we require the feedback (via Questionnaire responses) of participating Children.

The findings from this work will be included in the final Strategy report, with the hope that a Nationalised approach for Engineering-focussed Outreach will be developed with the support of the Institute of Mechanical Engineers (IMechE) and the Royal Academy of Engineers. We will also be writing research journal publications based on the results. Please be assured that all information reported will be anonymous.

3. Why has my Child been chosen?

All of the children in your child’s class, including your child, have been invited to test our Outreach Activities, which will be undertaken by Secondary School children in selected Schools in South Wales. Participation is voluntary, and you can withdraw your child from participating in activity at any point, with no penalty. Additionally, if your child does not feel happy about anything that they are asked to do, they can stop at any time, without fear of penalty, and will be informed of this throughout the session. However, as the Questionnaire is anonymous, once a Questionnaire has been completed and submitted, we would not be able to extract it from the dataset.

4. What will happen to your Child if they take part?

- We will arrange to undertake the Outreach Activity with your Child’s School at a convenient time to ensure there is no disruption of teaching.
- Any activity will be undertaken at your Child’s School; or, at Swansea University, Bay Campus (as a trip supervised by School Staff).
- Transportation between the Bay Campus and your Child’s School will be provided.
- The activity will be undertaken under the supervision of Swansea University Staff, trained Swansea University undergraduate Mechanical Engineering students, **with appropriate School staff in attendance at all times.**
- Prior to undertaking the Activity, a short Questionnaire comprising of 3 questions (tick-selection) will be undertaken; data with regards the Sex, Age, and School of your Child will also be collected. No names of children will be recorded in the Questionnaire.
- An identical Questionnaire will be completed after the Activity to assess if the Child’s understanding and interest in Mechanical Engineering has improved.
- There will be members of the team and teachers present to assist your child in completing the online questionnaires, which should take no longer than 5 minutes.
- A responsible adult from the Children’s school will have provided consent for the School to participate in the activity and our research, prior to any child being allowed to undertake the questionnaires.

- If you are happy for your child to undertake the outreach activities and for them to complete both questionnaires, you do not need to do anything. If you would like to **withdraw your child** from the study, please fill in the **Opt-Out Form**.

5. What are the possible disadvantages of taking part?

There are no obvious disadvantages to participation.

6. What are the possible benefits of taking part?

The questions we ask of your child will allow them to reflect on their viewpoint of Mechanical Engineering, potentially opening their eyes to the suitability of this as a career/job. Additionally, the children will be participating in an enjoyable, challenging and rewarding Outreach Activity. We will provide an overview of the Final Strategy developed from this work to your child's School, if it is of interest to you.

7. Will my Child's participation in the study be kept confidential?

The Questionnaire that your Child completes will be anonymous. The school's name will be captured in the data, but these specific names will not be included in the final publications/reports. Only approved members of the research team will have access to the data (which will be well-protected). The procedures for handling, processing, storage and destruction of data will be compliant with the Data Protection Act (1998) and Swansea University Guidelines – see details around Data Protection and Confidentiality on the next page.

8. What if I have any questions?

Any further information that you require about this project can be obtained from _____ . This project has been approved by the Research Ethics Committee at Swansea University. If you have any questions regarding this, any complaint, or concerns about the ethics and governance of this research please contact the Chair of the Research Ethics Committee, Swansea University. The institutional contact for reporting cases of research conduct is _____ .

Data Protection and Confidentiality

Your data will be processed in accordance with the Data Protection Act 2018 and the General Data Protection Regulation 2016 (GDPR). All information collected about you will be kept strictly confidential. The raw data will only be viewed by the researcher/research team. However, there is the intention to publish general findings from this study in research publications and a report will be prepared for the Royal Academy of Engineers who have sponsored this work via their Diversity Impact Programme. However, any data published will be anonymous.

All electronic data will be stored on a Swansea University password-protected computer.

Please note that the data we will collect for our study will be anonymous, your survey responses will not be associated with either your name or student number at completion of the Survey, thus it will not be possible to identify and remove your data at a later date, should you decide to withdraw from the study.

Please note that as your data is being collected online (via the Questionnaire), once the data has been submitted online you will be unable to withdraw your information.

Data Protection Privacy Notice

The data controller for this project will be Swansea University. The University Data Protection Officer provides oversight of university activities involving the processing of personal data and can be contacted at the Vice Chancellor's Office.

Your personal data will be processed for the purposes outlined in this information sheet.

Standard ethical procedures will involve you providing your consent to participate in this study by completing the consent form that has been provided to you.

The legal basis that we will rely on to process your personal data will be processing is necessary for the performance of a task carried out in the public interest. This public interest justification is approved by the Research Ethics Committee, Swansea University.

The legal basis that we will rely on to process special categories of data will be processing is necessary for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes.

How long will your information be held?

We will hold any personal data and special categories of data for up to 10 years to allow for repeated undertakings of the Survey, developing a Longitudinal study around changes in the landscape of females studying Mechanical Engineering.

What are your rights?

You have a right to access your personal information, to object to the processing of your personal information, to rectify, to erase, to restrict and to port your personal information. Please visit the University Data Protection webpages for further information in relation to your rights.

Any requests or objections should be made in writing to the University Data Protection Officer:

How to make a complaint?

If you are unhappy with the way in which your personal data has been processed, you may in the first instance contact the University Data Protection Officer using the contact details above.

If you remain dissatisfied, then you have the right to apply directly to the Information Commissioner for a decision. The Information Commissioner can be contacted at: -

Information Commissioner's Office,
Wycliffe House,
Water Lane,
Wilmslow,
Cheshire,
SK9 5AF
www.ico.org.uk

Appendix 6: Pre- and post-intervention questionnaires for Outreach Interventions 1 and 2

Pre-intervention questionnaire

Consent

I have read the Student Information Sheet and understand that my participation is voluntary, and I can withdraw at any point without penalty. However, I'm aware that as the questionnaire is anonymous, once I have submitted my response, this cannot be extracted from the dataset.

☐ I confirm

I am happy for the 50% For the Future project to use my questionnaire responses as part of their research.

☐ I confirm

Questionnaire

Please complete this questionnaire before participating in the activity.

Sex ☐ Male Age _____
☐ Female
☐ Other School _____
☐ Prefer not to say

Please select the option you feel most applies to you for each of these questions.

Question 1 – I understand what Mechanical Engineering is:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 2 – I have a positive opinion of Mechanical Engineering:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 3 – I am interested in pursuing Mechanical Engineering,

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Thank you so much for taking the time to complete this questionnaire!

If you have any questions about what will happen to your responses from this questionnaire then please contact 50%forthefuture@gmail.com. You can also see the [50% for the Future](#) website.

Post-intervention questionnaire

Consent

I have read the Student Information Sheet and understand that my participation is voluntary, and I can withdraw at any point without penalty. However, I'm aware that as the questionnaire is anonymous, once I have submitted my response, this cannot be extracted from the dataset.

☐ I confirm

I am happy for the 50% For the Future project to use my questionnaire responses as part of their research.

☐ I confirm

Questionnaire

Please complete this questionnaire before participating in the activity.

Sex ☐ Male ☐ Female ☐ Other ☐ Prefer not to say

Age _____

School _____

Please select the option you feel most applies to you for each of these questions.

Question 1 – I have participated in the following outreach activities recently (please tick any which apply):

- ☐ A 50% for the Future LEGO® Education Workshop Session.
- ☐ Researched and submitted an entry for the 50% for the Future Creative Writing Competition.

Question 2 – I understand what Mechanical Engineering is:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 3 – I have a positive opinion of Mechanical Engineering:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 4 – I am interested in pursuing Mechanical Engineering,

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

If you ticked **both of the options for Question 1**, then please answer the below Question 5:

Question 5 – Please answer all the parts of this question, for each part only tick one option:

- (a) Which of the activities did you find most enjoyable:
- ☐ 50% for the Future LEGO® Education Session.
 - ☐ 50% for the Future Creative Writing Competition.
- (b) Which of the activities did you find most improved your understanding of Mechanical Engineering:
- ☐ 50% for the Future LEGO® Education Session.
 - ☐ 50% for the Future Creative Writing Competition.
- (c) Which of the activities did you find most improved your opinion of Mechanical Engineering:
- ☐ 50% for the Future LEGO® Education Session.
 - ☐ 50% for the Future Creative Writing Competition.
- (d) Which of the activities did you find most increased your interest in pursuing Mechanical Engineering as a future career:
- ☐ 50% for the Future LEGO® Education Session.
 - ☐ 50% for the Future Creative Writing Competition.

Thank you so much for taking the time to complete this questionnaire!

If you have any questions about what will happen to your responses from this questionnaire then please contact 50%forthefuture@gmail.com. You can also see the [50% for the Future](#) website.

Appendix 7: Pre- and post-intervention questionnaires for Outreach Intervention 3

Pre-intervention questionnaire

Consent

I have read the Student Information Sheet and understand that my participation is voluntary, and I can withdraw at any point without penalty. However, I'm aware that as the questionnaire is anonymous, once I have submitted my response, this cannot be extracted from the dataset.

☐ I confirm

I am happy for the 50% For the Future project to use my questionnaire responses as part of their research.

☐ I confirm

Questionnaire

Please complete this questionnaire before participating in the activity.

Sex	☐ Male	Age	_____
	☐ Female		
	☐ Other	School	_____
	☐ Prefer not to say		
Age	☐ 20–29		
	☐ 30–39		
	☐ 40–49		
	☐ 50–59		
	☐ 60 and above		

Please select the option you feel most applies to you for each of these questions.

Question 1 – I have a good understanding of what Mechanical Engineering is and involves as a career:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 2 – I have a positive opinion of mechanical engineering, and am likely to recommend as a career to my students,

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 3 – I feel confident to discuss or bring into my teaching information/aspects of mechanical engineering,

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Thank you so much for taking the time to complete this questionnaire!

If you have any questions about what will happen to your responses from this questionnaire and/or the next steps for the project then please contact 50%fortheFuture@gmail.com. You can view the 50% for the Future website here: <https://www.swansea.ac.uk/mechanical/gender-balance-strategy/>

Post-intervention questionnaire

Consent

I have read the Student Information Sheet and understand that my participation is voluntary, and I can withdraw at any point without penalty. However, I'm aware that as the questionnaire is anonymous, once I have submitted my response, this cannot be extracted from the dataset.

☐ I confirm

I am happy for the 50% For the Future project to use my questionnaire responses as part of their research.

☐ I confirm

Questionnaire

Please complete this questionnaire before participating in the activity.

Sex ☐ Male ☐ Female ☐ Other ☐ Prefer not to say

Age _____

School _____

Age ☐ 20–29 ☐ 30–39 ☐ 40–49 ☐ 50–59 ☐ 60 and above

Please select the option you feel most applies to you for each of these questions.

Question 1 – I have a good understanding of what Mechanical Engineering is and involves as a career:

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 2 – I have a positive opinion of mechanical engineering, and am likely to recommend as a career to my students,

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 3 – I feel confident to discuss or bring into my teaching information/aspects of mechanical engineering,

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neither agree/disagree
- ☐ Disagree
- ☐ Strongly Disagree

Question 4 – General comments. If you have any comments/feedback about today's event and the impact it has had on you, please provide them here:

Thank you so much for taking the time to complete this questionnaire!

If you have any questions about what will happen to your responses from this questionnaire and/or the next steps for the project then please contact 50%forthefuture@gmail.com. You can view the 50% for the Future website here: <https://www.swansea.ac.uk/mechanical/gender-balance-strategy/>

Appendix 8: Creative Writing Competition

This is the text we distributed to schools for the Creative Writing Competition intervention.

**50% for the Future's Creative Writing Competition is now open for submissions
and will run until Friday 1 December 2023**

“Mechanical Engineering Through My Eyes...”

*Write a short story (fiction/non-fiction), a poem, a leaflet,
or a poster using the above title.*

Be as creative or inventive as you want!!!

There are two age categories for submissions: **11–13 years** and **14–16 years**.

2 AMAZING prizes for each age category!!

1st prize = VR Headset & Games

2nd prize = 3D Printer

Children of all abilities are encouraged to use their creativity and imagination to produce a piece of creative writing titled **“Mechanical Engineering Through My Eyes ...”**. The important thing is that you think about and look into what Mechanical Engineers do. We don't want you to worry about spelling, punctuation or grammar – just do your best!

All submissions **must**:

- Be written submissions of 500–1000 words (title not included in the word count), or, if you are creating a leaflet or poster, you can use pictures or drawings but there must be plenty of written text also;
- Be written by an individual, not as a group;
- Be your own idea and work ...

Your submission **must not**:

- Give any personal details about yourself/friends/family.

How to enter

The competition is now open for submissions, **until 18:00 on Friday 1 December 2023**.

All creative writing entries must be a digital document, so that your teacher can submit your entry on your behalf.

The winners and runners-up will be announced the week commencing 8 January 2024.

Why is this competition so important?

In January of 2022 the Department of Mechanical Engineering at Swansea University secured a grant from the Royal Academy of Engineering (RAEng) to develop a Strategy that will address the current below National Average representation of females on its undergraduate Mechanical Engineering degree course.

This competition aims to promote and raise awareness of Mechanical Engineering and address the misconception around the subject area, particularly with females. We want you to really think about and reflect on what a Mechanical Engineer does? How they have/do/will contribute to society? We want you to open your eyes to the world of Mechanical Engineering ...

Your submissions to the competition will help us to better understand your perception and ideas of what Mechanical Engineering is.

It is our intention to run this competition every year, to see how your perceptions and ideas change and develop over time. We are so excited to see your submissions this year!

FAQ's

When is the competition open?

The competition is now open and online story submissions will close at 6pm on Friday 1 December 2023.

If I write a story how long should it be?

Your fiction stories or non-fiction essays should have somewhere between 500 to 1000 words. If your submission has a word count a lot higher than 1000 then we will unfortunately have to disqualify your entry.

Do I have to write a story/essay?

We want you to be as creative as you like – so, no, you can also write a poem, or design a leaflet or poster... whatever you prefer.

How did you decide the two age categories (11–13 and 14–16)?

We carried out a survey with our Mechanical Engineering Students at Swansea University. The findings from this, told us that our students started to first become interested in Engineering from the age of ~13 and specifically in Mechanical Engineering around the age of 16. Therefore, we want you to start thinking a bit more about Mechanical Engineering before the age of 13, through to 16.

Why is spelling, punctuation and grammar not important to us for this creative writing competition?

We are keen that children of all abilities should be able to enter our competition, without the added pressure of spelling, punctuation and grammar. This is an opportunity to celebrate your creativity whilst getting you thinking about Mechanical Engineering.

Who are the judges?

Mechanical Engineering professionals at Swansea University will be judging the competition; we may also ask for some advice/opinions from teachers in your school.

Are submissions checked for AI?

All submissions must be the original work of the entrant and must not infringe the rights of any other party. In addition, the use of generative AI tools to create any part of the entry is not permitted and will lead to disqualification.

Can the submissions be written in Welsh?

Yes

How do I submit my work?

Your teacher will help you submit your entry

When will judging take place?

We will be reading your submissions and choosing a winner throughout the month of December 2023. Then the winner will be announced in the week commencing 8th January 2024 i.e. when you're back in School after the Christmas break.

What are the prizes?

Each age category will have a 1st and 2nd place prize.

1st prize = VR Headset and Games

2nd prize = 3D Printer

We have selected these prizes to encourage you to practice and develop skills around Mechanical Engineering, which we hope will further spark your interest in the subject.

Scoring rubric

This is the scoring rubric our panel used.

Marks	Overall quality (10 marks)	Overall creativity (10 marks)	Evidence of research (Eng/Mech Eng)
0	No submission	No submission	No submission/no mention of Engineering
1–2.5	Very poor, difficult to read, very short, does not answer brief	Little creativity	Engineering/Mech Eng only briefly mentioned
3–5.5	Reasonable quality, some issues in reading sections but aspects answer brief	Reasonable level of creativity and imagination around the brief	Evidence of research and common examples included
6–7.5	Good quality, easy to read, makes sense and does a good job of answering the brief	Good level of creativity and imagination around the brief	Clear evidence of research and good examples of application
8–10	Excellent, reads well, clearly answers brief to high level	Excellent level of creativity and imagination, highly fulfils the brief	Excellent evidence of research and unique or lesser known information

Appendix 9: Resources

- **Royal Academy of Engineering**
raeng.org.uk/media/Opkn3epz/women-in-engineering.pdf
- **Institute of Mechanical Engineers**
www.imeche.org
- **Getech**
Supplier of technology to educational providers. Source for the LEGO® kits
www.getech.co.uk/lego/

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