

**PROFESS 12**



## **Project Report 5**

# **The PROFESS 12 Summer School - Evaluation**

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The PROFESS 12 Summer School - Evaluation

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## Project title note:

PROFESS 12 is the acronym for “PROFessional skills for Engineering students - Summer School to achieve SDG 12”. The project aims to develop Professional Skills in Engineering Students through an innovative and inclusive Summer School designed to equip students with the intercultural skills necessary to meet the SDGs.

## Glossary

<b>Acronym / Term</b>	<b>Meaning</b>
CF1	Conference paper 1
EI	Engineers Ireland
EU	European Union
GCSE	General Certificate of Secondary Education, an academic qualification taken by pupils in Northern Ireland
GIA	General Inductive Analysis
HEA	Higher Education Authority
HEI	Higher Education Institution
IStructE	Institution of Structural Engineers
ME1	Online multiplier event 1
MS	Microsoft (e.g. MS Forms, MS Teams, etc.)
NI	Northern Ireland
PPE	Personal Protective Equipment
PROFESS 12	PROFessional skills for Engineering students - Summer School to achieve SDG 12
R2	Report 2
SDG	Sustainable Development Goal
SEFI	European Society for Engineering Education
TUDublin	TU Dublin
UDL	Universal Design for Learning
UNESCO	United Nations Educational Scientific and Cultural Organization
UU	Ulster University
W2	Webinar 2
WP	Work Package

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## Executive Summary

This report outlines the evaluation of the summer school which was a key element of the PROFESS 12 project. The key steps involved in the 5-day summer school along with the method by which the feedback and the reflections of the participants of the summer school were collected is described here. Thereafter, the reflections received in the form of audio and text files are analysed and themes identified from the experience of the summer school participants are explained in detail. The survey responses from the feedback on the summer school participation are also shown graphically. This analysis helped us identify how the aims and objectives set for the summer school were met by evidence through the feedback obtained from the participants. The key areas that are covered in the feedback include but are not limited to Sustainable Development Goals (SDGs) and Sustainable Development, overall personal and professional development and increased awareness of the importance of diversity and inculcating intercultural skills. The significance that this experience can have on the future choices students make is also discussed.

Students thoroughly enjoyed the summer school, felt it was well organised and would recommend it to their fellow students. They felt the pace and mix of activities on the programme was about right. There is evidence that the majority of students felt that all of the learning outcomes had been met, but particularly noteworthy were the learning outcomes related to understanding the SDGs, SDG 12, the circular economy and aspects of working with students from diverse backgrounds and appreciating intercultural differences.

A thematic analysis of the student reflections revealed five key themes;

- students enjoyed the social interactions and working with diverse people,
- they improved their understanding of sustainable development and the SDGs,
- they achieved personal development in developing communication skills, social skills, leadership and time management along with experiencing a change of mindset in relation to their role in achieving sustainable development
- they became more aware of ethical business practices, financial considerations and social influences in relation to sustainable development
- they appreciated the impact of technology and the role of research and development in achieving sustainable development

The evaluation of the summer school provides evidence of its success and effectiveness in achieving the original aims of the PROFESS 12 project.

## Summary of Overall Research Project

The main purpose of the PROFESS 12 (PROFessional skills for Engineering students - Summer School to achieve SDG 12) project is to build on the global research work on skills requirements, to translate them to an Ireland-specific framework and to then design, trial and evaluate an innovative and inclusive Summer School to provide students with opportunities to develop these skills. The UNESCO (2017) framework, the Guidelines for the Design of Inclusive Engineering Programmes (Mills, Ayre and Gill, 2010) and the use of the “The Intercultural learning for Pupils and Teachers Toolbox” (<http://intercultural-learning.eu/>) will inspire the design of the School, which will be co-created with students from North and South with a focus on solutions for SDG 12 (Responsible Consumption and Production).

We have **four objectives** in this project:

- To prioritise the professional skills that engineers will need to meet the SDG goals and Government commitments to 2030.
- To compare and contrast stakeholder views on the importance of specific professional skills so that we may learn from each other through our diverse experiences and gender differences.
- To co-create and test an innovative and inclusive Summer School to help students develop the skills necessary to meet SDG 12.
- To better understand each other’s cultural backgrounds and to build mutually beneficial sustainable relationships that capitalise on the intercultural synergies between researchers, academics and students, North and South.

The project consortium has two academic partners (TU Dublin and Ulster University) and the objectives will be achieved through several work packages which are summarised in Figure 1 along with the Project Outputs.

### Work Package 1: Literature Review and Professional Skills Survey

First, we will identify engineering students’, academics’ and employers’ perceptions of the professional skills that engineers North and South need to meet the SDGs (WP1). Focusing on the seminal work of Wiek et al., (2011) and UNESCO (2017) coupled with the previous work completed by the project partners in the A-STEP 2030 project, we will review the relevant literature and distil the findings to compile a list of professional skills requirements. We will be mindful of selecting literature from both genders to ensure an unbiased view. We will use this list to create a survey to gather the views of the key stakeholders (employers, academics and students) in engineering education (North and South) to help us prioritise the key skills required.

### Work Package 2: Key stakeholder perceptions on priority skills

WP 1 sets the scene for skills requirements on a global scale: WP2 turns our focus to the Island of Ireland. Using the results of the survey, we will compare and contrast stakeholder views based on the local context North and South, the discipline and stakeholder view and also the gender specific perception (WP2). The **key aim of this Work Package** is to learn from each other, hence a detailed analysis of the survey differentiated by key perspectives will help us better understand the perceptions of each group.

### Work Package 3: The PROFESS Summer School – Lead: Ulster University (M11-M18)

WP3 will run in parallel with WP2 to meet the key milestones of the project and involves the design and trial of the PROFESS 12 Summer School. Based on the skills identified in WP1 and WP2, we will initially create a Briefing Document for the Summer School (R3 in M11).

The design of the PROFESS 12 Summer School will **be co-created with engineering students** from both Universities in two separate Multiplier Events (ME1 and ME2) in M13. We foresee these as a think tank where students will be encouraged to be creative and outrageous in their ideas surrounding the design of the Summer School.

The Summer School will take place **physically over five days** with a kick off session (in the border region, meeting half way) on 4<sup>th</sup> March 2023, to coincide with the World Engineering Day for Sustainable Development (Milestone). Students will undertake icebreaker activities, be introduced to the concepts of gender inclusivity, the SDGs, UDL, unconscious bias and the value in developing intercultural skills. We will then spend two days in the North and two days in the South and in addition to student centred classroom activities, we will include cultural trips and activities to help the students integrate.

### Work Package 4: Evaluation of the PROFESS Summer School

Finally, the impact of engaging students, researchers and academics in this Summer School will be evaluated in WP4. The evaluation has three aims. Firstly, through both qualitative (discussions) and quantitative measurements the effectiveness of the Summer School from the students' perspective can be assessed. Secondly, students will be asked to reflect on their experiences and to provide feed forward advice for the next iteration of the project at a European scale.

Thirdly, we also wish to acknowledge and reflect on the importance of an all-Ireland project such as this as a way to help collaboration between researchers, academics and Higher Education Institutions (HEIs), North and South. Hence we will also investigate how effective the project was in enhancing relationships between researchers and academics and the HEIs involved through the use of a focus group between the researchers involved. The findings of this collaborative effort will be presented in Report R6.



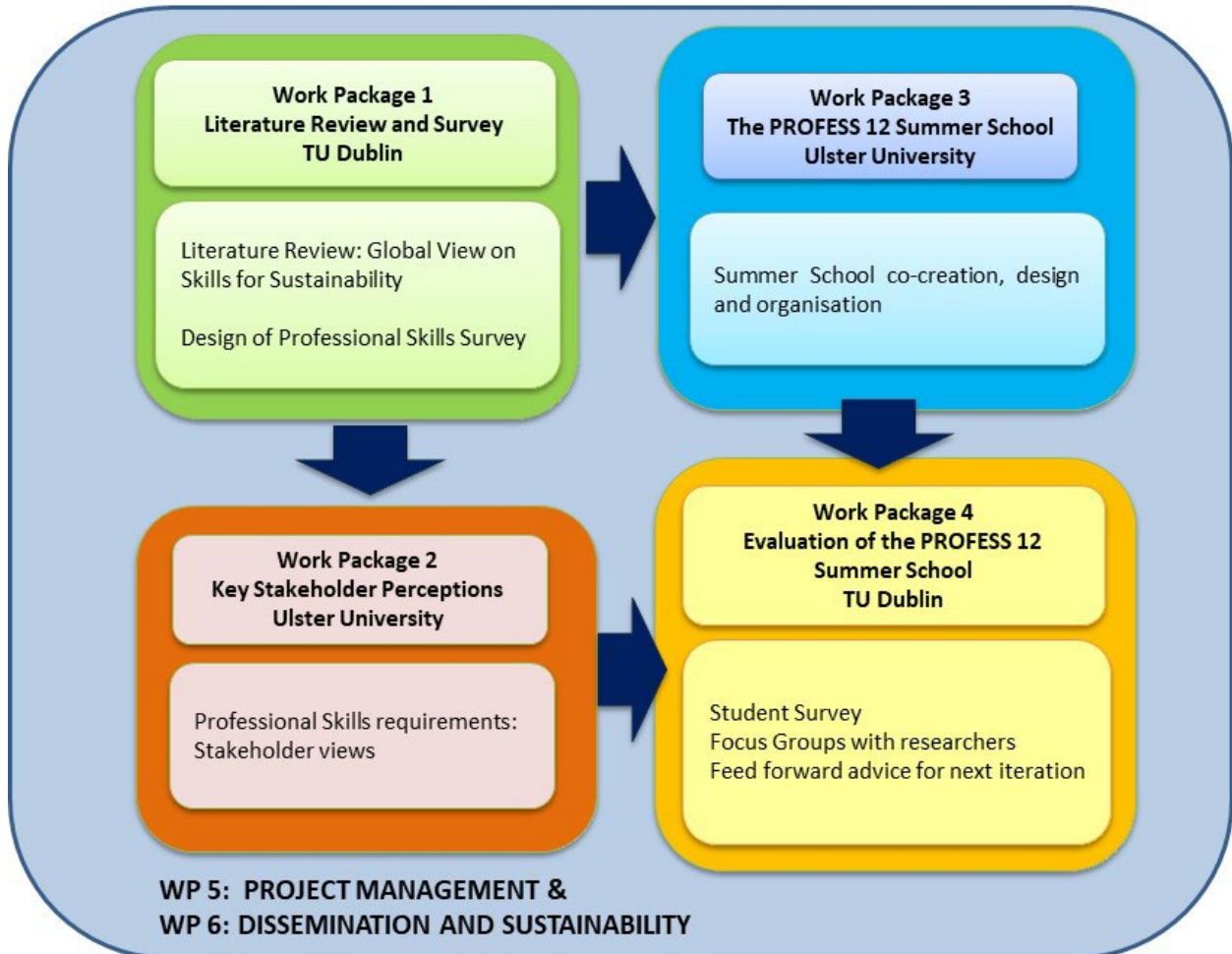


Figure 1: Work packages and Project Outputs in PROFESS 12

In addition to specific outputs from work packages, we also hope to achieve some intangible outcomes such as an improved cultural awareness, better understanding of skills requirements in engineering, implementation of innovative teaching practices, promotion of co-creation of curriculum elements and a better appreciation for the role of gender in research planning, data collection, analysis and dissemination.

## Organisation of Summer School

The organization of the summer school is described in detail in Project Report R4 – the PROFESS 12 Summer School Toolkit. However to set the scene for the evaluation, the student selection process, and an outline of the summer school are briefly described here.

### Selection Process

All TU Dublin and Ulster University engineering students were advised about the PROFESS 12 project and the sustainability themed summer school. A Microsoft Form was created and circulated to students; on this they were invited to register their interest in being involved in the project, which included a co-creation exercise, a launch day trip and the five-day summer school. Students were also asked to answer a few questions that focused on their views on sustainability, motivation and personal competencies which could contribute to the project. Finally, they were asked to describe what they envisaged they would gain through participating in the project. All students who completed the MS Form were invited to attend a co-creation exercise; one was conducted in each university.

After the co-creation exercises were completed, two factors were used to gauge the student's interest in the summer school; namely participation in the co-creation exercise and their responses to the questions on sustainability in the application form. The research team from both universities scored the responses for each participant anonymously. Several interviews were also conducted to gauge commitment and the gender balance, motivation, discipline (course wise) as well as year of study were taken into consideration in the final selection of participants. As mentioned in the project proposal, we aimed to have a gender balance of at least 40% women and 40 % men, however despite significant marketing of the programme to women engineering students, the final number was six women in total. We were advised of concerns from women applicants relating to missing a part time work opportunity for five days and being unable to arrange childcare for five days which meant that they were unable to attend the summer school and withdrew from the application process.

Ten students each from TU Dublin and Ulster University were selected and they were invited to attend the launch day event which took place on 4<sup>th</sup> March 2023. Before the Launch Day and the main summer school event, students were provided with information on what was expected from them, they were invited to provide consent for their feedback to be used in the project and key information was collected (identity documents/dietary requirements etc).

### Outline of Summer School Programme

We created a Student Handbook for the summer school and being mindful not to overwhelm students, they were only provided with things that were essential before they arrived, such as an outline plan of the summer school (Table 1), travel details and health and safety information. This information was provided one week before the Summer School and included an introductory video in line with Universal Design for Learning (UDL) Principles. Presentations and background information relating to the activities that were a part of the summer school were provided to them on a MS TEAMS drive when they arrived on site for the first day.

The first half of the summer school was conducted in Dublin. Students participated in group activities that focused on Sustainable Development Goals (SDGs) and SDG 12 (Responsible Consumption and Production). They were given group tasks which included preparing a presentation on SDG related topics and a task revolving around product development while keeping the concept of circular economy in mind. An interesting simulation exercise (Majoria/ Minoria) was undertaken to help them

learn about working with people from diverse backgrounds and cultures. This exercise emphasised how it feels to give and receive help whilst enhancing their negotiation and leadership skills. In order to fulfil another aim of the project (which was to improve the relationships between people from the North and South of Ireland), some cultural aspects of both summer school bases were also included in the schedule giving everybody a chance to relax and explore both host cities. A self-guided tour of Dublin's Guinness Storehouse was included as a part of the summer school. A visit to an escape room was arranged on the first evening as an icebreaker and to help the students wind down after a demanding and busy day of activities.

The second half of the summer school was hosted by Ulster University and activities planned in Belfast focused on sustainability aspects of the transport sector. The main industrial visits were to Spirit Aerosystems and Artemis Technologies. Students got an opportunity to learn about and better understand the manufacturing processes involved in production of aerostructures of commercial aircrafts as well as delving into the facility which focused on providing zero emission maritime transport solutions for the future. The historic Titanic Museum in Belfast was also explored by the participants during this 5-day event. The finalised overall schedule of the summer school is listed in Table 1 and a picture of the students on day one of the summer school is included in Figure 2.



Figure 2: Photo of students in PROFESS 12 Summer School

Table 1 Detailed Schedule of the PROFESS 12 Summer school organised between 29<sup>th</sup> May to 2<sup>nd</sup> June by TU Dublin and Ulster University.

	Monday	Tuesday	Wednesday	Thursday	Friday
Morning	<b>TRAVEL</b> UU students leave at 9.30am, UU Frederick Street entrance and travel by bus to TU Dublin TU Dublin students arrive at Bolton Street for 12.00	<b>Walk to</b> Breakfast 9.15am @TUDublin canteen  <b>Session 3</b> (10-12.45) Circular Economy	Check out of hotel  <b>Walk to</b> Breakfast 9.15am @TUDublin canteen  <b>Travel to Belfast on bus leaving</b> <b>10am</b> <b>Arrive 12.30pm at UU</b>	Breakfast at hotel 9am 10.00am - Introduction to Day (at hotel) <b>Bus at 10.30am to Artemis</b> <b>Technologies</b> <b>Session 6</b> (11am-12.30pm) Research Led Sustainable Development <b>Bus at 12.30pm to UU</b>	Check out & Breakfast at hotel 8.30am <b>Bus at 9:30 AM from hotel to</b> <b>UU with bags</b> <b>Session 7</b> (10am-11am) Personal Impact <b>Session 8</b> (11.15-12.30pm) Show and Tell
	LUNCH (12-12.45pm)	LUNCH (12.45-1.30pm)	LUNCH @ UU (12:45-1:30pm)	LUNCH @UU (12:45-1:45pm)	LUNCH@UU (12.30-1.30pm)
Afternoon	<b>Session 1</b> (12.45-2pm) General Information and Welcome <b>Session 2</b> (2.15 – 4pm) Sustainable Development and the SDGs	<b>Session 4</b> (1.30-4.00) Developing Intercultural Skills  <b>Walk to</b> Guinness Storehouse (4.45pm – 6.45pm )	<b>Bus at 1:30PM to Factory Visit</b> <b>Session 5</b> (2.00-4.45pm) Spirit AeroSystems – Composites Factory visit  <b>Bus at 4.45PM to hotel</b> <b>Check in Benedicts Hotel,</b> <b>Belfast 5-6pm</b>	<b>REFLECTION</b> (2.00-2.30pm)  <b>Bus at 2.30pm to</b> <b>TITANIC BELFAST</b> (3pm – 5.15pm)  <b>Bus at 5.30pm to hotel</b>	<b>TRAVEL by bus back to</b> <b>Dublin @ 1.30pm</b> <b>Arrive back in Dublin approx.</b> <b>4/5pm</b>
	DINNER (4-5) in Bolton Street <b>Walk to and Check into hotel</b> <b>(5.30-6.30pm) – Easy Hotel</b> <b>Dublin –</b>	DINNER @ 7.30pm <b>Walk to restaurant</b>	DINNER – 6.30pm <b>Walk to restaurant (5-10 min)</b> Themed evening Scalini, Botanic Avenue	DINNER – 6.30pm <b>Walk to restaurant (10 min)</b> Themed Evening Bo Tree, (University Avenue)	
Evening	<b>Walk to Incognito Escape</b> <b>Rooms (7-9pm)</b> <b>Snapping Dublin</b>	<b>Snapping Dublin</b>	<b>Snapping Belfast</b>	<b>Snapping Belfast</b>	

Key: **RED** = Travel **BLUE** = Working session **GREEN** = Cultural /Icebreaker Activities **BLACK** = Meals

## Research Questions

The research team wanted to better understand if the summer school was effective in reaching the aims of the PROFESS 12 project and also to gather information and feedback which would help refine the design of the next version of the summer school. Therefore, our main research question was:

- What were the experiences of the students who engaged in the summer school?

We were also interested in how their experience related to the aims of the summer school:

- How effective was the Summer School from the students' perspective?
- What can we learn from student reflections to provide feed forward advice for the next iteration of the project at a European scale.
- The final aim relates to the effectiveness of the summer school in enhancing relationships between researchers and this will be addressed in Report R6.

## Methodology for collecting feedback from students

The data was collected from students in three strands in order to obtain evidence to address the research questions; two reflective exercises which included a voice/text submission from each student interrogating their reflections on the site visits and summer school in general and an online survey which was circulated a week after the summer school ended. The students were asked to either provide responses as voice notes or text-based responses (typed or handwritten) – any of these formats were acceptable in line with UDL principles. Each of the three strands used to gather evidence is briefly described in the following sections.

### Strand 1 - Student Reflective Exercise 1: Site Visit Reflections

Students were asked to reflect on their visits to the companies and were encouraged to consider the prompts below.

- What did you learn about sustainability from the site visits to Spirit Aero and Artemis?
- How do you think research and development can contribute to sustainable development?
- What are the key messages you took away from site visits; in general and specifically in relation to SDG 12?

The responses aimed to obtain student feedback on the effectiveness of the site visits and their general thoughts on manufacturers' approaches to sustainable development.

### Strand 2 - Student Reflective Exercise 2: Job interview questions

The second reflection session focused more on how students would describe the summer school experience if they were asked about it in an interview. They were asked to use the following questions as prompts:

- I see from your CV, you attended a Summer School, what was that about?
- What were the key things you learned at this summer school?
- I see you did something on intercultural skills, can you tell me what you learned from that?
- What skills did you develop, I mean, how does your participation in that summer school help me if I employed you?

The design of this reflective exercise sought to support both personal development (in terms of preparing students for interviews - employability /interview skills) as well as providing a mechanism to gather evidence for the evaluation.

### Strands 1 & 2 –Student Reflections – Collecting and Collating

For both reflective exercises, QR code detectable MS Forms were used to collect the reflective feedback. Although not every participant submitted their reflections, those received were transcribed through the Microsoft Voice-to-Text transcription service which is available with the MS Word package. Once the voice based, text based and handwritten responses were received, they were compiled into a single document.

### Strand 3 - Student Online survey

A survey in the form of an MS Form was circulated a week after the summer school, which required participants to note their experience on various aspects of the summer school. A copy of the online survey is included in Appendix A and included questions on how well the school was organised, how effective the students felt it was in achieving the learning outcomes and the perceptions on how they developed their skills. All responses were anonymous.

### Strands 1, 2 and 3 – Student Response Rate

For the reflective questions on site visits, fourteen responses (seven from TU Dublin students and seven from Ulster University students) were received. Twelve students (six from TU Dublin and six from Ulster University) provided responses to the interview questions.

There were ten responses to the online survey from Ulster University students and nine responses from TU Dublin students.

### Staff feed forward advice on summer school

As the researchers were interested in developing the next iteration of the summer school, we also kept a record of feed forward advice as we progressed through the summer school. Notes were included to remind us what worked well and prompts to remind us what to change in the next iteration. Whilst this data is not used as part of the analysis of this evaluation, the feed forward advice is included in Appendix B so it is recorded for future reference.

### Staff feedback on project overall

Project Report PR6 includes an evaluation of the whole PROFESS 12 project from the researchers' point of view.

## Methodology to analyse Student Reflective Feedback

The research team used General Inductive Analysis (Thomas, 2006) to analyse the qualitative data included in the voice/text reflective responses. The following steps were adopted in the inductive analysis of the feedback data as shown in Figure 3 (Thomas, 2006).

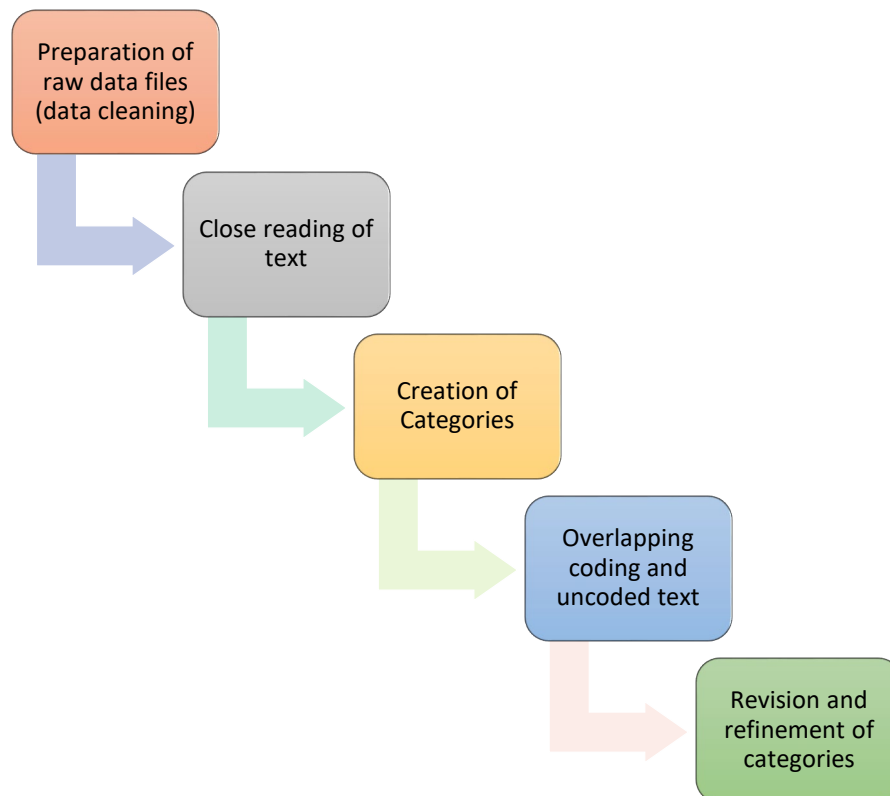


Figure 3: Steps in Inductive coding (Adapted from Thomas (2006))

**The first step** involved compiling and combining all the data received into a uniform format. In this case all the responses received for the seven reflective questions (from Student Reflective Exercises 1 and 2) were compiled in one word document.

**The second step** involved a thorough and in-depth reading of the texts and this was carried out by two researchers. This process was repeated by the researchers until a thorough understanding of the text being reviewed was achieved.

Once the researchers were well versed with the text, **step three** involved an independent analysis by the two researchers. Thomas (2006) notes this procedure as independent parallel coding and is recognised as a useful way to check consistency in the coding process and thus trustworthiness in the findings. In this step, each researcher began to identify and define categories. The categories were noted down and relevant extracts from student reflections were grouped to relevant categories by the researchers.

**Step four** involved each researcher reviewing the extracts of text which were coded to each theme, to identify overlaps and text which was uncoded. This step was to ascertain if categories were supported by specific extracts. At this point, after completing the individual analysis, the researchers

met and compared the findings. A great degree of similarity and overlapping was observed when this step was carried out and the categories were refined further.

**Step Five** included a revision and refinement of categories, which was obtained through discussion, debate and eventual agreement between the two researchers, resulting in an agreed set of categories which emerged from the analysis.



## Findings – Student Survey responses

Students were invited to answer questions relating to their overall experience of the summer school and how it was organized, their views on whether they had met the learning outcomes and also on which skills they have developed during the school. The questions had a 5 point Likert scale with possible responses which ranged from “Strongly Disagree” to “Strongly Agree”. Figures 4 to 6 indicate the overall responses from nineteen students in the programme who responded.

### Responses to survey questions on organisation of summer school and overall experience

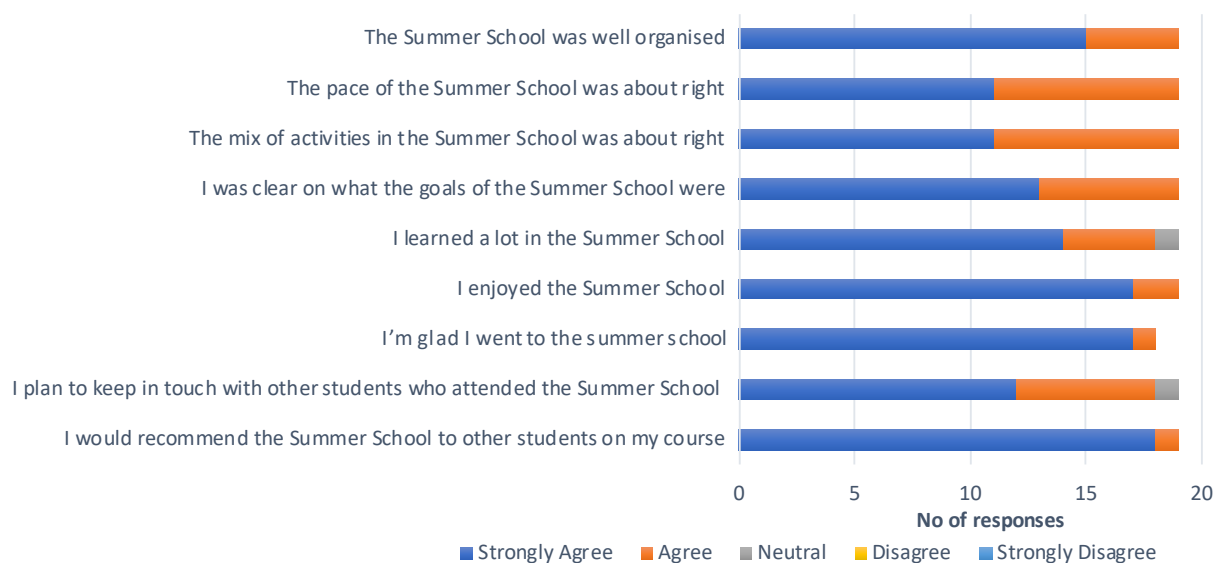


Figure 4: Student responses to survey questions on organisation of summer school and overall experience (Please note one student did not answer the question “I’m glad I went to the summer school”)

It is clear that the overall feedback from the summer school is positive, with students mainly strongly agreeing or agreeing that the summer school was well organised. There were some indications that the pace and the mix of activities were not ideal for all students, however, eighteen (strongly agree) and one (agree) student would recommend the summer school to others. Overall students enjoyed the summer school and were clear on what the goals of the summer school were. Eighteen out of the nineteen students who responded indicated that they had learned a lot in the summer school with one student remaining neutral on this response.

For the most part, students noted that they felt they had achieved the nine learning outcomes associated with the summer school, with a “strongly agree” or “agree” rating for five of the learning outcomes as shown in Figure 5 and Table 2. It is worth noting that across all learning outcomes students broadly “agree” or “strongly agree” that they achieved them. Further, no student noted “disagree” or “strongly disagree” for any of the learning outcomes. Two learning outcomes had the highest number of “strongly agree” responses: the appreciation of similarities and differences of different cultures and the learning outcome relating to collaborating with students from diverse backgrounds.

Only four learning outcomes received any neutral response as to whether the students felt they had achieved the learning outcome. These related to: appreciating the importance of R&D (three neutral responses), calculating a carbon footprint and better communicating and presenting (two neutral responses) and being aware of reactions in conflict and communication (one neutral response).

### After the summer school, I feel I am able to.....

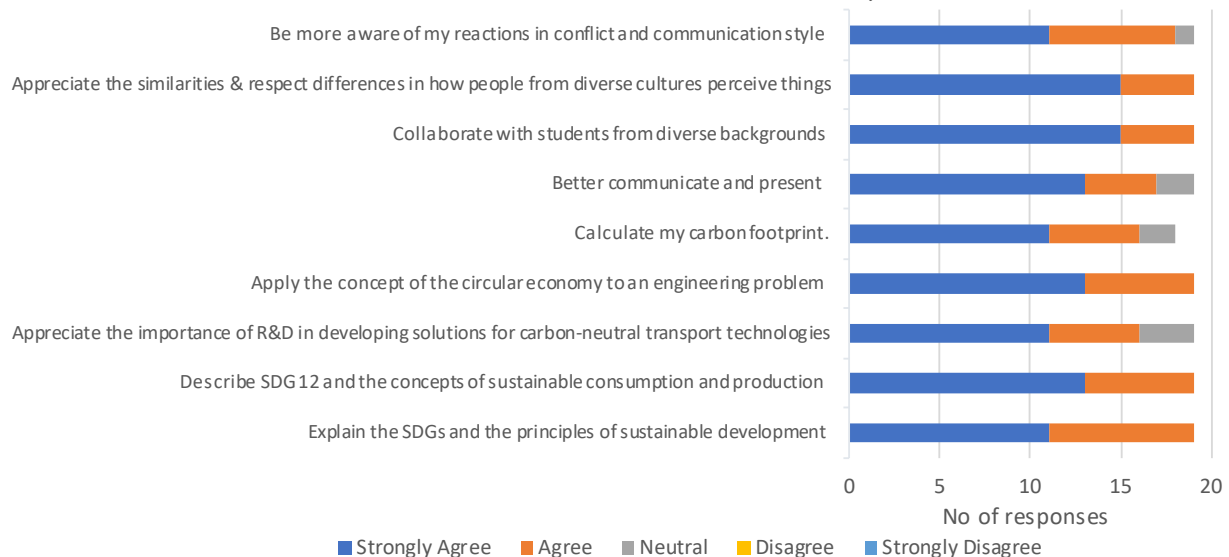


Figure 5: Student responses to achievement of learning outcomes (Note: One student did not answer the question “Calculate my carbon footprint”)

Table 2: Student response scores for achievement of learning outcomes

Learning Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Explain the SDGs and the principles of sustainable development	11	8	0	0	0
Describe SDG 12 and the concepts of sustainable consumption and production	13	6	0	0	0
Appreciate the importance of R&D in developing solutions for carbon-neutral transport technologies	11	5	3	0	0
Apply the concept of the circular economy to an engineering problem	13	6	0	0	0
Calculate my carbon footprint.	11	5	2	0	0
Better communicate and present	13	4	2	0	0
Collaborate with students from diverse backgrounds	15	4	0	0	0
Appreciate the similarities & respect differences in how people from diverse cultures perceive things	15	4	0	0	0
Be more aware of my reactions in conflict and communication style	11	7	1	0	0

The final survey question related to student perceptions of being able to develop their skills. Overall, there is a positive indication from students that the summer school was effective in developing all five of the skills noted, particularly an increased awareness of intercultural skills and developing skills to work in a team as shown in Figure 6. The majority of responses were very positive (either “Strongly Agree” or “Agree”). A small number of neutral responses were received: Problem solving received three neutral responses, with presenting (two neutral responses) and communicating generally (one neutral response). This may be explained by the fact that students were permitted to volunteer for presentation opportunities so perhaps not everyone availed of that opportunity through the full course. There were no responses of “Disagree” or “Strongly Disagree”.

### What was your experience of being able to develop your skills during the summer school

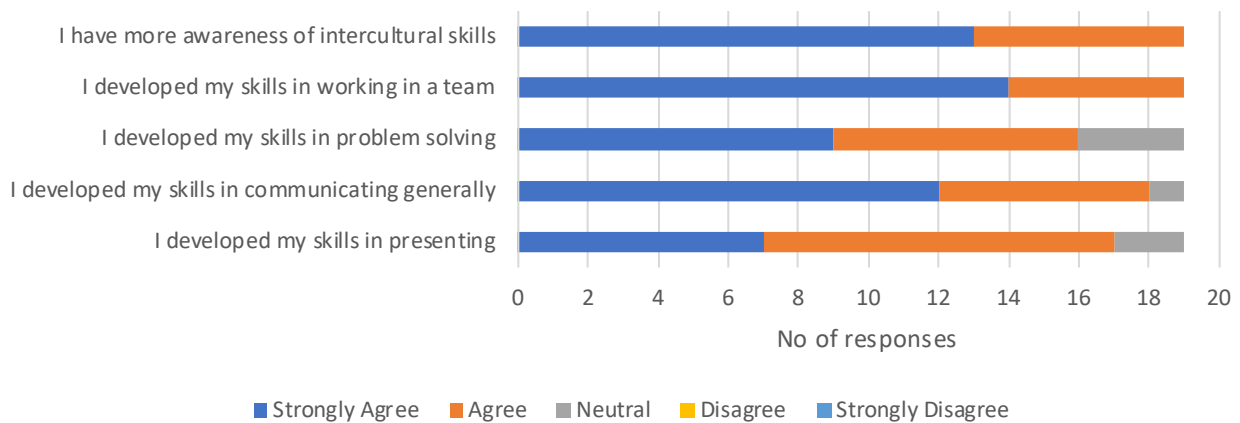


Figure 6: Student responses to experiences of developing specific skills

## Findings – Student Reflective Feedback responses

The responses to the general reflective submission and the job interview questions were analysed in accordance with General Inductive Analysis (GIA) principles as described above and the themes are summarised in Figure 7, under five high level themes and relevant sub-categories. These will now be described in detail along with accompanying quotes which support the findings. All student reflections were anonymised prior to analysis and allocated a label based on their declared gender, hence in quotations provided below, M1, M2 refers to Man Student 1, Man Student 2 and W5, W6 for example, Woman Student 5, Woman Student 6.

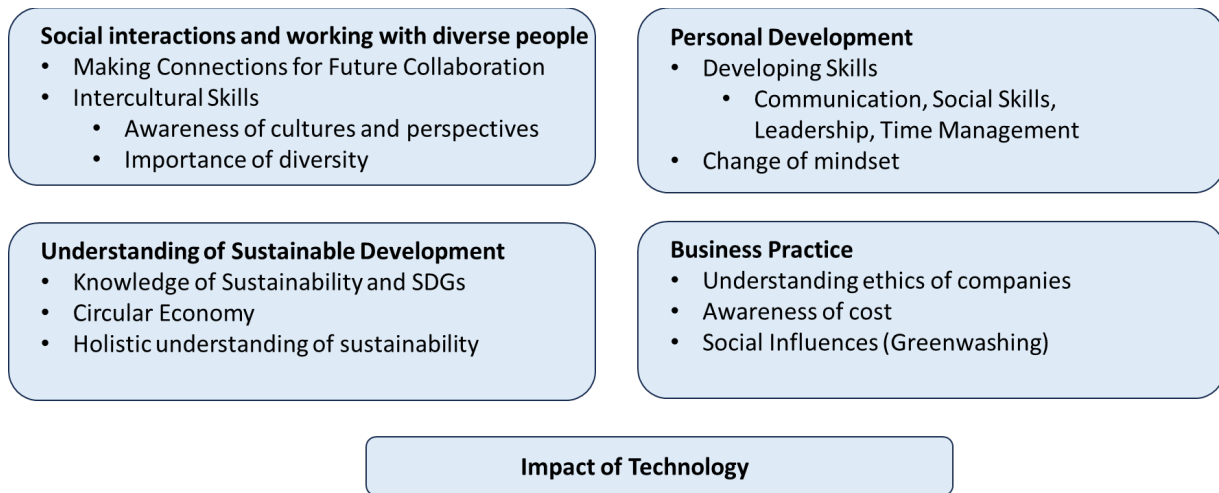


Figure 7: Themes and subthemes emerging from GIA analysis of reflections.

### Social Interactions and Working with Diverse People

The first key theme which emerged through the analysis of reflections was the students' experience of social interactions with others. They discussed how they understood that the aim of the project was to meet other engineering students and that they did achieve this outcome. The group of students bonded very well, and this can be recognised in some of the quotes about how they looked after each other and how they made friends not only with other students from their own university but also with students from the partner university. Interaction with and working with others was an important aspect of the summer school, however several subthemes which highlighted their motivations in working together also emerged.

*So this summer school, it was called PROFESS and was mainly focused between the collaboration between Southern and Northern Ireland, which means that it was a collaboration between Northern Ireland and the Republic University and engineers between both. The main goal was to get them together so they could work together and develop more their communication, presentation, and interpersonal skills. (M2)*

*I think it was a very good summer school and I got to meet new people, people from different backgrounds and everything. So very good. Yeah. (M10)*

### Making Connections for future collaboration

Students showed evidence of realising the importance of collaboration with other students, not just in the short term for the purpose of the summer school but also being aware of developing connections that may be useful in future.

*It was mostly about connectivity, getting to know other students from equivalent college down in Dublin. It was pretty good. It was five-day trip, had some site visits, team building, activities, that sort of stuff. It was very good for getting to know other people. Knowing other engineers, especially if we're going to be doing work down in the South and having connections is always a plus. It's always useful. (M1)*

*I really benefitted from .....making friends through it also and to have great links for the future for other engineers. (W3).*

### Building a Team (not group work) and looking out for each other

The benefits of the summer school in developing social and team working skills was evident through some of the commentary from students. The quote from the student who talks about working as a team, not a group shows an awareness of the closeness they felt and the friendships they made. There was also reference to students practising their social skills and how that will help them when they join a company.

*It was amazing because.... all the team we worked actually as a team and not as a group, a group of people. We worked as a team where we were getting support from each other. We were helping each other. We would.....If someone was missing, [during all the workshops/events/trips] we'll like look for that person and we will constantly look at and count how many was there, who was missing. (M2)*

*The main skills I developed were my social skills definitely, because during the PROFESS 12 summer school we're always in groups, where we were having to talk to each other and you know, the social element was really, really impressive. Like at the start, we were all a little bit quiet, but by the second day we were all talking to each other and we're all kind of good friends. So I think that will be a big advantage to working in a company, you know bringing a nice and friendly environment to the place (M11).*

### Intercultural skills

One of the main objectives of this summer school was to help students develop intercultural skills and one workshop specifically addressed this issue through a role play scenario. In this exercise, Majoria/Minoria (Michigan State University, 2000), the students are allocated to be a resident of Majoria or Minoria and each country is given a set of contextual background issues (one is developing but resource rich, the other, rich and politically stable). Members of each country come together to negotiate a treaty being unaware of the contextual aspects that the other team have been provided which can be controversial.

The concept of developing intercultural skills, being aware of different perspectives and an acknowledgement of what they had learned in relation to intercultural skills, came out clearly in student reflections:

*I gained a thorough awareness of intercultural abilities and their significance in today's globalised world because of my participation in the PROFESS 12 Summer School. I learned to accept and respect cultural similarities and differences while working closely with students from various backgrounds. This experience gave me a better understanding of varied methods to dispute resolution and communication techniques across countries. I learned essential skills in negotiating cultural variety and establishing effective communication by actively participating in intercultural exchanges. These intercultural competences are critical creating welcoming and productive cultures in both academic and professional settings (W2).*

*So I learned that different people have different perspective and perception. Different people have different perception of a subject and a specific situation. So for example, we did a workshop where we like I mentioned before, we had a majority and a minority group that were simulating one country and another country, two different countries with different cultures and different approaches, and then they were put together and they had to make a discussion. Something came along and basically, respect, communication actually being able to listen and speak clearly and present your ideas in an efficient way, that was key. It was an amazing experience where you could actually see and feel the moment and how different cultures can affect a person and how a conversation can lead a completely different way if there is a misunderstanding. (M2)*

*It was like a really beneficial environment in terms of the intercultural backgrounds and the engineering backgrounds, we all found a common ground and we're able to have a great respect and understanding of each other's engineering backgrounds and cultural backgrounds. (W3)*

#### *Increased Awareness of Different Cultures and Perspectives*

Within the theme of intercultural skills, there were two aspects which the students felt were important. The first was an increased awareness of different cultures and the realization that people view situations differently as a result of their own backgrounds. The students were positive about and open to the idea of getting to know other students as an initial means of breaking down barriers. They appreciated the value in open discussion to begin to address this.

*So people from different cultures, view situations very differently. And it's very important to try to understand where people are coming from..... or try to make an effort at least because everyone has different upbringings, different ways of thinking. You have to understand where they're coming from in terms of their ideas, so it's easier for us to collaborate with them because my way of thinking could be different to your way of thinking. So if I get to know you as a person, we break that barrier, then it would be easier to collaborate. So it will be very good to collaborate with people from different cultures and in turn you can come to a conclusion or idea for a project or anything, that suits both parties. (M10)*

*Intercultural relationships were established between students from both Dublin and Belfast. This aspect of the PROFESS12 project was perhaps one of the most intriguing moments, as it was interesting to gain insight into the perspectives of students from diverse backgrounds. (M8)*

The Majoria/Minoria activity aimed to help students better understand how essential it is to respect the similarities and appreciate the differences of other cultures whilst working with different individuals on various challenges.

*One of our workshops was Developing Intercultural Skills. This was a very eye-opening workshop where we discussed the importance of how different cultures might interact with one another. We also had an open discussion after the group task where we talked about people's different backgrounds and the differences and similarities between cultures. (W1)*

*When we were negotiating and talking, and especially when we first got there, it was really hard to try and break down the initial distrust in the barriers, and it was a great exercise on how we just make assumptions and assume people's intentions without always giving them a chance... and how conversation can give us the power to break down those barriers. So I think it was a fantastic activity in relationships and intercultural skills. Understanding that people have their own culture as well (M4).*

#### *Importance of Diversity*

Evidence from student feedback demonstrated the importance of developing intercultural skills, in particular the ability to work with people from diverse backgrounds and the importance of understanding what they can contribute. However, for some students, working with a diverse group of people was new to them and they did not seem to have had much opportunity to interact with such a diverse group of students before. Being put in such a diverse group for the duration of the Summer School was a new experience for them.

*I mentioned previously about working with the Ulster students and they all came from various cultural and engineering backgrounds, which really benefited me as I could hear all sorts of opinions and gave me a new outlook on engineering also. We did several workshops together in team building and building our intercultural skills, which taught us how to maybe not judge others initially and a huge benefit on communication and working through arguments or working through disagreements (W3).*

*The program emphasized the need to foster positive interactions with individuals from diverse cultural backgrounds, and the importance of understanding and respecting diverse cultural norms and practices. By promoting cultural diversity, the program aimed to create an environment that fosters inclusivity and promotes international understanding (M5)*

## Personal Development

The second key theme which emerged from the analysis was the personal development that students felt they had gained over the course of the summer school.

### Developing Skills

The students reflected extensively on the types of skills that they had learned through the summer school; these included presentation and communication skills, social skills, leadership and time management. One interesting aspect of the reflections within this theme is that they are future orientated. Students reflect on how these skills will be valuable when they are working as engineers, so they are thinking about how this summer school prepares them for a life in industry.

*I think communication, intercultural skills, interpersonal skills, presentation skills, and I think those they were key. Teamwork and respect.....there has to be respect, especially between different cultures. Different point of views and we had deep conversations about plenty of things. So yeah, yes, like it was amazing, really good. I learned a lot and I believe these skills, they were really good for the industry. (M2)*

*In particular, one that struck me was designing a project with the circular economy in mind. We decided to improve a cosmetics product due to many problems our users had with it. So I took leadership of that company and it taught me how to present and to come up with drawings and develop an idea into an actual product. I think this was entirely beneficial to my career, as I have a huge interest in the manufacturing and design aspects of engineering, especially with the ideals of keeping sustainability in mind (W3)*

*I think it goes without saying that this summer school has really given me insights and a greater understanding of what it is to be an engineer and I think can really benefit me as a working engineer (W3).*

*I also think that the strong intercultural element that we learned would be very important in companies. (M11)*

Several students reflected specifically on developing their communication and presentation skills. As part of the summer school involved the preparation of a presentation and students were invited to deliver presentations to the whole group (students and researchers) and summarise aspects of projects they were working on. The students' confidence in their own ability improved over the course of the week.

*The skills I developed and during this summer school were mainly communication and presentation skills, with us being initially thrown into the deep end and having to present a PowerPoint based on what SDG 12 was and which taught us how to research and present on something on a very last minute basis (W3).*

*The way you talk and the way you will be perceived is not always the same, as people will have different views and ways of thoughts compared to yourself. So that's the skill of being able to talk to someone and be able to be understood the first time. (M3)*



The project work and activities also gave students an opportunity to develop their leadership skills, showcased in several reflections.

*We also engaged in many other activities like I mentioned the design project, which I think really showed how I could take leadership in a project and really benefited me in terms of being able to maybe lead a team or put out my ideas and it also gave me a huge boost in confidence in terms of presenting myself to a crowd (W3).*

*So as part of a summer school, we took part in a number of different challenges in which we had to work as a team. So through this, I believe that our leadership, problem solving and creative thinking skills were definitely improved by visiting the companies in person and taking part in these challenges, we gained a real valuable insight into what sustainability actually is (M4).*

Students also provided reflections wherein they mentioned an opportunity to get to know other engineers and to open up to them and talk about various aspects of the summer school. This bond that was developed during the 5-day summer school was demonstrated in how they worked together on group activities and helped them improve their interpersonal communication skills. It was also clear that the social aspects of the summer school (the escape room experience and the visits to Guinness and Titanic) also gave them an opportunity to practice socialising in a non-formal way and helped strengthen their bonds. Although not mentioned in the reflections, one student did relate to the tutor that this was the first time they had begun to socialise properly again since the COVID lockdown and that they found it mentally exhausting as they had been out of practice.

*The main skills I developed were my social skills definitely, because during the PROFESS 12 summer school we're always in groups, where we were having to talk to each other and you know, the social element was really, really impressive. Like at the start, we were all a little bit quiet, but by the second day we were all talking to each other and we're all kind of good friends. So I think that will be a big advantage to working in a company, you know bringing a nice and friendly environment to the place (M11).*

The five-day event did include many tasks and required the group of students to complete activities within strict time frames, be it tasks or cultural activities, thus helping them understand the importance of time management. Although this was not a specific aim of the summer school it is interesting to note that this was a skill they became aware of as a result of the way the researchers allocated activities within the sessions.

*Also we had to develop a product based on customer complaints, opinions, what they wanted, what they would like to develop, what they would like to improve, things that they want to make better. So and we had to come up with all that in one hour. So time management it was key with the team that basically you just met but you could actually work with and we all work together and we were able to achieve really good skills also (M2).*

## Change of mindset – taking personal action

In order to meet sustainability targets a change of mindset is needed and this was evident in some students' thoughts as they reflected upon the summer school. In particular, there are action orientated statements which show that students are considering how they can take the learning from this summer school into their future projects and future life (working life/career and outside work) as an engineer and as a person. This change of mindset can be viewed as a distinct learning gain from their involvement in the summer school.

*This programme basically made me achieve all those skills and that mindset that can actually change and are seeking to change the future for a greater good. Of course, along with communication skills, interpersonal, intercultural skills, which nowadays is essential especially because we are working in an intercultural world where we have employees from different countries, different mindsets and have also students with that kind of mindset and that kind of experience, I believe they are key and they can bring so much to a company.(M2)*

*Some key things I learnt during the week were about how I can be sustainable within both my day to day and my work (W1)*

*We also learned about our own kind of impact on the Earth and what we can do to help to help reduce that (M11)*

*The key take away for me is to continue to work hard to reach our goals. Certainly we are moving in the right direction, but I believe we have a long way to go to reach that goal. But we're on the right track and as engineers, we have a key role to play in changing and making differences from the way we design to the way we consume material and products, so really it's been an awakening and an eye opening experience for me and I think it's going to be helpful for both of us as engineers to making sure that in whatever area that we end up in our career, we should be more aware on how we design, consume and maintain our products so that we become a part of this change. A part of this initiative that is going to be helpful in making the world a better and secure and safer place for everybody.  
(M12)*

## Understanding of Sustainable Development

The third key theme which emerged from the analysis related to an increased knowledge of sustainability issues. On the first day of the Summer School, students were asked to create a presentation on aspects of sustainable development and the SDGs, and SDG 12 in particular. It is clear from the reflections that the students were able to build on this knowledge through learning about and experiencing practical applications through other workshops such as the circular economy and site visits they undertook as part of the summer school. There are three sub themes within this section; Knowledge of Sustainability and SDGs, Circular Economy and Holistic Understanding of Sustainability. However, the final sub theme in this section is the ultimate aim of a training programme on sustainability, that students leave with a better understanding of the holistic nature of sustainable development, so that they understand in their work as engineers how everything is connected, and that only technical solutions to immediate problems will not achieve sustainable development in the long run.

## Knowledge of Sustainability and SDGs

Initially students did have a basic understanding of sustainability but through their participation in this school, they developed an in-depth understanding of the SDGs and SDG 12 in particular. They also gained significant insight on how the principles of SDG 12 can be incorporated in an engineering project.

*I also mainly gained a huge knowledge of sustainability through this programme, it really taught me how to see it and notice it and apply it to any aspect of life, not only engineering. It really showed how it can have such a big impact on the world and how us as engineers are the ones who need these skills, and it is such a necessary part of our job to be conscious of our environment and be conscious of the circular economy and all of the SDG 12 rules (W3).*

*First and foremost, I gained a better knowledge of the Sustainable Development Goals (SDGs). I learned about the principles and concepts of sustainable development and how they may be implemented to address global concerns through workshops and conversations.(W2)*

*We visited a number of facilities to see how sustainability is thought of as an issue in the real world. And we just learned a lot of different things about how we can implement sustainable practices. So I believe it was a great, fantastic beneficial experience because it gave us a chance to see what it's really like and it gave us so much knowledge, really of sustainability, that we might not have otherwise gotten. (M4)*

*The program's emphasis on sustainable practices highlights the importance of considering the long-term environmental impact of manufacturing and production processes and promoting sustainable consumption to ensure a better future for generations to come. (M5)*

## Circular Economy

Although the students were introduced to the circular economy through a one-off activity to design a product in line with circular economy principles, it was encouraging to see that this concept remained with them as they reflected on the summer school. Real life examples which were used highlighted the waste and potential recycling capabilities of standard products, however students came away with a good understanding that recycling should be the last resort; reducing our consumption should be the priority.

*One specific key thing I learned was how we can reduce the materials we use by. We're using the materials we have, so in turn to decrease the materials that we have to recycle. So it's very important because I think right now in today's world, there's a lot of focus on recycling. But what can we do before we have to recycle, because recycling in itself has emissions, it's expensive. It uses energy. So before we get to this stage where we have to recycle, we could reduce the materials we have already, we can reuse them. So we don't have to go to the process of*

*recycling. So you can think of it as a Plan A, Plan B, plan C. Plan A should be reducing, Plan B should be reusing, and recycling should be the last resort (M10).*

*I also learnt how important the life cycle of products are and how they can become part of the circular economy compared to the linear economy (W1).*

*So one of the key things I learned was about the linear and circular economy, and how the linear economy really has been a detrimental factor to global warming. And how the circular economy really is the way forward for humans, sustainable production. Within the circular economy, we learned about how products should really be made where, these products should be made to be strong, lasting, should be able to come apart and be fixed easily. They should have a long life and shouldn't just break after a few years. And if they do break, you should be able to replace parts (M11)*

#### Holistic understanding of sustainability

Often, sustainability or sustainable development focusses on the impact of production processes on the environment, but students reflected on a more holistic understanding of sustainability and the importance of taking a holistic view. In particular, one student commented on the impact on society showing a broad range of understanding about what the concept of sustainability incorporates.

*So really this school equipped me with skills that the average engineer may not have. Just because of how niche the subject was and really isn't taught in engineering courses. Especially like taking a holistic view to many things. (M11)*

*So as part of a summer school, we took part in a number of different challenges in which we had to work as a team. So through this, I believe that our leadership, problem solving and creative thinking skills were definitely improved by visiting the companies in person and taking part in these challenges, we gained a real valuable insight into what sustainability actually is (M4).*

*It's a big word at the minute and not everyone would fully know the full extent of which sustainability is, whereas as part of this school we've learned about a number of different aspects and see how there's multifaceted problems relating to sustainability (M4).*

*Making products more sustainable and efficiently benefits all parties and even our society as a whole by decreasing waste and pollution.(M9)*

## Business Practice

The fourth key theme which emerged from the analysis related to business practice and specifically the attitudes of companies in relation to sustainability. The students reflected here mainly on what they learned during the site visits to the two companies.

### Understanding ethics of companies

There was a realisation from students that there are some companies that are really trying to make a difference and to do things sustainably. This surprised some students who had perhaps held a more cynical view that everything is greenwashed or that saying and doing something about sustainability were two separate things. Further, some students made the link that as an engineer in practice they would want to work for an ethically sustainable company, perhaps making them more aware of considering a company's sustainable practices as an ethos that would attract them to join a particular company.

*We made two visits to different companies and on their facilities we saw how they are actually worried about the environment and with technologies and researchers they're actually making to improve those areas and try their best to not affect [the environment] as much as possible. The remaining area that they are working with is to develop materials, working on composites so they can actually make their best and actually not touch the environment that much and try their best to be as energy efficiency as possible, and it was an amazing experience.....Both companies were excellent. Excellent. I was speechless how they are actually developing, how they are focusing on those SDG areas and they will have a big impact on those on reducing the amount of pollution and everything that is coming along can become more sustainable. I was really impressed that they were actually thinking ahead and making their part on that too (M2).*

*We also covered how not only us as individuals can have influence but how companies can take a key interest in their own carbon footprint and impact on the environment.” (W1)*

*It was great seeing how companies take an interest in becoming more sustainable (W1)*

*This summer school helped me to understand small ways that companies can make changes to reduce their carbon footprint and increase their sustainability (W1)*

*But I really thought it was great both of them that like the people working there are just so passionate about what they do and seeing, seeing a place where someone can really grow. And develop their engineering skills is really important. (W4)*

*With the {REDACTED COMPANY} I found, you know, I think the whole idea for their {PRODUCT} was really SDG-12 oriented – they cared about delivering a cleaner form of travel. (M11)*

### Awareness of cost

Despite cost not being brought in as a focus in any of the exercises, several students mentioned the impact that sustainable practices in companies can have costs, or that if there is a cost associated with a sustainable practice, this should be made clear to the customer and highlighted. Yet there was also an awareness that companies need to consider the bottom line.

*We had to make presentations.....we had to develop presentations in a short period of time, come up with innovative ideas and ways that to use renewable materials and materials that we can actually come along and easily be sustainable, but also focus on the profit, how much that would cost, how much that the company would be able to actually provide and also think in those areas, not just think about sustainability and the good for the environment, but also think about the cost and how that would affect the customer (M2).*

*Doing research and investing, actually investing a lot on research and development to do their best to be sustainable and actually show that to the customer, that this has a cost, but the cost is also worth it so we can have a planet in the future (M2).*

*Companies are keen and are focussed on developing products and services that are sustainable not only for the environment but also because it is financially beneficial for them in the long run.(M3)*

### Awareness of social influences (Greenwashing etc.)

Students also realised through the site visits that companies are not only making an effort to reduce their negative impact on the environment but also doing so without using the buzz words of sustainability. The initial assumption of some participants was that companies claiming to have a commitment to sustainability merely paid lip service to it and in reality, had a “greenwashing” agenda but through this experience students realised that some companies actually engage in social aspects of sustainability; consider how their designs impact the environment, the economy and the community.

*We did a workshop where we looked at four products and we chose makeup. The makeup industry, a lot of makeup brands, they greenwash people, where people think they are buying a sustainable product, but they really aren't. We were tasked with creating a product or an idea, concept where we would make a more sustainable product. (M11)*

*It was also nice to see from {REDACTED COMPANY} that there is a genuine demand for eco friendly and green transportation and that it is actually less superficial than I had originally believed.....that a lot of companies were using the buzzwords of eco friendly and green and sustainability to improve their image without actually dedicating to creating something that is manageable for the planet and for the humans that reside on it, as well as the wildlife and fauna (M6).*

*Key messages have taken away from the site visits. Really, that sustainability has finally grown beyond a fad and has really become a crucial and everyday facet of engineering and manufacturing. And the processes that they undertake. It's never just an afterthought at this point it is a requirement into a lot of the new systems and processes that they are undertaking and specifically in relation to SDG 12.*

(M6)

## Impact of Technology

The final theme which emerged was the importance of Research and Development (R&D) and new technologies on finding future solutions to sustainable development problems. Students foresaw this as being a critical part of achieving SDG 12.

*There are new methods and techniques that can be developed that will help the economy reduce its carbon footprint and produce products and services that are for the circular economy that's helping the future of the company. (M3)*

*Both companies, they are really focusing on developing their technology in a way that they will make an impact in the industry. Of course, they want both to be relevant and they want both to be economically stable and competitive in the market, but at the same time, I felt that both of them, they are looking for ways to improve their technology in more sustainable and environmental ways (M2)*

*I believe research and development have a huge role to play in terms of sustainable development because as I said earlier, the sustainability point of anything involves the entire supply chain, the entire life cycle assessment of the product or project or you know services. So research and development can help by doing these life cycle assessments from the cradle to cradle again, and in each stage they can calculate the carbon emission and then compare. Have some sort of scenarios where they can compare different approaches and then pick the best option to make sure that we are all following and going in the right direction (M12).*

*Without research and development, there is no sustainable development. People won't ask the right questions. The right testing won't be done. The right data won't be gathered to really create, a greener and more sustainable future, and to explore different materials and new processes and setting up new networks for the trade of raw materials and finished goods. (M6)*

## Discussion

The purpose of the evaluation of the summer school from the students' perspective was twofold; to ascertain how effective the summer school was in achieving its aims and associated learning outcomes and to gain an understanding of the students' experiences of participating in the school to provide feed forward advice for the next iteration of the project at a European scale.

Overall, the students felt that the summer school was well organised, the goals were clear and the pace and mix of activities was about right (100% responses "Strongly Agree or Agree"). The organisation of the summer school including the pace and mix of activities arose from careful and considered planning which involved co-creation exercises with students, and which produced a summer school handbook and a student handbook. The plan for the summer school was reviewed by the team in detail at several points along the design process to ascertain that the activities were clearly aligned to learning outcomes and that there were not too many activities in the plan. In fact, at one point in the design process a full morning of workshops was removed to allow some down time for students and a later start one morning (a specific request from the students at the co-creation exercise). All students indicated that they enjoyed the summer school, and all eighteen students who responded to the survey would recommend this summer school to other students. Overall, the responses indicate that the summer school was a success in terms of organisation and overall experience. The positive responses in the reflections from students also support this view.

In the main, the learning outcomes were achieved with five out of nine learning outcomes receiving only a "Strongly Agree" or "Agree" rating. This indicates that for most students they felt that the activities they were involved in were appropriate for achieving the learning outcomes, particularly those associated with understanding the SDGs, and SDG 12, the circular economy and aspects of working with students from diverse background and appreciating intercultural differences. These findings indicate that two of the key aims of the summer school have been met, improving awareness of the SDGs and developing intercultural skills.

These aspects also came to the fore in the analysis of the student feedback reflections, where two key themes were associated with i) social interactions and working with diverse people and ii) understanding sustainable development. It is worthy to note that the students' attention was drawn explicitly to these two learning outcomes in several workshops.

On the first day of the summer school, students were asked to undertake research and prepare a presentation on sustainable development, the SDGs and SDG 12, building a foundation of knowledge. It is interesting to note however that from the building of foundational knowledge on day one, students evolved their understanding of sustainability more holistically when they provided their reflections on day five. They highlighted the impacts on cost for companies and on society as a whole, reflecting the three pillars of sustainable development (Environment, Economy and Social). This suggests that the mix of activities and the different perspectives provided to the students were successful in supporting the development of this holistic view.

One such activity was an afternoon workshop on the circular economy where students worked in groups to reimagine a product from design and manufacturing stage based on the principles of the circular economy. The products included makeup, a chair and food packaging as indicated in Figure 8.





Figure 8: Photos of students working on circular economy project.

With regard to developing intercultural skills, it is clear from the reflections from students that the Majoria/Minoria exercise also had a profound impact on their awareness of different cultures and how it is important not to assume, but to spend the time getting to know others before “judging them” as noted by one student. The student reflections in particular give deep insight into how students perceived this exercise and the value they achieved from engaging with it. One of the interesting aspects of the reflection analysis is that it also highlights the intangible measures of working with others collaboratively. As one student mentions, the students worked as a team, not a group, which to their view means they looked out for each other and supported each other. This was certainly evident from the researchers’ viewpoint, but it is worthy to note that the students recognised this too.

In regard to the achievement of the remaining four learning outcomes, in the majority of cases, the students perceived that they had achieved them (“strongly agree” or “agree”), but only a very few students indicated a neutral response. It is striking that there were no “Disagree” or “Strongly Disagree” responses. Three students noted a neutral response to “Appreciate the importance of R&D in developing solutions for carbon-neutral transport technologies”, two students to “Calculate my carbon footprint” and “Better communicate and present”.

The research team discussed the findings in regard to seeking to unpack why these few neutral responses were provided. Two site visits were organized to companies who are working on research design and manufacture of carbon neutral technologies. One of the site visits included a long tour around a large manufacturing facility and it was difficult to hear the tour guide discuss the technologies at certain times. It may have been better to organize a short presentation from the company first before the tour, in order to emphasise the company approach to research and development of technologies. A presentation was provided in the second tour, which was appreciated by students and noted in their reflections. The exercise to calculate one’s own carbon footprint was undertaken on Friday morning at the end of the week and was only allocated 1 hour. It is thought that perhaps the students were tired at this point and going forward, it is recommended that either this activity is moved to a different time in the week, or removed completely. Finally, students were permitted to volunteer to make the presentations so perhaps not everyone felt they had the

opportunity to develop their communication and presentation skills. This highlights the importance of small groups to enable each student to engage in the activity.

As an exercise throughout the summer school, the researchers also kept a log of what was working well and what aspects should be reviewed for the next iteration. This is included in Appendix B.

Complementing the survey feedback on achievement of learning outcomes, students also perceived they had developed their skills, particularly in relation to intercultural aspects and working in a team. Again, there were a majority of positive responses for communication, presenting and problem solving too. This data is supported by the analysis of their reflections where a key theme which emerged related to their own Personal Development and they specifically mention communication skills, social skills, leadership and time management. A particularly interesting outcome of the qualitative analysis is that several students reflect on their change of mindset or the change of mindset that is needed to help achieve sustainable development. Some reflections indicate evidence of future thinking, action orientated towards their career as an engineer and how they now feel empowered and educated to help contribute to sustainable development in their life. This is an impactful outcome of the summer school which can have long term positive consequences on the engineering profession.

Whilst the survey data gives evidence of student perceptions on what the summer school has achieved the analysis of reflections provides an insight into outcomes which were not planned as part of the summer school. We have already discussed, the acknowledgement of collaborating with others and working in diverse teams, the improved knowledge of sustainable development and the holistic understanding of sustainability in addition to the development of their skills in communication, social skills, leadership and time management. All of these aspects emerged as themes in the reflections.

However, two additional themes emerged from the qualitative analysis which are worthy of discussion. The first related to business practices and revealed that several of the students were genuinely surprised that there are companies trying to do their best in relation to sustainability. There seemed to be an assumption that most companies, say one thing but do another or try to greenwash their activities to hide poor practices. This was a key learning point for students and several also reflected on how this may affect their decisions on the type of company they wish to work for in the future. The site visits also engaged students in thinking about the financial cost of undertaking sustainable practices giving them a more holistic view of the impact that an engineer can have on society through their day-to-day work. This aspect was not discussed as part of the summer school, but future iterations could include more of a focus on financial implications of sustainable development.

The final theme related to the impact of technology and the importance of research and development in finding solutions to help build a more sustainable future. One of the company visits had a prototype available to view and this seemed to make a big impact on the students, seeing themselves working in R&D type projects in the future. As one student put it “Without research and development, there is no sustainable development. People won't ask the right questions. The right testing won't be done. The right data won't be gathered to really create, a greener and more sustainable future.....”.

## Limitations

Generalisability of findings, along with objectivity, reliability and validity of the research instrument are important factors in considering the quality of quantitative research (Borrego et al., 2009). Acknowledging these quality factors and reflecting on the exploratory nature of the survey and reflective exercises, it is important to be aware of research design limitations and implications for interpretation of the findings.

Research design limitations include:

- Survey: the number of questions was restricted to minimise respondent burden. Some descriptive information was collected about respondents (ideally, the list of variables collected could have been more extensive) and detailed definitions of certain terms were not included;
- Survey: the sampling method used (convenience sampling, a non-probability sampling approach) was dictated by practical and resource constraints and only included the 20 students involved on the course.
- Reflective exercises: the reflections were completed using prompts which may have directed students to talk about particular aspects of the summer school which were not at the forefront of their experiences.

It is not our intention to generalise the findings as they correspond to the individual experiences of students on the summer school, however they do provide interesting insights, exposing further lines of enquiry that merit exploration.

## Conclusions

This report outlined the evaluation of the summer school from students' point of view by analysing feedback from an online survey and written or voice responses to reflective questions. In response to the overall research question, what were the experiences of the students who engaged in the summer school, we can draw several conclusions.

Students thoroughly enjoyed the summer school, felt it was well organised and would recommend it to their fellow students. They felt the pace and mix of activities on the programme was about right. There is evidence that the majority of students felt that all of the learning outcomes had been met, but particularly noteworthy were the learning outcomes related to understanding the SDGs, SDG 12, the circular economy and aspects of working with students from diverse backgrounds and appreciating intercultural differences. Learning outcomes which were slightly more difficult to achieve for all students related to "Appreciate the importance of R&D in developing solutions for carbon-neutral transport technologies", "Calculate my carbon footprint" and "Better communicate and present".

Whilst students benefitted from the summer school, learning, developing and acquiring skills that were designed into the summer school, they also reported other learning/benefits that were not anticipated. A thematic analysis of the student reflections indicated that students appreciated the opportunity to interact with other engineering students of diverse backgrounds and they became more aware of the importance of respecting other cultures and appreciating diversity. Participants

also indicated that they felt they had achieved some personal development in relation to communication skills, social skills leadership and time management, but also that they had a change of mindset in relation to sustainability and felt empowered to act in their engineering career.

Students' understanding of sustainable development also grew and they acknowledged the importance of considering sustainability holistically, taking into account not only environmental concerns, but the impact on society and the economic factors associated with sustainable solutions.

The summer school exposed students to site visits to companies and the reflections indicated that students gained a lot of awareness of ethical and sustainable business practices as a result. The feedback showed a positive attitude to companies who were genuine about following through on sustainable practices and there was evidence to show that students will be mindful of these types of companies when choosing a future employer. Finally, feedback indicated that students have become more aware of the importance of research and development in relation to creating sustainable products and processes to ensure a more positive future for us all.

The evaluation exercise also provided feed forward advice for the next iteration of the summer school. Whilst the overall outcome of the summer school was successful, there are some areas for consideration.

- Energy levels were low at the end of the week and students may not have been as receptive to learning due to tiredness or overstimulation with workshops during the day and events in the evening. The recommendation for the next iteration is to reduce the length of some of the workshops and to allow some down time for students to rest or explore the local areas on their own time to enhance their cultural understanding.
- It is important to remember when organising site visits that some students may not have been exposed to that particular aspect of manufacturing or design before and therefore an introductory presentation on the work of the company, outlining what students are likely to see during the visit is recommended.
- We identified some barriers to engagement for female students who were restricted from attending due to childcare responsibilities or work commitments. In future, considerations should be given to providing some funding towards childcare arrangements or to explore the possibility to attend on a part time basis or participate in some elements remotely (i.e. day time only or non-residential options). This may necessitate that some aspects of the school are designed as core and mandatory.

## Acknowledgements

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## Appendix A – Online Survey



**TU Dublin Students - PROFESS  
12 - Evaluation of Summer  
School**

Feb 7, 2024

Thank you for engaging in PROFESS 12. This was the first time the Summer School was run; it was a pilot. We are really interested in your feedback (on what went well and what could be improved) so that we can apply the learning to future Summer Schools.

1. Please rate the following statements about the Summer School. These statements are about the organisation of the Summer School and your overall experience.

*Select one option on each row*

	Strongly Agree	Agree
The Summer School was well organised	<input type="radio"/>	<input type="radio"/>
The pace of the Summer School was about right	<input type="radio"/>	<input type="radio"/>
The mix of activities (classroom, industry visits, cultural, social) in the Summer School was about right	<input type="radio"/>	<input type="radio"/>
I was clear on what the goals of the Summer School were	<input type="radio"/>	<input type="radio"/>
I learned a lot in the Summer School	<input type="radio"/>	<input type="radio"/>
I enjoyed the Summer School	<input type="radio"/>	<input type="radio"/>
I'm glad I went to the Summer School	<input type="radio"/>	<input type="radio"/>
I plan to keep in touch with other students who attended the Summer School	<input type="radio"/>	<input type="radio"/>
I would recommend the Summer School to other students on my course	<input type="radio"/>	<input type="radio"/>

2. We would like to understand if you felt the aims of the Summer School were met. The aims are listed below.

*Select one option on each row to indicate how much you agree with the statement:*

After the summer school, I feel I am able to.....

	Strongly Agree	Agree
Explain the SDGs and the principles of sustainable development	<input type="radio"/>	<input type="radio"/>
Describe SDG 12 and the concepts of sustainable consumption and production	<input type="radio"/>	<input type="radio"/>
Appreciate the importance of R&D in developing solutions for carbon-neutral transport technologies	<input type="radio"/>	<input type="radio"/>
Apply the concept of the circular economy to an engineering problem	<input type="radio"/>	<input type="radio"/>
Calculate my carbon footprint.	<input type="radio"/>	<input type="radio"/>
Better communicate and present	<input type="radio"/>	<input type="radio"/>
Collaborate with students from diverse backgrounds	<input type="radio"/>	<input type="radio"/>
Appreciate the similarities and respect the differences in how people from diverse cultures perceive things differently	<input type="radio"/>	<input type="radio"/>
Be more aware of my reactions in conflict and communication style	<input type="radio"/>	<input type="radio"/>



3. What was your experience of developing your skills during the Summer School?

*Please consider each skill listed below, then select one option on each row.*

	Strongly Agree	Agree
I developed my skills in presenting	<input type="radio"/>	<input type="radio"/>
I developed my skills in communicating generally	<input type="radio"/>	<input type="radio"/>
I developed my skills in problem solving	<input type="radio"/>	<input type="radio"/>
I developed my skills in working in a team	<input type="radio"/>	<input type="radio"/>
I have more awareness of intercultural skills	<input type="radio"/>	<input type="radio"/>

4. What were your pre-conceptions about people from the North/Northern Ireland, before the Summer School?

5. Did these pre-conceptions change after the Summer School? If so, how?

*Please answer Yes or No. If Yes, please explain.*

6. What key lesson are you going to take forward as a result of your engagement in the summer school? \*

7. What were the best 3 things in the Summer School?

8. What were the 3 things you enjoyed the least in the Summer School?

9. What should we leave out of the Summer School next time?

10. What should we add to the Summer School next time?

11. What is your gender?

*Select one* \*

- Woman
- Man
- Non-binary
- Prefer not to say

12. What is your age? \*

13. Which University did you represent?

*Select one \**

Ulster University

TU Dublin

14. What is the name of your course (and year, if applicable)?

*Type answer to include name of course and year, if applicable \**

15. If you have any other comments, please add below.

## Appendix B – Feed forward advice from instructors

Good things to continue	
	<p>Start the week with the thought provoking things, do easy tasks or less mentally taxing tasks at end of week</p> <p>Escape room was great icebreaker</p> <p>Need at least 4 adults to accompany them</p> <p>Buses for transport everywhere, saves time rather than individuals walking or taxis</p> <p>Great bonding experiences for the team</p> <p>Framing the certificates brought some professionalism</p> <p>The photographer taking individual photos for Linked In – that went down a treat</p> <p>Gender consideration in activities – makeup bottles.</p> <p>Pens as merchandise</p> <p>Only send general timetable before the summer school – gives flexibility and does not overwhelm,</p> <p>Hoodies were a great hit.</p> <p>Majoria minoria – great activity</p> <p>Circular Economy project – got them working together.</p> <p>Feed them well.</p> <p>Keep instructions simple each day.</p> <p>Regular, “bite-size” information</p> <p>Set menu (in restaurants) is simpler/easier to manage with a large group</p> <p>Ask students to create WhatsApp group – useful for sharing reminders about where to meet and when (e.g. after dinner send message to remind all about where/when the next morning) and finding out where “missing” people might be</p> <p>Itinerary for industry site visits</p> <ul style="list-style-type: none"> <li>- Good to have intro briefing/presentation to provide overview of facility/set scene for tour</li> <li>- Good to have senior female and male engineers hosting</li> <li>- Allow for informal chat, Q&amp;A with staff during tour</li> </ul>
Things to remember	
	<p>Allow time for buses, getting everyone on, getting lost, comfort breaks</p> <p>Leave gaps in case we are running late, particularly for employer visits</p> <p>Build in contingency in case we are late or something drops out (employer visit)</p> <p>Consider gender mix in research team</p> <p>Purchase prizes etc, when in last town to save on carrying.</p> <p>Consider a prize in October for most impressive seedbombs</p> <p>Name badges helpful (at least for Day 1)</p> <p>Where printing required, ideally do this at the destination uni, rather than carrying printed material</p> <p>If specifying time to meet (for a briefing, to get a bus somewhere, to walk to a restaurant), tell the students 15 min earlier than needed</p>

Student WhatsApp group – staff found this useful for communicating to student group during the week - though staff to check (not assume) everyone is in

Hotel stays: don't assume students have stayed in a hotel before – may need to explain that if staying in same hotel for 2 nights, don't need to pack up and check out after 1<sup>st</sup> night

Although guidance provided before summer school about clothing/no logos on site visits, may need to reiterate this on the evening before any site visits and perhaps also remind /check at breakfast. Maybe allow time for people to change before leaving hotel?

Industry site visits – may require material to be read/signed in advance. Allow time to explain what's required, distribute, read, sign and collect.

Voice answers are better way to get reflections from participants on their experience of the summer school. Text based answers seemed to be less personal and more polished like an exam related answer.

## Things to change

- Improve check in procedures at Dublin hotel to speed things up (passport numbers etc)
- Check length of time to walk between places – try for less than 30 mins
- Allow for some down time in each city, perhaps have dinner late one evening to allow for that.
- Perhaps allow for an activity on Thursday night, bowling or black taxi tour?
- Active timekeeping during activities
- Bring first aid kit
- Think about giving students more responsibility in organising events?
- Sustainability of the school – can students be encouraged to go off and do something themselves?
- Ask them to create testimonials for the school
- When asking them to reflect, give them time to reflect before asking them to upload.
- Take a photo of all the certificates and prizes before we give them out – that would have been nice for the final report.
- Take the personal photos on the first day (when everyone is well dressed) and let them know before hand.
- Ideally no long walks with luggage
- Consider “easy read” or similar format for some of the written info
- Regular reminders that it's OK for students to ask questions if unsure about anything
- Regularly check understanding - are students clear on where/when to meet, what to bring/wear, etc.
- Timing/duration for industry site visits -in pre-visit briefings with industry reps:
  - be clear on necessary pre- and post- visit activities (e.g. at beginning of visit: check-in/security passes, shuttle buses, donning PPE and reverse at end of visit) and allow time for these as well as for actual tour.
  - be clear about and agree arrival/departure times (to minimise losing some control over timings when passing over to enthusiastic/passionate hosts)
- Industry site visits
  - perhaps more direct guidance to students – look interested, take notes, ask questions

	<ul style="list-style-type: none"> <li>- perhaps “plant” some questions (or pointers/issues they might want to consider) with students in advance?</li> <li>- perhaps an award for most engaged student at site visits?</li> <li>- Tell students to put away their phones during visits</li> <li>-</li> </ul> <p>Leave gaps / recognise it’s OK to have space in the agenda or protect time for some activities that will mean some people have some down time (e.g. Linked in photos). We squeezed a lot into a short space of time on Friday morning (2 classroom sessions, individual + group photos, prizes, also refreshments coming into the room). Perhaps this diluted effectiveness of some activities. To-ing and fro-ing may have been distracting for some.</p> <p>Mix up lunches a bit. Students had too many sandwiches.</p> <p>Accessibility (re overnight stays) - it’s not always possible for people (often women) with caring responsibilities (dependents including children, eldercare) to be away for 1+ overnights or only with a lot of advance planning and also may be costly. Consider how students could be included</p> <ul style="list-style-type: none"> <li>- perhaps participate on day-time only basis in-person at 1 uni and virtually at 2<sup>nd</sup> uni for class room type activities (though this changes dynamic, restricts level of participation)</li> </ul> <p>Sustainability – given Summer School focus, aim to reflect this ethos in prizes/awards (i.e. buy local, responsibly produced if at all possible)</p> <p>Practical/logistics - by end of the week, some students had acquired a lot of additional stuff (merchandise, prizes). Will be interesting to see if any feedback from student evaluation on carrying this around/getting it home at end of week. Perhaps consider some less bulky items and/or send afterwards (though recognise this could be time-consuming/expensive)?</p> <p>Ensure no-one misses out on activities (1 student missed Guinness Storehouse, 1 student missed UU group photo). Perhaps pair students up so that Student A looks out for Student B (x10) - would this make it easier to identify if anyone missing, who it is and then to follow up?</p>