Assessing for Sustainability;
Reflective and peer learning assessments as a means of promoting student engagement

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EESD2023
QUEST FOR SUSTAINABLE SOCIETIES

Beyond '**CORE ENGINEERING COMPETENCES**', engineering programmes seek to develop both **TRANSFERABLE SKILLS** and **PROFESSIONAL VALUES** in the engineering graduate. Moreover, and to an increasing extent, accreditation bodies require that graduates are equipped with a range of **SUSTAINABILITY ATTRIBUTES**, which can traverse and transcend each of the aforementioned domains (Gutiérrez Ortiz et al., 2021).

- Core Chem. Eng. competences
- Transferable skills
- Professional values
- Sustainability attributes
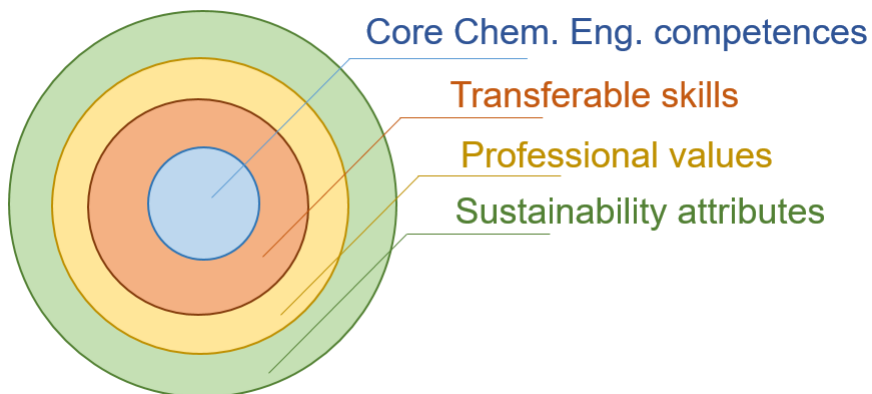
Gutiérrez Ortiz, F.J., Fitzpatrick, J.J., Byrne, E.P. 2021. Development of contemporary engineering graduate attributes through open-ended problems and activities, *Eur. J. Eng. Educ., 46*(3), 441-456.
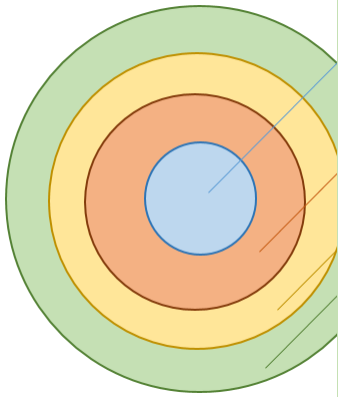
❖ **Sustainability (core) knowledge** and **understanding**, including around the issues and challenges, as well as a deep appreciation of the importance of the social, ethical, ecological and economic dimensions of sustainability, and the interconnectedness of each.

❖ **Sustainability skills:** ability to develop appropriate greener technologies, processes and approaches.

❖ **Sustainability values:** e.g. concern for the environment, commitment to sustainable development, empathy, quality, diversity, commitment to social justice, flourishing communities, human well-being, etc.

Gutiérrez Ortiz, F.J., Fitzpatrick, J.J., Byrne, E.P. 2021. Development of contemporary engineering graduate attributes through open-ended problems and activities, *Eur. J. Eng. Educ.,* 46(3), 441-456.

Increasingly, 'accreditation bodies require that graduates are equipped with a range of sustainability attributes (Byrne, 2023), which can traverse and transcend each of the aforementioned domains (Gutiérrez Ortiz et al., 2021)'.

a. Sustainability/Sustainable/Sustainable Development/United Nations SDGs
b. Equity/Equality, Diversity, Inclusion, EDI/DEI
c. Ethics/Ethical
d. Global
e. Environmental/Environment
f. Society/Societal/Social
g. Cultural/Multicultural
h. Multidisciplinarity/Interdisciplinary/Transdisciplinary
i. Complex Systems/Complex/ Complexity

Byrne, E.P., 2023. The evolving engineer; professional accreditation sustainability criteria and societal imperatives and norms. *Educ. Chem. Eng.,* 43, 23-30.

Examination of **TRANSFERABLE SKILLS** (e.g. communication, teamworking, dealing with complexity and uncertainty) and **NORMATIVE VALUES** (e.g. around safety, ethics, social and environmental wellbeing) do not typically lend themselves to traditional assessment approaches (e.g. closed book exams).
Teaching sustainability or EESD also falls into this framework.

This paper considers some of the assessment techniques used on a module (course) entitled '*Sustainability and Environmental Protection I*', taken as:

- a core module by third year **BE/ME undergraduate students** of **Process and Chemical Engineering** at University College Cork, and by

- Graduate students taking a **Higher Diploma in Sustainability in Enterprise**
  (profile: mature students from a diverse range of disciplinary backgrounds with a fairly extensive of life and work experiences)

PE3011 Sustainability and Environmental Protection I

Module (Course) Learning Outcomes
On successful completion of this module, students should be able to:
- Articulate **contemporary frameworks, concepts, constructs, MODELS, VALUES and ethics** around **SUSTAINABILITY** and sustainable development, including the UN Sustainable Development Goals;
- Identify the **nature of COMPLEX SYSTEMS**, **inherent UNCERTAINTY**, **non-equilibrium thermodynamics** and **process change** as they relate to professional practice and the wider world;
- Identify **different perspectives, FRAMINGS, paradigms worldviews** and **diverse multi-cultural CONTEXTS**, and **WORK COLLABORATIVELY** with others in seeking (through **inter- and transdisciplinary approaches**) to propose useful **interventions and potentially TRANSFORMATIVE outcomes**;
- Develop and refine capacity for **CRITICAL REFLECTIVE analysis, empathetic, integrative** and **COMPLEX SYSTEMS THINKING**.

Assessment components employed across the module

Assessment	Description	Marks
Book review	Write a newspaper/magazine style book review from a list of thought provoking books on some aspect of sustainability	20
In-class exercise(s)	A series of in-class peer and general class discussions, often using live polling app (*slido*); grades were awarded for participation	5
Peer paper reviews and reflections	Use of *Perusall®* app to read and comment on, and comment on peer comments for a selection of (three) selected papers	10
Group transdisciplinary sustainability assignment	Assignment where group identifies and reflects on authentically positive action, idea or initiative which can help precipitate transformative change	15

Book review
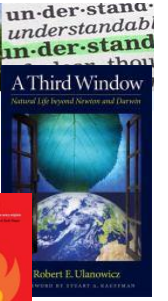
PE3011 Sustainability & Env. Protection I
(Edmond Byrne)

Book Review Assignment (20 marks):

UCC PE3011 Sustainability and Environmental Protection I   E.P. Byrne

In-class exercise(s);

peer-to-peer and general class discussions

In-Class Reflection:

Critical Thinking Group Exercise:

*Can you suggest examples (in society, economics, natures, business, education, etc.) of where either **separation** or **inter-connection** is **promoted** or recognised, and consider respective **advantages** and/or **drawbacks**?*

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De Witt Worldview Test Question (Q.6)

https://wvtest.com/

	S	**Rank?** **[1] most -** **[4] least**
People look at the world from different perspectives, which are all equally valid		
The universe is governed by mechanical, natural laws		
God stands far above life on earth		
Reality is complex: it is both scientific and spiritual at the same time		

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De Witt Worldview Test Question (Q.6)

Deterministic: The universe is governed by mechanical, natural laws (2.6)

Relativistic: People look at the world from different perspectives, which are all equally valid (3.0)

Complex: Reality is complex: it is both scientific and spiritual at the same time (3.0)

Deistic: God stands far above life on earth (1.4)

2023 class: from 47 (4 most align with; 1 least)

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Reflection; Framing Reality:

*Which of the four **worldviews** do you find most affinity with?*

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Which of the four worldviews do you find most affinity with?

Multiple Choice Poll ☑ 44 votes 👥 44 participants

Traditional - 3 votes
7%

Modern - 10 votes
23%

Postmodern - 2 votes
5%
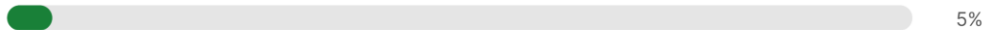
Integrative - 29 votes
66%

slido

Reflection; Framing Reality:

*..To what extent might the worldviews framework help us progress around **Sustainability** (/narratives)?*

To what extent might the worldviews framework help us progress around Sustainability (/narratives)?

Multiple Choice Poll · 40 votes · 40 participants

Very well - 4 votes
10%

Fairly well - 8 votes
20%

May have some uses - 25 votes
63%

Not very well - 1 vote
3%

The framework is irrelevant (wrt sustainability) - 2 votes
5%

slido

Peer paper reviews and reflections

Group transdisciplinary sustainability assignment

> **Spec:** "*Identify, research and outline an example or case study of an **authentically positive initiative or idea** which can genuinely help precipitate **transformational change towards sustainability**. ...critique its implementation, identifying potential barriers for implementation, how these might be overcome, potential consequences, difficulties or problematic issues.*"

Pfandsystem (plastic bottle deposit returns) The Pfand system of plastic bottle deposit returns that is very popular in Germany, and across mainland Europe.

https://dpg-pfandsystem.de/index.php/en/

WASP 3D Printing Architecture/eco-homes. This appealing concept helps bring people back in touch with nature, working with what the planet naturally provides, but respectfully. Involves transformative change, alongside the creativity that architecture can bring, while seeking to be ecologically sound.

TECLA | A 3D printed global habitat for sustainable living

21 January 2021

A new circular housing model, created using entirely reusable, recyclable materials taken from the local terrain.
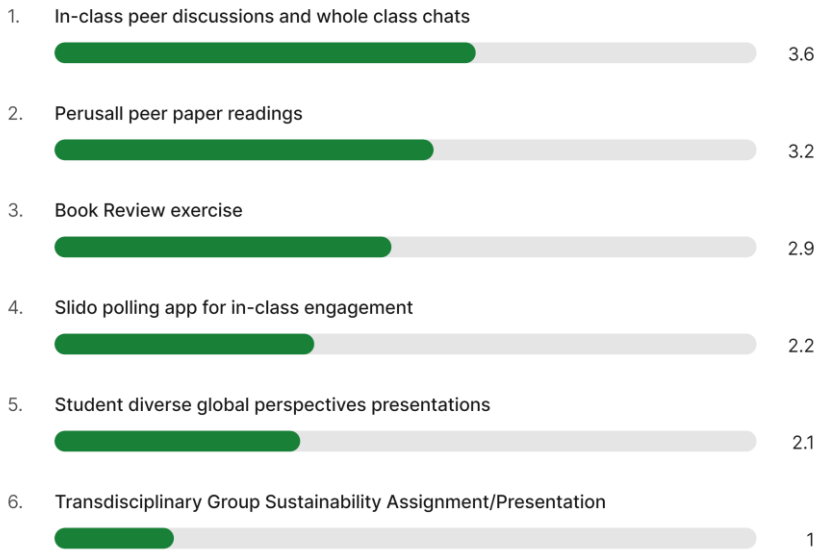
Crane WASP

Giant 3d printer for building 3d printed house


Student Feedback

↕ Rank the innovations in PE3011 (E Byrne's section) in order of value towards engagement and learning the material

Ranking Poll   ☑ 22 votes   👥 22 participants

1. In-class peer discussions and whole class chats

   3.6

2. Perusall peer paper readings

   3.2

3. Book Review exercise

   2.9

4. Slido polling app for in-class engagement

   2.2

5. Student diverse global perspectives presentations

   2.1

6. Transdisciplinary Group Sustainability Assignment/Presentation

   1

☆ In terms of supporting engagement and learning, how would your rate the following: 'Perusall' Paper Readings and Peer Commentaries

Rating Poll   ☑ 41 votes   👥 41 participants

Score: 7.8

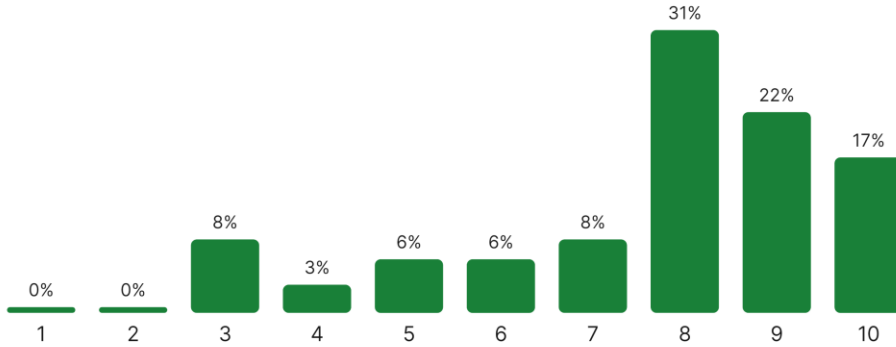| 1	2	3	4	5	6	7	8	9	10
0%	5%	2%	0%	5%	2%	20%	24%	20%	22%
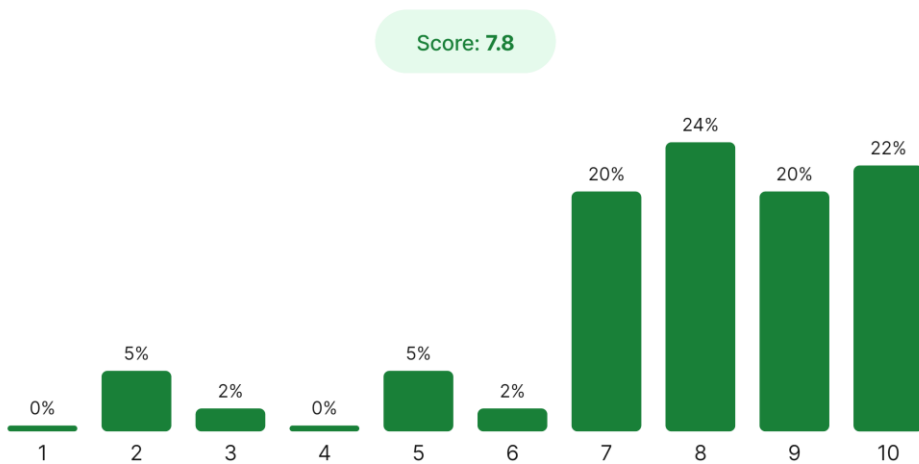
slido

☆ In terms of supporting engagement and learning, how would your rate the following: Sustainability Book Review Exercise

Rating Poll   ☑ 36 votes   👥 36 participants

Score: **7.7**

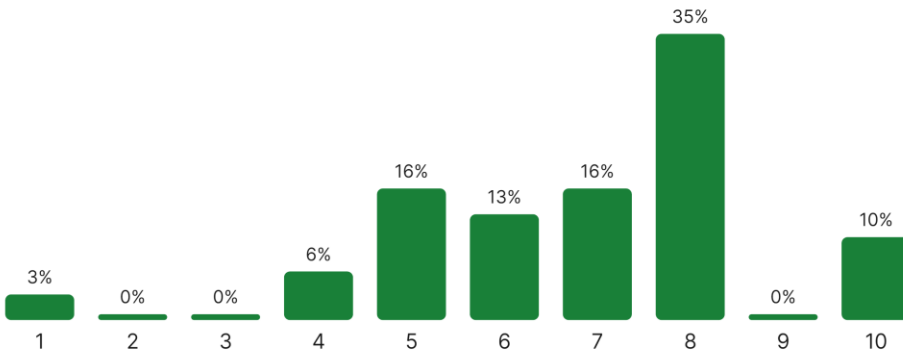| Rating	1	2	3	4	5	6	7	8	9	10
%	0%	0%	8%	3%	6%	6%	8%	31%	22%	17%

slido

☆ In terms of supporting engagement and learning, how would your rate the following: Group Sustainability Presentation

Rating Poll   ☑ 31 votes   👥 31 participants

Score: **6.8**

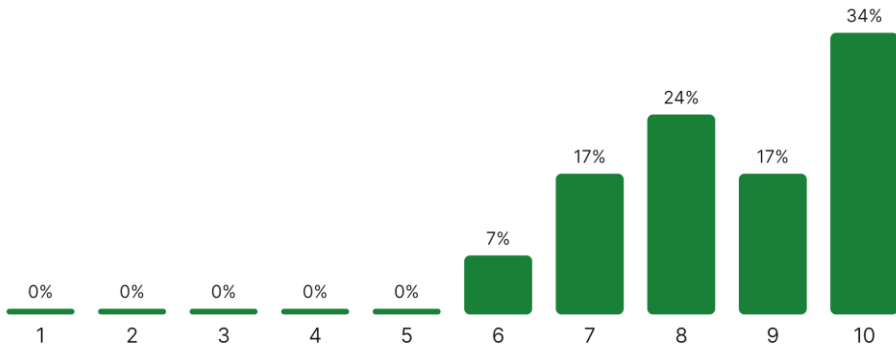| Rating	1	2	3	4	5	6	7	8	9	10
%	3%	0%	0%	6%	16%	13%	16%	35%	0%	10%

slido

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⭐ In terms of supporting engagement and learning, how would your rate the following: (Ed Byrne's) PE3011 Content/Material/Slides

Rating Poll · 41 votes · 41 participants

Score: **8.5**

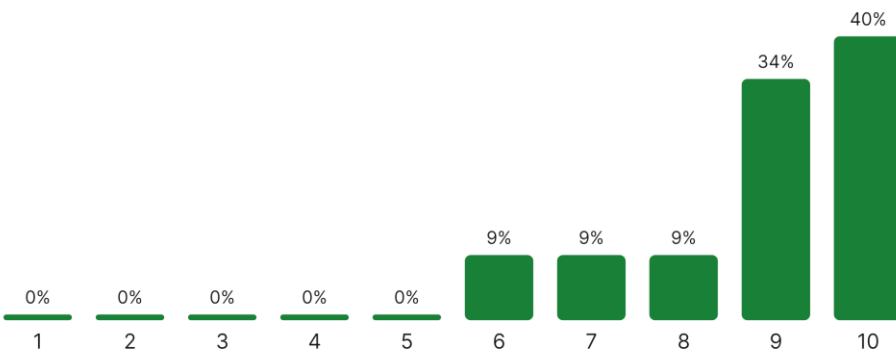| 1	2	3	4	5	6	7	8	9	10
0%	0%	0%	0%	0%	7%	17%	24%	17%	34%

slido

⭐ How would you rate the teaching and learning experience for PE3011 as a whole? (Ed Byrne's section only)

Rating Poll · 35 votes · 35 participants

Score: **8.9**

1	2	3	4	5	6	7	8	9	10
0%	0%	0%	0%	0%	9%	9%	9%	34%	40%

slido

Student Reflections

*Investigating to what extent the **complexity**, **interconnectedness** or **uncertainty** of sustainability issues have become more evident:*

"How might you describe how your conception of 'Sustainability' has evolved (if at all) by taking this module?"

It has allowed me to think about sustainability in a different light and highlights the **complexity** of the issue.

Seeing sustainability in the sense of a **complete system**, from the **social** to the **universal**, the **constraints** and **impacts**.

My grasp of the **complexity of the world** we live in and how a simplified perspective of that world fails to account for really important **dynamics** - has evolved from this class.

Sustainability is a compound of a **number of disciplines- complex,** with **no one answer**.

I look at it with a **holistic mindset** now, before my view on sustainability was just recycling, reducing fossil fuels etc. Now I see it as a **way of life**.
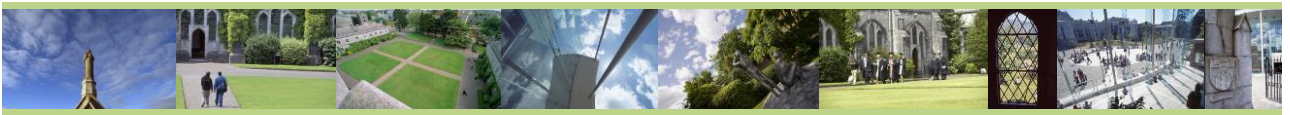
Importance of **joining together** to overcome individual paralysis.

Being more **open minded** to **different solutions**

Consuming what I **need** as opposed to what I **want**!

Sustainability is a **multidisciplinary** issue which can only be put in place when **all disciplines work together**.

It's much more **complex** than just **reducing** emissions and protecting species.

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Coláiste na hOllscoile Corcaigh

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