Engineering and Society

Embedding active service learning in undergraduate curricula
Engineering has an image problem

#11% is not enough

5% of primary school teachers have a STEM higher qualification

Gender identity is formed between ages 5-7
Overview- The engineering skills challenge

- **Male**
  - Students taking GCSE: 600k
  - Students achieving A*-C grade in 2 sciences and maths at GCSE: 300k
  - Students taking A level maths and physics: ~30k
  - Students taking engineering, IT and construction apprenticeships at level 3: ~30k
  - Students taking engineering degrees (UK domiciled): 15k
  - Engineering graduates going into professional engineering occupations: 8k

- **Female**

Royal Academy of Engineers
Social Cognitive Theory

“An individual's learning is not only related to their personal capabilities and experience, but also to their observations of others within the context of social interactions, experiences, and outside media influences”.


**Direct learning**

Experience of success and emotional arousal = mastery

**Indirect learning**

Social norms and social persuasion
Vicarious experience = role modelling
STEM engagement... with whom?

Engineers
- Improving public engagement skills is a key aim for engineering professional bodies (EPC, 2014)
- Recruitment into engineering is needed to meet the employment gap (Engineering UK, 2017).

Teachers
- 50% of primary school teachers identify low confidence and subject knowledge in engineering (ENGINEER, 2014)
- Initial Teacher Education is key opportunity to embed experience in curriculum.

Key Stage 2 Primary School Children
- Children, particularly girls, decide on the appropriateness of science as a career before age 11 (Archer et al, 2013).
- Girls like connecting STEM disciplines with relevant real-world problems (High Level Group on Science Education, 2007).
Engineering and Society

New 15 credit module at UWE for third year engineering students

• Importance of “Engineering Citizenship”:
  – Professional development
  – Lifelong learning
  – Competencies and social responsibilities of a professional engineer.

• Understanding of and engagement with the effect of engineering upon society
  – Part of the professionalism demanded by the UK Engineering Council ‘s Specification for Engineers (UK-SPEC).
Paired Peer Mentors

Year 3 Initial Teaching Education students

Public Engagement skills

Year 3 Engineering Students BEng/MEng

Engineering knowledge

Inquiry-based science education

Key Stage 2 Primary School Children
Engineer and teacher training

Engineer training:
• Communication skills
• Pedagogical theories

Teacher training:
• Engineering Design Process
• STEM concepts
Engineering Design Process

- Force and Balance
- High Flyers
- Mechanics
- Sinking and Floating
- Electricity

www.engineer-project.eu
Researching conference
Evaluation Design

**Student Engineers**
- Open response questionnaires
- Reflective diaries
- Perceptions questionnaire
- Engineering Outreach Self-Efficacy Scale

**Pre-Service Teachers**
- Open response questionnaires
- Reflective diaries
- Perceptions questionnaire
- Engineering and Science Subject Knowledge Confidence Scales
- Teaching Engineering and Science Self-Efficacy Scales

**Children**
- Open response questionnaires
- Perceptions questionnaire
- Post-it note feedback wall
Self-efficacy

Confidence in ability, where 1 is Not at All and 10 is Completely

P<0.00  P<0.00  P<0.00

Engineering subject knowledge  Engineering teaching self-efficacy  Science teaching self-efficacy

Pre mean  Post mean

Inspiring the next generation

**Engineer 9:** I've really enjoyed this project because not only did I feel like I was teaching a class, I felt like I was teaching a generation.

**Teacher 7:** I am excited and confident that I can effectively give pupils motivation. It is an interesting and engaging way to teach science.
Paired peer mentor model

**Engineer 10:** Working in a pair was very helpful. There were instances where my engineering knowledge was necessary to speak to the class and equal instances where my partner helped knowing how to speak to the children, control the class etc.

**Teacher 10:** It was useful having an engineering expert during certain aspects of the teaching lesson, as he was able to explain the scientific terms regarding forces - like lift, weight, mass and thrust.
UK Engineering Council’s UK-SPEC

Requires skills and proven (evidenced) competencies in the following areas:

A. Knowledge and understanding

B. Design and development of processes, systems, services & products

C. Responsibility, management or leadership

D. Communication and inter-personal skills

E. Professional commitment
Professional Engineer

- **Professionalism: Chartered Engineer**
  - Personal commitment to professional standards, recognising obligations to society, the profession and the environment.
  - General and specialist engineering knowledge and understanding to optimize the application of existing and emerging technology.
  - Provide technical and commercial leadership.
  - Apply appropriate theoretical and practical methods to the analysis and solution of engineering problems.
  - Demonstrate effective interpersonal skills.

---

**UWE Bristol**

**University of the West of England, England**
University social responsibility

The module aims to enable engineering students to:

• Understand and critique pedagogical theories and strategies for teaching Science, Technology, Engineering and Mathematics.

• Demonstrate an ability to design, plan, communicate and deliver STEM concepts to different audiences (e.g. teachers & school pupils).

• Develop awareness of ethics and risk assessment in professional practice, including codes of practice, professional standards & workplace ethics.

• Action plan for their future career and personal goals in employment.
Module Assessment

**Formative Assessment:**
Develop Log Book from School STEM Engagement Activity

**Summative Assessment**

- **Portfolio**
  Log Book & career plan with focus on UK-SPEC

- **Group Presentation**
  on agreed Societal Theme

- **Reflective Report**
  Personal review of the module and related learning
Engineering in a wider context

Competencies

• Practitioner as methodologist – able to choose, use, evaluate methods, techniques, tools and technologies.

• Reflective practice within professional development.

• Instigator for equity within society.

Appreciation of society’s issues
Professionalism in determining equitable solutions.
Welcome

Welcome to Curiosity Connections – the network for people inspiring primary STEM learning in the Bristol region. Have a poke around and explore what’s on offer...
Engineering and Society

Embedding active service learning in undergraduate curricula

Presentation by
Laura Fogg-Rogers
Senior Research Fellow in Science Communication
@laurafoggrogers
Laura.foggrogers@uwe.ac.uk

Wendy Fowles-Sweet
Director of Professional and Workforce Development
Wendy.Fowles-Sweet@uwe.ac.uk

24/11/17
Engineering Education Research Conference