



Build Your Own Digital Railway

Teacher Resource Sheet

WHAT IS STEM

The National Science Foundation first coined the STEM acronym, which stands for Science, Technology, Engineering, and Mathematics, in the 1990s. STEM encompasses many subjects and it is important because it has helped transform and advance many aspects of our lives. STEM education focuses on integrating the STEM subjects into one curriculum to emphasize its real world application. Recent initiatives in STEM education target young students in order to improve proficiency in STEM subjects and inspire them to pursue careers in engineering and other related fields. In response, an outpouring of prominent business leaders, politicians, and academics have been actively encouraging and promoting the teaching and funding of STEM activities in schools over the past decade.

STEM EDUCATION IN THE UK

According to a review of the UK's policies on science and innovation, "There has been a 20-year decline in the number of pupils taking A-level physics" (Sainsbury, 2007). This demonstrates a need for creating a pipeline of skilled graduates in STEM fields since their demand will only increase with the growth of related science and technology careers. The Royal Academy of Engineering's report Jobs and Growth details how the demand for people to fill Science, Engineering, and Technology (SET) occupations currently exceeds supply, which is only likely to intensify with an increase in economic growth (Harrison, 2012). Presently, there is a need for more than 100,000 STEM graduates a year but only 90,000 individuals are graduating with STEM-related degrees (Harrison, 2012). This leaves an annual deficit of over 10,000 STEM proficient workers. This trend is highly worrisome because engineering alone accounts for 21% of the UK's GDP (Browne 2012).

The Parliamentary Office of Science and Technology has long acknowledged the lack of STEM skilled workers in the United Kingdom, and notes that 42% of employers in the UK claim there is a shortage of STEM proficient employees (Parliamentary Office of Science and Technology, 2013). In a report published in 2013, the UK government planned several reforms designed to improve on the situation, most notably including a review of the national curriculum that would increase the focus on English, math, and science. Following an inquiry at the House of Lords in 2012, current recommendations include making mathematical study compulsory past age 16.

The National STEM Centre has taken a major role in implementing these changes, with a focus on evaluation of practices and improvement of STEM education (National STEM Centre, 2011). From as early as Key Stage 1, students are expected to spend a third of their class time studying science and mathematics. Both are required until the end of a student's secondary education (Key Stages 3 & 4), at which point they may choose three subjects in which to continue (Elliott, 1997; UK Department of Education, 2014). Despite the early focus on STEM learning, engineering is still an unpopular choice for students in higher education. It is important for students to participate in STEM outreach programs so they are educated on STEM and the career paths they can pursue if they study STEM. It is also important for educators to understand STEM and all that it entails.



WHAT IS ENGINEERING

Engineering is combining creative and practical skills to design, create, test, and improve products and processes. There are many avenues of engineering and almost every product you come into contact with throughout the day involves some sort of engineering.

TYPES OF ENGINEERING

Engineering plays a major role in many different industries and it is not just for one type of person. There are over 200 types of engineering that students can pursue, each with its own characteristics and career outcomes. Below is a table describing some of the most popular types of engineering:

Types of Engineering	
Aerospace	Responsible for the research, design, and production of aircraft, spacecraft, aerospace equipment, satellites, and missiles.
Agricultural	Look for solutions to problems involving the use of plants, animals, and the natural environment.
Automotive	Design, build, maintain, and operate self-propelled land and sea vehicles.
Biomedical	Combines mechanical engineering with human anatomy to develop technologies related to health care such as prosthetic devices, and medical diagnostic machines.
Chemical	Combines chemistry, mathematics, and physics to the design and operation of equipment and methods for the manufacturing of chemical products.
Civil	Design, management, and construction of buildings and infrastructures such as: highways, railways, transit systems, airports, and bridges.
Electrical	Generation, production, transmission, distribution, and application of electrical components.
Environmental	Develop solutions to problems affecting the welfare of humans and nature such as pollution, water quality, and hazardous waste control.
Industrial/ Manufacturing	Utilize knowledge of equipment, processes, and materials, human resource, and production to improve efficiency, productivity, and effectiveness.
Mechanical	Utilize knowledge of mathematics, material science, and physics to design, manufacture, and maintain mechanical equipment.
Petroleum	Exploration, development, and processing of oil and gas.
Software	Design, develop, and maintain software systems and products.
*definitions from: http://www.aboriginalaccess.ca/adults/types-of-engineering and http://www.nacme.org/types-of-engineering	



WHY STUDY ENGINEERING

There are many benefits to studying engineering. It is a very rewarding career that allows people to blend their knowledge of STEM subjects with creativity and innovation.

Job Satisfaction

- Engineering is ever changing. Those who enter engineering as a career path will be exposed to many interesting and new opportunities to work on a variety of different projects.

Transferable Skills

- Studying engineering allows students to gain knowledge and experience working in different environments and developing different skills. Students are able to develop communication, teamwork, and critical thinking skills which can be applied to many different life scenarios.

Wide Variety of Career Opportunities

- Studying engineering allows people to have a wide range career opportunities. People who study engineering can easily move between different engineering fields and industries because they have a wide range of skills and capabilities.

Creative Thinking

- Engineering is a very creative profession. It requires students to find innovative solutions to open ended questions or problems.

Potential to Benefit Society

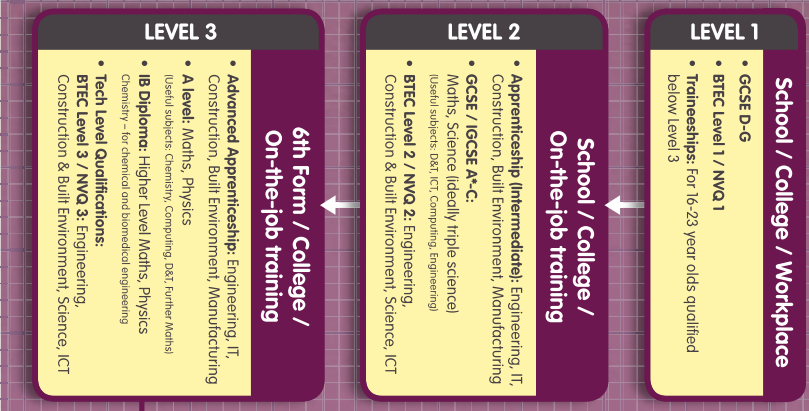
- Everything engineers do benefits society in some way, shape, or form. Although not all engineers can see the benefits they bring to society, they do contribute to bettering the lives of people.



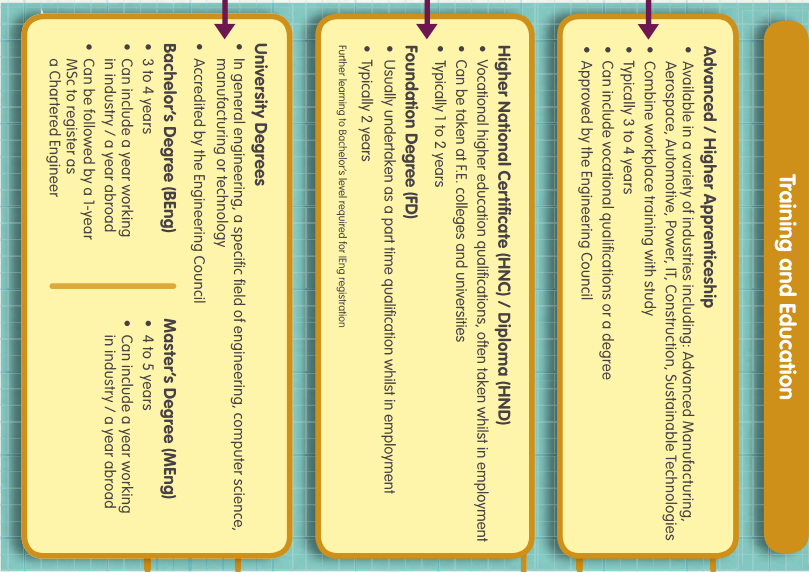
ROUTES TO ENGINEERING

Career Route Map For Engineering in England

Where do I start?



What next?



Progressing to...?





TEACHING STEM

'Changing the Conversation' is a social movement towards benefitting the engineering industry. Some of the problems include a misconception of engineering the career opportunities available, the field's lack diversity, specifically the percentage of women within the industry, and how engineers communicate with professionals (and students) outside of the industry. While teaching about the above information and similar STEM-related concepts, consider the following notes and statistics from *Engineering UK 2015: The state of engineering* authored by Dr Anil Kumar, Neil Randerson, and Elliot Johnson:

- "Almost one if five (17%) of all STEM teachers think that a career in engineering is undesirable for their students" (p48).
- "engineering came highest on a list careers that teachers professed to being unfamiliar with: 39% of teachers stated that they had no personal understanding of engineering as a profession" (p49).
- "STEM engagement activities should incorporate several key elements which include... continuing professional development for STEM teachers" (p49).
- "Uninspiring teachers was one reason pupils gave to inspectors to explain why they did not wish to continue studying science" (p49).
- "one in five children said they did not feel informed about what jobs are available" (p50).
- "The Social Mobility and Child Poverty Commission reported that '55% of employers think not enough young people leave school with work experience...children are more likely to struggle to get access to high quality opportunities'" (p51).
- "encouraging women into the STEM sector is vital in order to fulfill business needs" (p53).
- "the World Economic Forum [states] that... 'a nation's competitiveness depends, among other things, on whether and how it educates and utilizes its female talent'" (p53).

The Engineering UK Report annually updates the status of engineering, reviewing the year's most important engineering and STEM-related studies, a multitude of challenges the UK must overcome to move forward and realise its full potential. The original report can be found here:

http://www.engineeringuk.com/EngineeringUK2015/EngUK_Report_2015_Interactive.pdf



Useful Websites

Below you will find a list of useful websites for presenting STEM to students.

Tomorrow's Engineers is a one stop shop for information and resources about the careers available in engineering. It also contains resources for students and young people, including engineering case studies, and downloadable resource packs for teachers.

<http://www.tomorrowsengineers.org.uk/>

Young Engineers is a national network of schools and individual students that offers engineering oriented resources and activities as well as opportunities to attend engineering focused events and compete in engineering challenges.

<http://www.youngeng.org/>

Royal Academy of Engineering is the UK's national academy for engineering. Developed with teachers, the Academy has produced a suite of engineering based resources for teachers and STEM Ambassadors.

https://www.raeng.org.uk/education/eenp/engineering_resources/default.htm

STEMNET works with schools and colleges to help educators inspire students in STEM. They help educators access a range of STEM Enhancement and Enrichment (E&E) opportunities, including STEM Clubs and links with STEM Ambassadors.

<http://www.stemnet.org.uk>

References

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