



Royal Academy
of Engineering

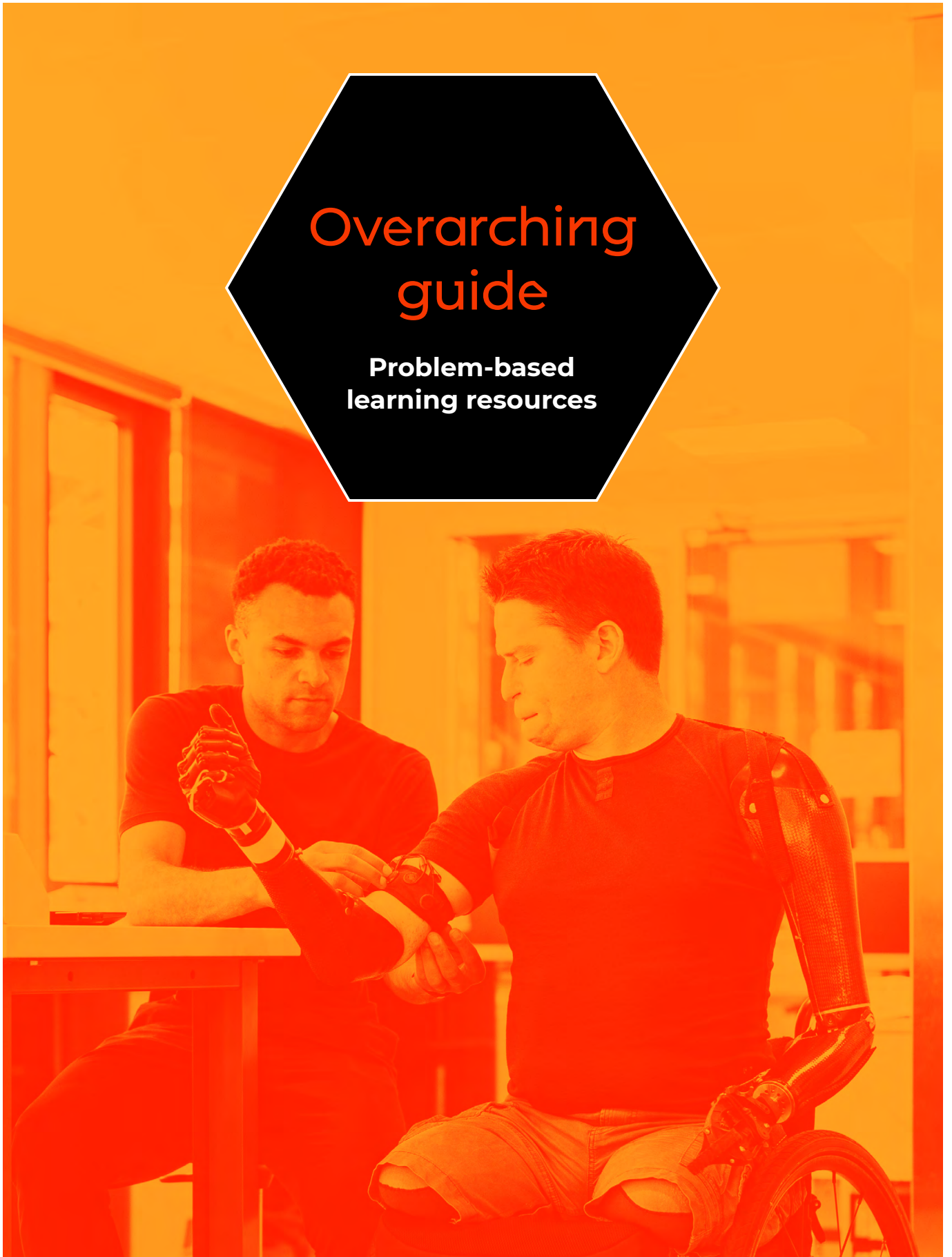
Sheffield
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ENGINEERING

Overarching guide

Problem-based
learning resources



Introduction

Sheffield Institute of Education Research and Knowledge Exchange Centre developed an Engineering Solutions (ES) approach to teaching and learning through Problem-Based Learning (PBL) that draws heavily on the RAEng report “Learning to be an Engineer” (RAEng, 2018) and research evidence showing that interest in Science, Technology, Engineering, and Mathematics (STEM) education is increased by emphasising a “people-centred” rather than a “kit-centred” approach (Bevins and Price, 2016).

PBL offers a pedagogical approach that encourages active and group learning framed by a belief that effective learning is stimulated when students construct knowledge for themselves and co-construct with others (Glaser and Bassok, 1989). PBL is iterative in nature involving teachers/lecturers acting as facilitators to guide and advise students through the learning process while encouraging autonomy and responsibility within their learning.



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What are these materials and why have they been produced?

Rather than providing a collection of technical content for learning via direct instruction, these resources take the form of five open-ended projects that conform to a PBL model where students are encouraged to research and develop their own work plans to achieve a technical objective and prepare them better for the world of work.

The projects are as follows:

1. Cliff Railway

Students act as consulting engineers to explore the challenges faced in the design, construction, and maintenance of a cliff railway (funicular)

2. EV charging station

Students act as consulting engineers to explore and consider the factors involved in designing, installing, and maintaining a charging station for electric vehicles (EV) to achieve peak operational performance.

3. Growing Environments

Students are tasked with developing a low-cost hydroponic growing system that minimises its environmental impact through the reuse of waste to create the growing chambers and minimising energy consumed by the system.

4. Portable Incubators

The safest place to be born is in a well-equipped and well-staffed hospital, but babies can be born unexpectedly early and in distress for a number of reasons: war zones or disaster aftermaths for example.

In this project, students are tasked with developing an incubator that is portable, reliable, and easily deployed in a wide range of circumstances.

5. Engineering Opportunities

Students identify an engineering project to address a practical need in an environment they're familiar with and introduced to a range of creativity techniques and team working skills through an engineering design cycle.

The project tasks include practical, investigative activities, group work (e.g. team planning meetings), and a series of individual paper-and-pencil exercises (e.g. writing reports, mathematical exercises).

In addition to the above material, there are two further documents to support understanding of the resources and to build your own, these are:

1. Engineering Solutions – an innovative pedagogy
2. Developing your own engineering solutions

The first document examines the theory and pedagogy behind the resources based on the research and the second acts as a guide to help practitioners produce their own versions to suit their own specific needs.

Which qualifications do they support?

Fundamentally any level 3 qualification as the material can be geared towards the student’s field or learning from mechanical to electrical, as the fundamentals remain the same.

The resources are designed in a way that also caters to the three pathways of the Engineering & Manufacturing T Level.

What materials are included for each project task?

The five project tasks are organised in the same way and have a set of resources as stated in the table below.

Resource	Usage
Student pack	Consisting of a 12-page booklet that gives details of the proposed task and a series of forms to use throughout the various stages of the project.
Teacher pack	A guide for practitioners that contains an introduction to the whole project providing an overview describing the objective, suggestions of how to organise the project, assumed background knowledge and links to relevant specifications, and a detailed Lesson Plan for each lesson.
Technique sheets	There are 29 technique sheets provided to support the revision of topics that the students may need to complete the project, and guidance within the teacher pack provides suggestions for techniques that students are most likely to need.

Do the materials provide a complete resource for delivery?

The resources are intended to form the basis for practitioners’ own lesson materials and schemes of work and share a common approach through the processes of **Codify, Plan, Perform, Review** and **Present**.

The projects are designed to occupy learners for up to 30 hours depending on the approach taken, but teaching and learning will inevitably involve some smaller repeated cycles, or cycles with some components omitted for convenience, throughout the project duration.

