Enhanced contextual problem solving by engagement in design and build competitions: A case study-based review.

Ian Tuersley & Kate Mawson,
University of Warwick
Structure of Engineering Degrees at Warwick:

Year 1, Year 2, Year 3, Year 4/5

- **BEng Graduate**
- **MEng Graduate**

Intercaled year (if desired)

Individual Project

Group Project
Engineering Degree Streams Offered by Warwick:

- Engineering (General)
- Automotive Engineering
- Civil Engineering
- Electronic/Electrical Engineering
- Mechanical Engineering
- Manufacturing & Mechanical Engineering
- Systems Engineering

- Engineering and Business Management
- Engineering and Business Studies
Typical 4\textsuperscript{th} Year Group Projects:

- Improving the Sustainability of Warwick University's District Energy System
- Additive Manufacturing of electronic circuits, electronic devices and sensors
- Demonstrator for outreach activities in biomedical engineering
- WUSAT – Warwick Satellite
- Analysis of Vibrations on Lightweight Footbridges Caused by Passing Trains
- Appropriate technology for hearing loss in lower income countries
- Mobile Robotics (‘Rescue Robots’)
- Formula Student (Racing cars)
- ........
Warwick Human-Powered Submarine:

- Objective is to design and build a human-powered submarine according to the ISR /eISR competition regulations
  - Annual Competition, alternating between US (ISR) and Europe/UK (eISR).
Warwick Human-Powered Submarine:

- ISR is sponsored by the US Foundation for Underwater Research & Education (FURE) and hosted biennially by the Naval Surface Warfare Centre at Carderock, MA. Judges include Admirals and NASA astronauts.

- eISR sponsored by the IMarEST, Babcock International, DE&S (Defence Equipment & Support, part of the UK MoD), QinetiQ and other companies.

- Both events attract truly international competition, from countries as far afield as New Zealand, Canada, USA, Netherlands, Germany, Mexico and of course the UK.
Perceived Benefits to the Students;

- Authentic Assessment (Frey et al, 2012)
- Enhanced student engagement through creative practices (Zepke & Leach, 2010)
- Experiential Learning
- Legitimate Peripheral Participation (LPP)
- Real-World experience of sponsors, outreach, media coverage (marketing/promotion)
- ... all delivered in an environment of supportive competition.
Evidence of benefits?

Project marks against non-competition based projects:

Group Project Average Marks 2013-17

(Paired t-testing suggests a very highly significant difference between the average marks – importantly, across the 1st/2(i) grade boundary.)
Evidence of benefits?

Student feedback:

Verena Oetzmann, (2016/2017 team leader):

“In addition to all the challenges that we women in engineering face, being the female leader of an otherwise all male team was a demanding but very rewarding role. The lessons I have learnt throughout my time, coupled with the many skills procured along the way, have been invaluable as preparation for working life after university. 

Despite being the most difficult venture that I have undertaken at university, it is certainly among the most enjoyable, rewarding and memorable experiences I have ever had.”
Evidence of benefits?

Staff (Project Directors) feedback:

• Consistently elevated level of student engagement;
  o the end goal is ‘real’ (and often high-profile)

• Enhanced employment opportunities;
  o Reports of ‘competitive’ projects being a highlighted feature of job interviews. Many engineering companies and organisations now target these events for graduate recruitment and ‘future leader’ programmes
  o Establishes strong links with sponsor companies. A number of these students have gone straight into related internships or jobs as a direct result of their involvement with the project.

• Significantly improved ‘key skills’, such as;
  o Problem solving, team-working, planning/time management, budgetary awareness etc.
Possible Drawbacks?

• Competitive element may encourage ‘gaming’;
  • research being conducted into improved ‘peer assessment’ methodologies

• Misplaced priorities;
  • enjoyment of competitive elements can lead to too much time being spent to the detriment of other, higher-stakes assessments.
Driving Teaching Excellence - How?

• We recommend the use of team-based projects in STEM teaching environments.

• We recommend that such projects engage with (external) competition events wherever possible
  • Providing LPP via enforced deadlines, budgets and assessment.

• If such competitions don’t exist?
  • Create them! (potential for profile-raising engagement). We would be very interested and willing to discuss opportunities.

   (ian.tuersley@warwick.ac.uk or K.Mawson@warwick.ac.uk)
Thank you for listening
Any Questions?
**Engagement:** Zepke and Leach (2010)

**Table 1.** A conceptual organizer for student engagement

<table>
<thead>
<tr>
<th>Research Perspectives</th>
<th>Proposals for Action</th>
</tr>
</thead>
</table>
| Motivation and agency (Engaged students are intrinsically motivated and want to exercise their agency) | 1. Enhance students’ self-belief  
2. Enable students to work autonomously, enjoy learning relationships with others and feel they are competent to achieve their own objectives |
| Transactional engagement (Students and teachers engage with each other) | 3. Recognize that teaching and teachers are central to engagement  
4. Create learning that is active, collaborative and fosters learning relationships  
5. Create educational experiences for students that are challenging, enriching and extend their academic abilities |
| Institutional support (Institutions provide an environment conducive to learning) | 6. Ensure institutional cultures are welcoming to students from diverse backgrounds  
7. Invest in a variety of support services  
8. Adapt to changing student expectations |
| Active citizenship (Students and institutions work together to enable challenges to social beliefs and practices) | 9. Enable students to become active citizens  
10. Enable students to develop their social and cultural capital |