Rose Edmondson outlines how children and teachers are engaged in a hands-on engineering challenge to enrich their STEM learning

Figure 1 Celebrating success on the GMEC Challenge day

ExtraOrdinary Spaces: engaging pupils with real-world engineering

Do you want your pupils to understand how science applies to real-world contexts, to provide more hands-on engineering experiences in your curriculum or to improve the way you integrate STEM industry partners within children's learning? These are some of the questions asked as part of the Greater Manchester Engineering Challenge (GMEC), an annual programme developed by Manchester University's Science and Engineering Education Research and Innovation Hub (SEERIH).

Background and rationale

The GMEC is an innovative campaign that has been run annually since 2018. It was designed to inspire primary and secondary pupils from ages 7 to 14 to engage with engineering in a mainstream setting. The approach to the programme was based around *Tinkering for learning* (Bianchi and Chippindall, 2018) and drew on the 'engineering habits of mind' and 'engineering design process' described in *Thinking like an engineer* (Lucas, Hanson and Claxton 2014). In line with SEERIH's principles, the programme also includes the provision of professional learning for in-service teachers, with the ultimate aim of disseminating the learning around engineering in primary schools to larger audiences through a pupil-facing event programme.

The theme 'ExtraOrdinary Spaces' was carefully selected for GMEC 2020, as the construction industry is a priority area of interest for Greater Manchester and for Oldham in particular. With a view to enhancing knowledge and awareness of the construction industry, the discipline of civil engineering was selected. Other areas of interest, in Greater Manchester in particular, which were integrated into the programme, were wellbeing and sustainability.

ExtraOrdinary Spaces: Designing the programme

The GMEC Challenge for 2020 involved two parts:

- **In school: Pupils imagined and designed a 2D plan for a new community space based on a real area in Oldham. They researched and integrated sustainable features while also engineering in features for improving health and wellbeing.**
- **The University Challenge event: Pupils showcased their designs to peers and STEM VIPs. They worked alongside industry engineers to create a large, scaled 3D model inspired by their new knowledge and skills.**

A key part of the programme for 2020 was using what had been learnt in previous years, which is why it was decided to put a huge focus on the development of the knowledge and skills of both teachers and pupils. Although engineering does not have

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a specific key focus in the primary curriculum in England, having focused on the research on engineering habits of mind and the engineering design process, it quickly became obvious how easy it is to make links to other areas of the curriculum, including maths, technology and science.
It was agreed that the aims of GMEC 2020 would be:

- **to provide a hands-on, engineering challenge to inform and engage pupils, teachers and engineers in the engineering design process using a range of engineering habits of mind;**
- **to raise the profile of construction through civil engineering, with emphasis on how social issues such as sustainability and wellbeing are engineered into new and existing builds and spaces;**
- **to involve industry engineers, academics and university students as co-developers and mentors to the project team and schools;**
- **to provide a professional learning programme for in-service teachers, with related curriculum-linked resources.**

Box 1 shows an outline of the project design, giving an overview of key events across the year and the discussions that took place. As can be seen, collaboration and communication were key factors in making the project effective.

Involvement of key partners

The partners from industry and beyond who engaged in the programme included Jacobs Engineering, Siemens, Bruntwood and the charity Maggie's Oldham. Alongside these key partners were students and staff from the Faculty of Science and Engineering of the University of Manchester and from Class of Your Own (specialist educational consultants for civil engineering). Each partner had close contact with the SEERIH team and collaborated to share their interests and visions for the programme, which allowed an informed programme to evolve.

On reflection there were three main roles:

- **Coach: This role informed and offered guidance about the processes and practices of engineering and in particular civil engineering. A meeting at the beginning of the programme was crucial in sharing ideas and harvesting information about contemporary contexts.**
- **Co-creator. This role was adopted by just one of the partners, who offered a very hands-on approach. The experience, knowledge and creativity from Iggy Smith from Jacobs Engineering was vital, both in supporting the creation of resources that matched those used in the workplace (e.g. 2D specialised maps) and advising on regularly used sustainable materials and technologies. His specialist advice about landscaping and civil engineering helped to make the project authentic.**
- **Ambassador. This role was more typical of industry involvement, providing face-to-face engagement with teachers and pupils through presentations at teacher and pupil days. There were a range of ambassadors from industry, including young professionals, and students and staff of the university; all were inspirational. Regardless of whether they were speaking on the stage, one-to-one or as part of a team, their knowledge, enthusiasm and passion shone through and may well have planted the seeds for some pupils to seriously consider a role in civil engineering in the future.**

Increasing science capital related to sustainability and wellbeing

Although these themes fit specifically with the Greater Manchester STEM strategy priorities for 2020, they are exceptionally important issues for society as a whole at the moment, particularly when considering civil engineering design. Our main focus was on how the themes of sustainability and wellbeing might fit directly into a school's local community, especially for the pupils themselves to appreciate that these themes are very real issues in their own communities.

During the immersion event, teachers received information about new technologies and sustainable materials used in buildings in our locality, for example in Circle Square and the Whitworth Art Gallery. This raised the teachers' awareness of how engineers integrate sustainability into buildings, from their heating to the choice of interior and exterior materials.

A surprising but highly valuable association was made with the Maggie's Centre in Oldham, a cancer specialist support unit. Their new building truly embraced wellbeing throughout: it was at the heart of all aspects of the design, with light, calm and tranquillity flowing though the building. It gave the teachers much food for thought, to take away to discuss and possibly implement in their own extraordinary community designs. And, as Trish Morgan, the Centre's Head said:

Maggie's Oldham was delighted to be asked to be involved in the GMEC project. It was a brilliant opportunity for us to raise awareness of how we support anyone with a cancer diagnosis, and their family and friends too, and we are really keen to inspire engineers of the future.

Box 1 Key events in the design process

- **September 2019: Initial scoping meetings** – To develop ideas and to upskill in the area of focus: civil engineering. Meeting with key groups/ organisations.
- **October–December 2019: Recruitment phase** – Approaches to participants in GMEC 2019 including all partners and interested schools.
- **December 2019: Immersion event and follow-up twilight event** – Involving 33 teachers from 28 Greater Manchester schools, 7 engineers, industry collaborators and SEERIH staff.
- **January–March 2020: In-school engineering tasks** – All schools developing understanding and awareness using bespoke pre-Challenge day tasks.
- **March 2020: GMEC Challenge day** – Attended by 140 pupils, 37 teachers and teaching assistants from 18 Greater Manchester schools, 17 engineers, VIPS from industry/education and University of Manchester and SEERIH staff.

Figure 2 Examples of children's 'mini-me' designs, created by measuring their height in cm and dividing by 50 (the scale required in the project); these were used by teachers and children to check their model communities were of an appropriate size and scale

Applied mathematics and D&T

The application of engineering is not explicit in the primary science curriculum in England; however, there are many links that can be developed when exploring opportunities through the lens of the engineering design process. In particular, maths skills, science and technology all dovetail into engineering activities.

It was a pleasure to develop the purposeful use of maths in this project as a tool to engage young children by helping them to appreciate how maths is applied in context. As a teacher, I really enjoyed providing the opportunity for pupils to see how maths is embedded into their lives and to appreciate its relevance. This perhaps will become even more important now that Ofsted, the UK inspectorate, are keen to see in practice a broad and balanced curriculum.

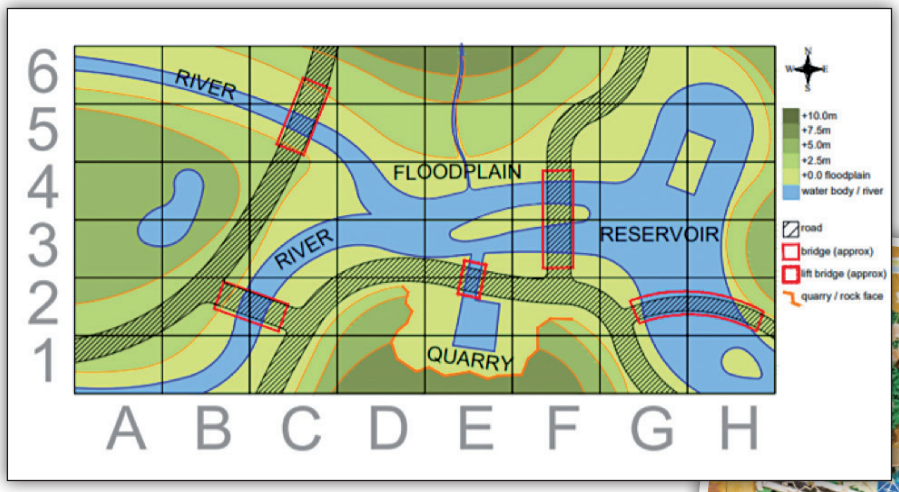

Figure 3 A 2D map turned into a collaborative 3D design

What was the impact on pupil learning?

Here are a few sound bites from the day from the pupils:

I got some advice from loads of different engineers. And also my favourite advice was that I should never say 'no', and I should say 'yes' to everything and try hard.

Fun and inspiring to find out that you can have different types of engineering.

Amazing. Fun!

And one teacher commented:

Our school is nearly 100% EAL and it's been a fantastic opportunity for our kids to come, communicate with other schools and other children from different backgrounds; and particularly showing them what engineering is like, is really showing them the aspirational side of engineering. The teamwork is just brilliant and I think it's been a fantastic day, giving a lot of opportunities to our kids.

A pupil evaluation toolkit was used to evaluate impact. It was designed by the Institution of Engineering and Technology (IET) and was adopted to track change from the previous two years of IET-funded GMEC projects:

- **100% of pupils felt that what they did for the GMEC was important or that they now have a better understanding of how engineers make a difference in their life. 97% also gave the experience full marks for enjoyment.**

- **100% of teachers reported they had learned something new to improve their teaching and work practices with science and engineering.**
- **96% of teachers said that the event was relevant to their needs and that they felt more confident in the topic areas that were addressed. Verbal feedback discussed ways that the GMEC Challenge could inform their D&T lessons and incorporate maths into both science and art.**
- **100% of teachers felt that the project had supported them to raise the profile of science and engineering in their school.**

Summary

Speaking as both a teacher and a SEERIH Teacher Fellow, I see the value of an event like GMEC as something that is great at raising children's science capital – or indeed their engineering capital! By raising the profile and relevance of engineering across the curriculum it shows how the STEM subjects are all interrelated.

Participating in GMEC this year has enabled pupils:

- **to see how engineering is integrated across a range of cross-curricular subjects;**
- **to recognise the impact that civil engineering has directly on their own lives and local communities;**
- **to explore the relevance of sustainability and wellbeing in their communities and beyond.**

Teachers and partners have also talked about enjoying the experience and how it has given them deeper knowledge, skills and awareness of engineering and how to embed it into classroom contexts. If I were to consider some ways of making it even better, they would be:

- **looking into the long-term impact of the programme in schools;**
- **finding out whether teachers need further support and guidance when trying to feed engineering experiences into their curriculum;**
- **finding a way of creating a sustainable long-term relationship between participating schools and their ambassadors/industry partners on the teaching of engineering in the future.**

I look forward to another year with SEERIH to further hone my own approach to engineering and bridging the primary–secondary phases through lively, contemporary and novel engineering challenges. Who knows how many engineers this could create for our future?

References

Bianchi, L. and Chippindall, J. (2018) *Tinkering for learning: learning to teach engineering in the primary and KS3 classroom*. London: Royal Academy of Engineering.

Lucas, B., Hanson, J. and Claxton, G. (2014) *Thinking like an engineer: implications for the education system*. London: Royal Academy of Engineering.

Further information

If you think GMEC is something you might want to engage with in the future there are a variety of resources including teachers' guides, presentations and examples of work produced available on the SEERIH website: **https://seerih-innovations.org/tinkering4learning/gmec**
A more detailed report summarising the GMEC 2020 event is available by contacting the SEERIH team via **fascinate@manchester.ac.uk**

Rose Edmondson is a University of Manchester SEERIH Teacher Fellow and a science teacher at Falinge Park High School, Rochdale.
Email: rose.edmondson@manchester.ac.uk