Primary Engineer Action Research Outcomes 2018

Primary Engineer is demonstrating an evidenced impact in Primary and Secondary schools across Scotland through teacher-led action research. 37 teachers have delivered practitioner-led enquiry as part of Primary Engineer's postgraduate certificate in *Engineering STEM*, looking at a range of themes and creating strategies within engineering education, including development of pedagogy, links between gender and self-efficacy in STEM and the importance of project-based learning. This Masters' level course has attained Professional Recognition status by the General Teaching Council for Scotland, winning an Excellence Award in 2017, and is accredited by the University of Strathclyde.

Colin Dorman, a primary school teacher in North Lanarkshire, created a community of practice across the upper school (8-12 yrs.) to investigate gender barriers within STEM education. From extensive surveys and interviews, Colin found that girls at the start of the project already lacked self-efficacy, or confidence, in their own abilities in STEM, even when their attainment was equal to or better than that of boys, so there was an early gap identified. Colin's research evidenced that through engineering projects, including the Primary Engineer and Secondary Engineer Leaders Award (in Scotland known as the Scottish Engineering Leaders Award), the confidence of all pupils in STEM improved at the same rate. His findings also showed that the biggest gains in self-efficacy for girls at the end of the intervention centred around (Design and) Technology. Interestingly, although all engineers who visited the school as part of the project were male, this still had a significant positive influence on girls' attitudes towards engineering. Colin's action research has impacted directly on colleagues across the school, highlighting how little research on the self-efficacy gap there has been at Primary level education (Education Scotland, 2015; Archer *et al*., 2013). As Colin's research concludes, "Ultimately, it is important to recognise and address these issues as early as possible if there is going to be a true paradigmatic shift that addresses the gender gap in STEM education and careers."

Michele McMahon is a primary school teacher in one of the most socio-economically disadvantaged parts of Glasgow. Michele's research looked at developing Engineering Habits of Mind (Lucas *et al*., 2014) through her delivery of Primary Engineer programmes across the school, supporting teachers through coaching and mentoring to develop their own pedagogy. Via pre-intervention and post-intervention structured observations and impact evaluations, Michele demonstrated that creative problem solving and problem finding skills increased in her pupils as a result of project-based learning, with the largest gains in 'model-making to show ideas' and 'adapting and improving' approaches. Michele's findings also evidenced that collaborative working had improved in many of the pupil groups within the sample who had found it easier to compromise and solve differences. "For me, it's about encouraging the pupils to take responsibility for their learning and guiding them along the way. I am more open to the children leading the learning as a result of this research project and hope that this will continue."

Lorna Hay, a Primary school teacher in a rural Fife school, introduced one hour of 'Primary Engineer time' with the eleven and twelve-year-olds in her Primary 7 class as part of the piloting of the Institution of Primary Engineers® across the school. Lorna's frequency analysis of the observation data revealed improvements in her pupils' learning behaviours in resilience and team work and in their

problem-solving skills, namely clarifying, improving and problem finding. The improvements were validated by pupil survey responses and teacher interviews. Parent and carer engagement also featured in Lorna's research through teacher interviews, "…the children were so enthusiastic...the majority of parents who came to parent's night said, 'I know [about the engineering], they can't stop talking about it.'"

Lynne Mylet is a Technology teacher in a Secondary school in Glasgow. Lynne's action research focused around the Primary Engineer and Secondary Engineer Leaders Award programme and working to build 'science capital' (Archer *et al*., 2013) through engineer engagement with students. Lynne delivered the programme to all S2 pupils (13-14yrs) at the school prior to them making subject choices. The outcomes of Lynne's research revealed that whilst the (Design and) Technology pupil numbers were capped at the previous year's level due to staff numbers and timetabling, the growth in those electing to study Physics had more than doubled. In 2017/18, nineteen students elected to study physics at National 4 and 5. After Lynne's intervention the number of pupils for the 2018/19 academic year had risen to 32, an increase of 68%. "The impact [of this project] on my class […] is that it has greatly improved their critical thinking skills and confidence in speaking about their designs. I have been working on similar projects since the Leaders Award project and I have noticed a marked improvement in their analytical skills when given a short brief. Prior to this project, students were unlikely to question or analyse the work that they had been given and simply followed instructions, normally from a worksheet or from the board. Now they can think for themselves and problem solve more readily than before. This is an area which will greatly improve their employability in the future and I will keep trying to foster this skill in my students in future years."

Ends:

Primary Engineer and Secondary Engineer Leaders Awards are known as the Scottish Engineering Leaders Award in Scotland.

The Curriculum for Excellence Technology subject area is equivalent to Design and Technology in England.

The Primary Engineer PGCert *Engineering STEM* is validated by the GTCS, accredited by the University of Strathclyde and part-funded by Skills Development Scotland.