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Tracey McKie, a Primary 1 teachers from a rural school in Ayrshire, undertook action research to consider changes she could make in her practice to better facilitate the learning of STEM and the development of STEM skills. Her action research paper, STEM WARS: The Forces Awaken identifies three principle aims:

- **To improve my own confidence and classroom practice and develop an appropriate pedagogy for the teaching and learning of STEM.**
- **To have a positive impact on pupils engineering STEM experiences.**
- **To enable pupils to become more actively engaged in their learning experiences, generate more ideas and take more risks.**

Tracey self-identified a lack of confidence in delivering STEM in the classroom and this is exactly the aim of the course: to encourage those who lack experience or confidence to engage, learn more and become the experts in their school.

Alongside Tracey's personal goal, she provided a context through the 'Early Intervention and Prevention' section of the Local Authority Community Planning Partnership Review of the Single Outcome Agreement.

> "*Schools in East Ayrshire support the belief that STEM subjects are key to securing positive opportunities and career paths for future generations and this begins in primary school. Whole class projects are mapped to the Curriculum for Excellence and designed to inspire and enthuse. The Early Years Engineer and Primary Engineer programmes provide children with the opportunity to apply practical maths and science to design and technology projects. All projects are linked to practising engineers to bring the "wow" factor into the classroom and provide real world context for learning.*"

Reading at Master's level (Archer, 2013; Lucas et al. 2014, Barefoot Computing, 2014; Curt Gabrielson, 2013; Doorley, 2014; Cuoco et al, 1996; Resnick & Rosenbaum, 2013) led Tracey to consider her role in the classroom and her practitioner enquiry focused on the question:

"If I become more of a 'fellow tinkerer' will the children become better at adapting.

When considering the intervention part of my proposed action research I considered that I would like changes to occur in these areas:

1. The adult/teacher role
2. The language that we use in our classroom
3. The methods and tools we use in our classroom" (McKie, 2016, p. 10.)

'Tinkering' is identified by Lucas *et al*. (2014) as a key 'habit of mind' shared by engineers working across all the discipline. This was of particular interest to Primary Engineer as anecdotally, there is a perception that learners in the Early stage demonstrate good manual / tinkering skills, but that

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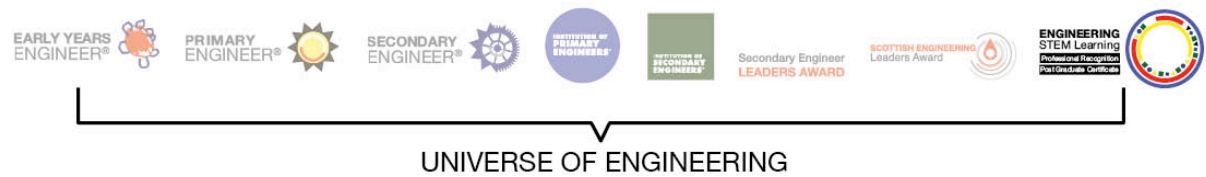
through lack of practice this is 'trained out' them by the time they complete primary, making them ill-equipped for technical classes from S1. This action research would give an opportunity to provide some much needed teacher-led evidence-base to 1) identify if this problem exists and 20 possible solutions.

Working within her P1 class, and with a sound methodology including observation notes, thoughts, photographs, videos and soundbites and fellow professional feedback, she found two main themes:

> *"Two main themes permeated my reflective diary and notes from observations. Firstly, my lack of confidence in my ability to help the young pupils generate 'good' scientific questions and my ability to model effective 'tinkering'.*

This initially posed a challenge to me in attempting to help them identify their problem and scaffold them to find a solution without just providing them with one which was acceptable to me. Notably a core requirement of the early years curriculum (Building the Curriculum 2, 2007) relates to challenging children's thinking and children identifying their own questions for investigation. Much emphasis is placed on the need to raise different kinds of questions, ensuring that a range of investigation types can be explored. What my reflections illustrated was that the undertaking of this study in the short timescale is more complicated and require further study. Implications for the future for my practice are a need for me to continue to find a way to dedicate good periods of time to these kinds of activities in order for the rest of the investigative work to be worthwhile.

The second theme which became evident was peer review. The pupils responded much better than I expected to the informed evaluation of the process necessary, and appeared resilient during the review process. They accepted comments from their classmates and were keen to return to their tinkering projects to make any improvements necessary. They also made helpful and insightful comments using the EHoM language. Time was a key issue in respect to pupils returning to their projects. Schools prioritise literacy and numeracy teaching often limiting other subjects, such as science and the technologies to afternoon sessions."
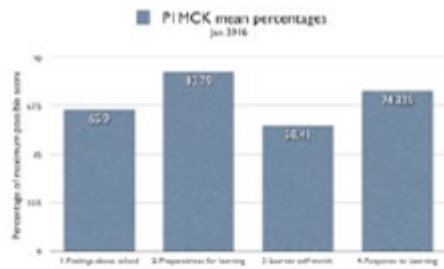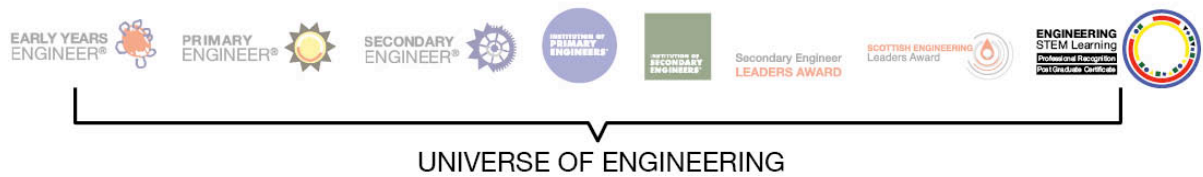
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Fig. 5

The survey was re-administered at the end of March 2016 and comparisons made.
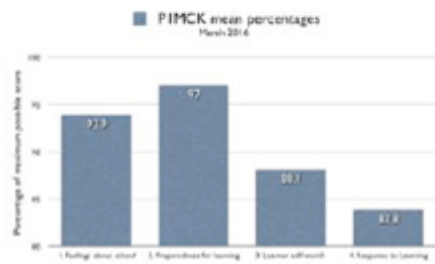

Fig. 6

Over the course of the action research and her intervention, Tracey noticed quantitative improvements alongside her qualiativie ones.

> "Overall feedback from the pupils (and colleagues) was very positive. The PASS Attitudinal survey at the end of the project indicated that the majority are in the top percentile, above the national average, in being positive about self and school. There was an increase in all areas, but the area with the most marked increase was in 'Learner Self-worth' - 29.69%, closely followed by 'Feelings about school' with an increase of 28%."

The impact spread further than simply the classroom though:

> "One of the most important aspects of this study, in my view, was that it afforded an opportunity for me to explore both the theory and practice of innovative pedagogy, STEM learning and EHOM. I feel that as a result of engaging with this experience I now have a clearer understanding of the body of literature on pedagogical approaches and of the practical application of that body of knowledge. I now have much more confidence that I can share my experience with my colleagues, backed up by the theory and practice. My teacher role changed from directive to supportive. By stepping back and letting the children lead, I have also learned to collaborate with the children more to set attainable goals and together explore different ways to achieve them. Most importantly though, I have rediscovered the joy of teaching!"