

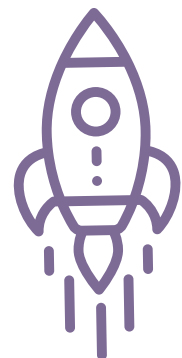
Primary Engineer Programmes
...the first step[®]



**Primary Engineer[®] Post Graduate Certificate
in Engineering STEM Impact Report**

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The origin and aims of the Primary Engineer® Postgraduate Certificate in Engineering STEM

At Primary Engineer®, we feel it is vital that teachers feel capable and confident in delivering the right information and skills, to support young people's development and ability to make informed decisions about their future.

The origins of this course design are founded in the challenges and solutions offered in The Skills Investment Plan for Scotland's engineering and advanced manufacturing sector, produced by Skills Development Scotland (SDS) in 2014. It highlighted the need across Scotland to raise awareness of engineering sector careers alongside the continued professional development (CPD) of teachers. In 2015, with the support of SDS, the University of Strathclyde and the General Teaching Council of Scotland (GTCS), we developed our Postgraduate Certificate (PGCert) in Engineering STEM.

Our aim is to provide teachers across the whole of the UK with an opportunity to extend their CPD from one day practical courses with Primary Engineer®, to an ongoing form of applied learning, critical reflection, and practice development. Teachers engage in a programme rich in evidence based research, which

they can practically apply in their setting. We also wanted to provide teachers with access to renowned experts in their academic fields and to opportunities to engage with a diverse range of industry professionals, both of whom can actively support their development. We also felt it was important to provide teachers with tangible evidence of their development, and this is provided in the form of 60 Masters level credits through the University of Strathclyde and Professional Recognition status by the GTCS, recognising the enhanced, significant, sustained and reflective enquiry a teacher has undertaken and the development of their professional learning in a particular area.

The meaningful action research that takes place during this course, is aimed to provide a valuable evidence base for improving STEM teaching and learning.



Skills
Development
Scotland

University of
Strathclyde
Glasgow

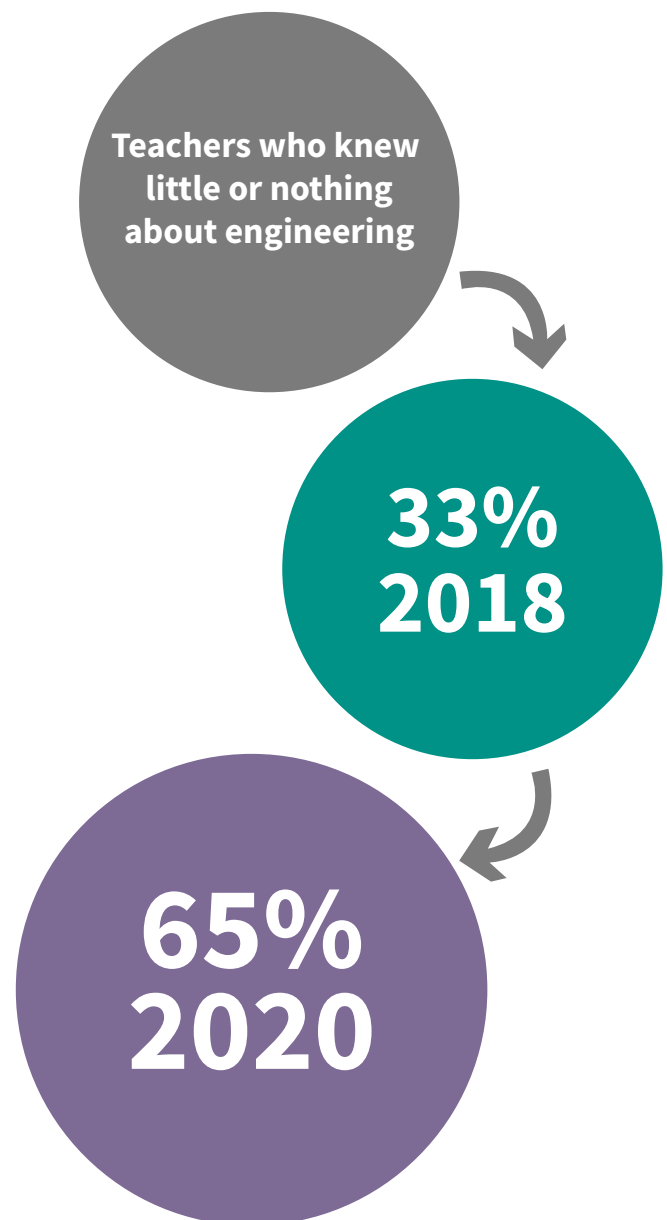
Why STEM Education is Important

In 2015, the Perkins review¹ emphasised the importance of young people to the future UK economy, as we see an ever increasing skills mismatch in the STEM sector. What we know, is that 20% of the UK workforce is in STEM based occupations and therefore STEM skills are critical in the move to rebalance the UK economy and improve productivity. UK businesses are desperate to fill thousands of STEM related jobs, but the lack of young people with the correct STEM skills is costing UK industry £1.5bn per annum in attempts to solve the problem².

The evidence shows that a large proportion of young people across the UK still have a limited understanding of STEM and, as a result, many perceive themselves to lack the ability to pursue a STEM career and are unsure of what a STEM career could look like³. For instance, recent data shows 47% of 11-19 year olds said they knew little or nothing about what engineers do and just 39% of 14-16 year olds said they know what to do next to become an engineer⁴.

We can see this has a tangible impact on industry, with businesses citing lack of awareness (31%) or lack of meaningful work experience opportunities (35%) as the main barriers to young people considering STEM careers².

However, many students have also cited poor experiences with teachers contributing directly to their negative perception of STEM and STEM careers⁵ and recent evidence suggests teachers have an increasing lack of knowledge of engineering confidence and knowledge to pass on to young people^{4,6}. A 2018 survey⁴ found that 33% of teachers knew little about engineering. More recently, Engineering UK reported that the number had now increased to around 65%², highlighting the need to develop teacher confidence and understanding of STEM, as well as possible STEM career routes for their pupils.



1 Perkins, J., 2013. Professor John Perkins' review of engineering skills. London, Department for Business Innovation and Skills.

2 STEM Learning. (2018). Skills shortage costing STEM sector £1.5bn. STEM Learning. Viewed 1st July 2020.

<https://www.stem.org.uk/news-and-views/news/skills-shortage-costing-stem-sector-15bn>

3 Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2013). Not girly, not sexy, not glamorous: Primary school girls' and parents' constructions of science aspirations.

Pedagogy, Culture & Society, 21(1), 171–194. <https://doi.org/10.1080/14681366.2012.748676>

4 Engineering UK. (2020). Educational pathways into engineering. Engineering UK

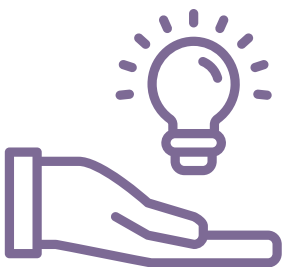
5 Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital and family habitus: How families shape children's engagement and identification with science. *American Educational Research Journal*, 49(5), 881–908. <https://doi.org/10.3102/0002831211433290>

6 Belfield, C., Crawford, C. and Sibieta, L., 2018. Long-run comparisons of spending per pupil across different stages of education.

The Importance of Investing in Teacher Development

2020 highlighted how important it is for schools to consider alternative approaches to teaching and learning. Schools and teachers rose to the challenge and many will use, or want to use, these experiences as an opportunity to make long standing changes to their practice.

Increasing the availability of high quality CPD to teachers has also shown to improve pupil learning and attainment. Over time, delivering effective teaching is far more cost effective than other interventions that result from a lack of progression in the classroom, such as catch up groups and one-to-one tuition. By developing a more critical engagement with information and improved awareness, teachers and schools can create a curriculum model that focuses on student inquiry and engagement with collaborative, networked technology to support and promote depth of learning, which, as we have seen over the last year, is vital. This is exactly what the PGCert in Engineering STEM encourages throughout the course, as teachers investigate new ways to approach teaching and are given opportunities to apply and reflect on those methods.⁷



“This course is well ahead of the game. It should be viewed as an important testing ground for ideas about how education can be made more relevant to the needs of society.”

Iain MacLeod, Emeritus Professor,
University of Strathclyde and
Secretary of IES

“It’s superb to see the impact that has been made not just on the young Primary Engineers®, which is obviously very positive, but also the impact on their teachers. It’s genuinely heart-warming to hear educators say of the programme, ‘I didn’t think I could do this, but now I know that I can!’, and it is greatly encouraging to me to know that they’re applying that positive attitude and approach in looking after future generations of engineers.”

Dr Lynne O’Hare,
Advanced Forming and
Research Centre

⁷ Chu, S.K.W., Reynolds, R.B., Tavares, N.J., Notari, M. and Lee, C.W.Y., 2017. 21st Century skills development through inquiry-based learning. Singapore: Springer Singapore. doi: <https://doi.org/10.1007, pp.978-981>.

The Course Outcomes

Throughout the course, teachers engage with post-graduate level STEM educational theory and enquiry, which allows them to be awarded the 60 Masters level credits. As part of the course, teachers are required to complete 4 assessments, either as written assignments or presented orally in the form of presentations.

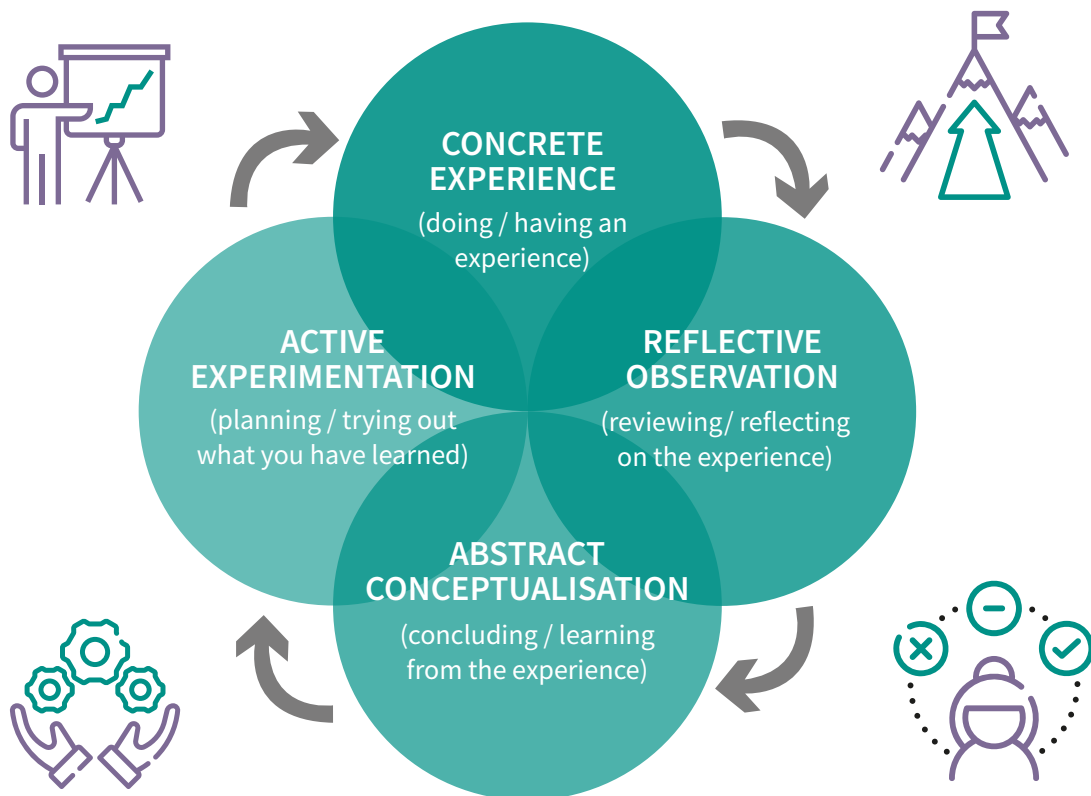
They will interview a diverse range of engineers to shape their understanding of STEM skills and use seminal texts, lectures and one-to-one tutorials to support their research. The structure of the course and assessments encourage well-known and effective cycles of learning experiences⁸, where teachers apply learning, reflect on their experiences, adapt, and improve their practice.

Their final assessment is an action research project within their setting, which allows them to apply everything they have learned during their journey through the course. The course is delivered by an experienced and qualified teacher, adult educator, and lecturer in education.

The accessibility of the course

Our interactive online approach to lectures and seminars allow teachers to engage in meaningful conversation and real-time engagement with experts in their fields, but recordings can be accessed anytime. We are fortunate to have lectures delivered by Professor Bill Lucas and Dr Janet Hanson, whose pioneering work on Engineering Habits of Mind, alongside The Royal Academy of Engineering, has become an integral part of engineering education and this course⁹.

Lectures, seminars, and tutorials all take place after school hours using online meeting technologies and all module content is accessible online.



8 Stice, J.E., 1987. Using Kolb's Learning Cycle to Improve Student Learning. *Engineering education*, 77(5), pp.291-96.

9 <https://www.raeng.org.uk/publications/reports/thinking-like-an-engineer-implications-full-report>

The Impact



50 GRADUATES



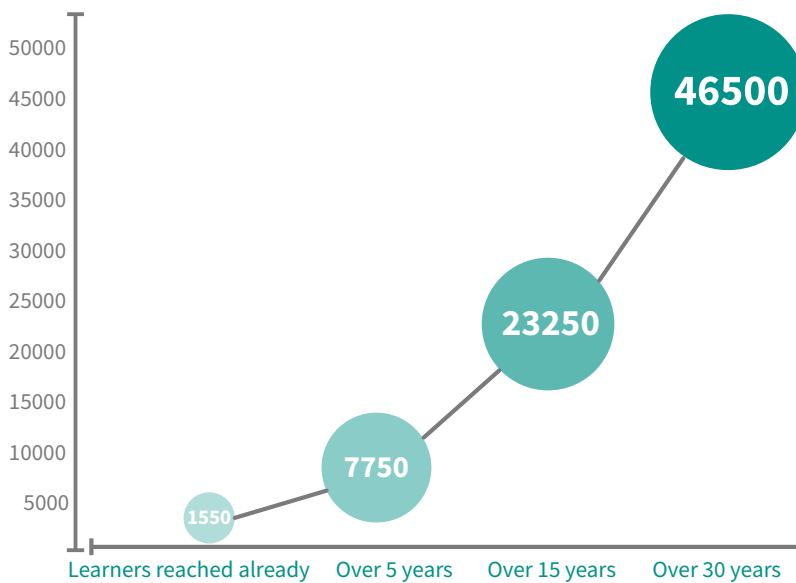
80%
Female Teachers



76%
Primary Teachers



Impact on young people



At least **1,550 pupils** will have directly benefited from the **50 teachers** who have completed this course*. Using some reserved estimates, we can see that those teachers are likely to **impact over 23,000 pupils** during a **15 year career** and over **45,000** during **30 years****.

Fundamental to this course is teacher interaction with industry and their engineers. Companies such as **Babcock, Cardiff University, GE Caledonian, Hass F1, Jaguar Land Rover, Network Rail, NHS, Nokia, Scottish Engineering, Siemens, Skills Development Scotland, Williams F1** have provided these **50 teachers** with insight and understanding of STEM pathways, inspirations and skills expected within the STEM sector for their pupils. Over **400 diverse engineer interviews** have taken place so far over the **5 years** of the course at the average of **80 per cohort**.



Over
400
Engineer
Interviews


*Based on a class teacher teaching one class of 31 pupils over the academic year


**Impact data over time is based on a class teacher teaching one class of 31 pupils over the academic year

50 Action Research Projects




Across these 50 research projects there were many areas of focus and some projects had multiple foci

50% 
Problem solving, creativity or creative problem-solving skills


18% 
Visualisation or adaptability


“I tested and then successfully applied signature teaching approaches in the development of creative problem solving in senior-phase secondary vocational education”

Alwyn McKenna,
Secondary School Teacher

34% 
Improving their teaching approaches

22% 
Encouraging teamwork or collaboration

16% 
Problem finding skills

12% 
STEM aspirations or improving gender self efficacy in STEM

“I investigated whether allowing children ‘free play’ opportunities within the block play area had an impact on pupil’s ability to work in a team”

Shavonne Higgins,
Early Years Teacher

“I used cooperative learning strategies to improve teamwork within creative problem solving tasks in my classroom”

Steven McAvoy,
Primary School Teacher

The Long Term Impact

As well as completing exciting and important action research, many of our teachers have used the PGCert in Engineering STEM as the start of a journey of continuous development and improvement to their practice, whether it be within their school, local community or even creating new career opportunities. The case studies below capture the long-term impact the course can have on those who complete it.

Dan Woodcraft, Primary School Teacher

Dan's interest in the course came from wanting to find out more about how STEM education can be incorporated into the curriculum. His research introduced pupils to a wide range of engineering disciplines, which had a positive impact on their knowledge of engineering in the wider world and encouraged them to consider careers in these fields.

Since completing the course, Dan has gained a leadership role within his school. More recently, Dan has been supporting Primary Engineer® in product development workshops and has embedded several new initiatives in his school to raise STEM aspirations.



Result

37.5%
increase

of pupils being able to explain what an engineer does and the number of pupils who would consider engineering as a career doubled to almost

50%

Dan says;

“Through research and training throughout the course I gained a much greater understanding of what STEM learning is and why it is important for the future of our learners and future of the economy.”



Lorna Hay, Pitteuchar East Primary

Prior to joining the course, Lorna had completed a one-day CPD course with Primary Engineer® and was looking for the next step in her development. Having interviewed 32 different engineers, Lorna was able to understand key inspirations and skills they felt young people needed to be successful in the world of work. Throughout her research, Lorna was able to use a combination of a tinkering approach to her teaching, alongside project-based learning through the Institution of Primary Engineers®.



Since completing the course, Lorna has gone from strength to strength. Lorna has become a leader of STEM within her school, drafting parts of their School Quality Improvement Plan, organising whole-school STEM events and supporting other teachers in delivering engineering experiences. As an advocate of the Institution of Primary Engineers® as a platform to increase STEM engagement across her school, Lorna supported its launch at the House of Lords in 2019.

Lorna is also currently supporting the [Scottish Government's Education and Skills committee](#) with an inquiry into STEM for 3-7 year old's and is seen as a pioneer for STEM education in Scotland, speaking at the Institution of Engineering and Technology conference on how we can promote inclusion and diversity in engineering.

In 2020, Lorna's school was also named as one of the first ever STEM Nation Schools in Scotland, a great achievement. A journey that begun during Lorna's time on this course, and highlights Lorna and her school's commitment to outstanding STEM education. Lorna remains a key part of the Primary Engineer® family and works closely with us across our programmes.



Result
80%

of pupils said that their enjoyment of engineering had either 'increased a little' or 'increased a lot':
for the girls, it was

100%

Lorna also added

"As well as increased levels of engagement, I also saw improvements in the problem-solving skills of my learners, including developing a positive attitude to mistakes."

Fran Long, Education and Training Lead at the Faraday Institution

Fran is a former specialist science teacher at Woodstock CofE Primary school. The course influenced her mindset and outlook on education, and she focused her teaching on looking to provide real life context and application of learning. Using a wide range of role models, Fran measured the impact of a STEM assembly programme on pupils who received monthly contact with real scientists and engineers, from a diverse range of careers. The impact was a positive one on STEM aspirations and perceptions, and markedly increased creative problem-solving skills and resilience within. Fran's work really highlighted the importance of support mechanism that provides these links with engineers, which Primary Engineer® provides through its programmes. This fantastic research project has recently been accepted and published in the [Journal of Emergent Science](https://www.ase.org.uk/resources/journal-of-emergent-science/issue-18/raising-stem-career-aspirations-through-primary-years)¹².

Fran's success in school after the course led to her nomination and subsequent awarding of [Primary Science Teaching Trust](#) Fellowship status. Her school was also awarded Gold for the [Primary Science Quality Mark](#) during that time, highlighting Fran's continued commitment to Science. Since leaving teaching, Fran has written CREST Awards based on the British Insect collection as part of her role at the Oxford University of Natural History and published '[The Bee is Not Afraid of Me](#)' for children which includes references to how insects have inspired engineers in technology development.

Fran has also led primary science teacher CPD for STEM Learning, and in her current role as Education and Training Lead at the [Faraday Institution](#) is creating dynamic and diverse pools of talent for fields of battery technology and energy storage. For example, Fran works closely with [SEO London](#) helping to attract undergraduates from minority or low socioeconomic backgrounds. Her new role has also seen her design a [PhD training programme](#)¹³ where an appreciation of engineering and science mindsets has been key.



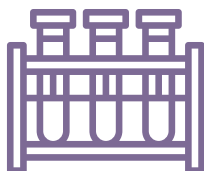
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¹² <https://www.ase.org.uk/resources/journal-of-emergent-science/issue-18/raising-stem-career-aspirations-through-primary-years>

¹³ https://faraday.ac.uk/wp-content/uploads/2020/09/PhD_Training_Programme_Guide_2020-21.pdf

Fran has presented at Buckinghamshire and Oxfordshire Young Scientist of the Year Awards.

As well as the Science Oxford STEM work experience evening. At Sandhurst STEM Careers Fair, Fran was even able to share with HRH Princess Anne about her work to raise STEM career aspirations through a range of inspiring 'hands-on', real-world relevant science and engineering challenges.



Fran quotes that the course,

“deepened and strengthened my pre-existing interest, understanding of and enthusiasm for engineering roles and how to inspire the next generation. Showcasing ways to include engineering in an engaging way, in an already crowded primary curriculum, was exciting and rewarding, especially given the positive impact it had on pupils’ STEM career aspirations.”

What next?

For those who complete this award winning course, it is often just the start of a journey to improve their teaching of STEM. Our aim at Primary Engineer® is to support teachers throughout that journey and we welcome our graduates into the family. They work closely with us, completing many of our fully-funded [CPD courses](#) and taking part in our free to enter competitions such as [If You Were an Engineer, What Would You Do?](#)® or [STATWARS](#)®. With their support during workshops and testing, we are developing new and exciting products to support our research, as well as growing a learning-orientated network.



Primary Engineer Programmes
...the first step®



IF YOU WERE AN
ENGINEER
WHAT WOULD YOU DO?®



STATWARS®



If you are interested
in taking part in this great
opportunity and would
like to know more,
please contact us on
pgcert@primaryengineer.com

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