

# Implementing the Tomorrow's Engineers Code

**An evidence-based, practical guide from NUSTEM,  
Northumbria University.**



**Northumbria  
University**  
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**nustem**

# Implementing the Tomorrow's Engineers Code

## The importance of diversity

Companies with diverse executive teams perform better financially<sup>1</sup>. Diverse teams solve problems more efficiently and effectively<sup>2</sup>. One way to increase the diversity of an organisation is to encourage young people from traditionally under-represented areas to join the organisation. However, children make gendered and career limiting choices before the age of 8<sup>3</sup>. If engagement work is to eventually increase the number of people entering STEM employment, we must therefore work with, and understand the needs of, younger children.

Children are heavily influenced in their career choices by those around them – their families, communities and teachers. Not only is it important to include these influencers in STEM engagement activities, it's more effective.

Increasing the diversity and number of young people who want to work in STEM is a very complex problem comprising multiple societal and economic challenges. Employers must collaborate to forge a sector which is truly welcoming to people from diverse backgrounds. Doing so will require that, together, we improve the quality, focus and effectiveness of our STEM engagement activities.

NUSTEM, at Northumbria University, has developed a Theory of Change<sup>4</sup> which provides an overview of the complexity of the challenge, and possible pathways to change. Using this Theory of Change we have responded to the Tomorrow's Engineers Code by identifying good practice recommendations, described below. Some of these recommendations can be implemented by organisations straight away, whereas others will require more strategic planning and commitment. We've given a brief explanation of why each recommendation has been included, and further information may be found at the end of the document.

## About NUSTEM

NUSTEM's vision is for a vibrant and sustainable STEM sector which meets the needs of learners and employers, reflecting the diversity of wider society.

We work in partnership with over 40 primary and secondary schools in the North East of England, and with other organisations and companies that share our vision. We develop and deliver face to face workshops and create resources for families and teachers to use with their children and young people. Our approach is practical, hands-on and career-inspired.

Our approach often includes helping children and young people – along with their families and teachers – to recognise the personal characteristics of STEM workers. Over time, this helps them feel more confident that a career in STEM is for 'people like them'. Alongside this, NUSTEM shows the breadth and application of STEM in the world around us. Our evaluation has shown that children in our partner primary schools become more open to a wider range of jobs. They also develop a more nuanced, less stereotyped view of scientists, engineers, and other STEM workers.

Through a combination of practice and research we are able to identify achievable routes to effective STEM engagement.

# The Code: in practice

Ensuring programmes contribute to a sustained and rich STEM journey for all young people.

NUSTEM recommends	Work with children's existing influencers e.g. families and teachers, as well as with children and young people.
	Ensure activities for use by families are accessible to those without a science background.
	Design activities which feature multiple interactions over a period of time.
	Highlight the link between activities/resources and school curriculum topics.

Ensuring all young people have opportunities to engage in engineering-inspiration activities, so that no one is left behind.

NUSTEM recommends	Work with people from under-represented groups, including partnering with existing networks.
	Work with children across the whole attainment range.
	Design inclusive activities to suit a variety of interests and backgrounds.
	Work with more children and families who might not usually choose STEM activities e.g. youth groups, sports clubs, museums and visitor centres, libraries, religious and cultural centres.

Promoting a positive, compelling and authentic view of engineering, and showcasing the breadth of opportunities.

NUSTEM recommends	Provide communication training for presenters which includes awareness of unconscious bias and language use.
	Include attributes needed to be successful in engineering as part of activities.
	Focus on the utility of engineering. Use interesting contexts and real-world examples.

Improving the monitoring and evaluation of programmes and activities to develop a shared understanding of what works.

NUSTEM recommends	Use feedback from participants to improve your activity.
	Think carefully about what you want your activity to achieve and use that to measure how successful it was.
	Work with other organisations, like NUSTEM, to identify and measure the impact you want to have.

# Implementing the Code

The following sections present each of the recommendations broken down into short-term actions, that could be put in place relatively quickly, along with medium- and long-term suggestions which would take more time and planning to implement.

## Ensuring programmes contribute to a sustained and rich STEM journey for all young people.

### Work with children’s existing influencers e.g. families and teachers, as well as with children and young people.

**Why:** As children and young people start to make career choices they are influenced by those around them. It’s important that these influencers also know about STEM careers and don’t limit children’s possibilities.

Short term	Medium term	Long term
Run an after-school activity ‘for families’ instead of a school workshop during the day <sup>5</sup> .	Build links with local community hubs such as libraries and museums. Run activities regularly in collaboration with partners.	Develop a series of family-orientated workshops that explore engineering themes over several weeks.

### Ensure that activities for use by families are accessible to those without a science background.

**Why:** Many published activities assume the use of materials or existing knowledge which aren't available in many family homes. Plan for inclusivity from the start.

Short term	Medium term	Long term
Audit your current activities using NUSTEM STEM@Home Principles <sup>6</sup> .	Ensure that family activities meet the STEM@Home Principles.	Curate a collection of ‘at home’ activities and disseminate these through schools and local community networks.



### Case study: STEM@Home

Our [STEM@Home principles](#) were developed during the first COVID Lockdown to ensure inclusivity and accessibility of online STEM activities. We used them to develop family [STEM learning activities](#) for use in an environment where time, resources, and existing STEM knowledge might be limited.



## Design activities which feature multiple interactions over a period of time.

**Why:** One-off activities rarely lead to changes in attitudes or behaviour. However, longer programmes of activity have been shown to be effective<sup>7</sup>.

### Short term

For your current activities, provide 'follow on' ideas to participants so that there is something for them to do after the activity.

### Medium term

Design a series of shorter resources or engagements that explore a topic e.g. monthly Saturday morning drop-ins at a library.

### Long term

Work in collaboration with other organisations to create a programme of activities for people to take part in.

## Highlight the links between your activities/resources and school curriculum topics.

**Why:** Although the Code is aimed at informal education, teachers and schools are more likely to see the benefit of your activity, and use it with more children and young people, if they can link it clearly to the curriculum they have to teach.

### Short term

Familiarise yourself with the current school curriculum - what is being taught in schools and what children might know.

### Medium term

Identify and highlight curriculum links in your activities to show context and application to students<sup>8</sup>.

### Long term

Develop longer term relationships with schools; co-create activities/resources with teachers and support their inclusion in teaching.



### Case study: STEM Person of the Week

'STEM Person of the Week' is a teacher-led programme of subtle careers education, developed in partnership with primary teachers. Each week, a school introduces a STEM role model via presentations and postcards. In science lessons the attributes are explored, with teachers commending the children for showing them in class.



## Ensuring all young people have opportunities to engage in engineering-inspiration activities, so that no one is left behind.

### Work with families from under-represented groups<sup>9</sup>, including partnering with their existing networks.

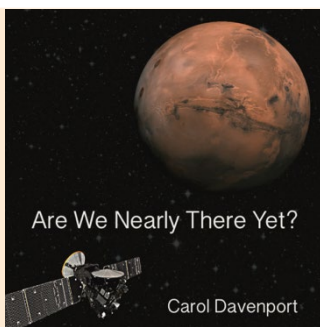
**Why:** Your existing contacts and networks are likely to consist of those groups already well represented in engineering. Working with other networks can help you to diversify who you work with, and bring a wider range of talented people into engineering.

Short term	Medium term	Long term
Audit the diversity of the schools and groups you are working with e.g. what is the socioeconomic background or ethnicity mix of the schools <sup>10</sup> ?	Approach and work with a mix of groups, not just the high-attaining or affluent ones. e.g. target children in schools serving areas of deprivation.	Work with groups in their own communities. Build links with organisations already working in the area e.g. charities, libraries and social venues.

### Work with children across the whole attainment range.

**Why:** There are a wide range of roles within Engineering, some of which do not require graduate qualifications.

Short term	Medium term	Long term
Work with whole classes where possible, rather than a selected group <sup>11</sup> , particularly in primary.	Amend your activities to show that in engineering hard-work and creativity are as important as attainment.	Highlight the variety of routes to engineering, not just A-levels e.g. apprenticeships, BTEC, T-levels. Make sure your company recruitment policy is open to non-standard entry routes.



#### Case study: Family Space Explorers

'[Family Space Explorers](#)' was a UK Space Agency funded project developed by NUSTEM in 2017 and delivered in local libraries and cultural venues. Toddlers and their carers read a story linked to space exploration, and then did a simple activity together.



## Design inclusive activities to suit a variety of interests and backgrounds.

**Why:** It can be easy to reinforce unhelpful stereotypes about engineers and engineering during activities or with resources. This can be minimised through careful choice of images, examples and classroom interactions.

### Short term

Use the IOP 'Inclusive teaching' ideas to audit and adapt your activity or engagement to be inclusive<sup>12</sup>.

### Medium term

Provide communication training for activity leaders to help them learn strategies for ensuring inclusion of all children.

### Long term

Work with educators to review your materials to ensure activities are accessible to all children in a group.

## Work with more children and families who might not usually choose STEM activities e.g. youth groups, sports clubs, museums and visitor centres, libraries, religious and cultural centres.

**Why:** Working with a broad range of organisations and in different settings brings engineering to audiences who might not normally take part in activities branded as STEM or engineering.

### Short term

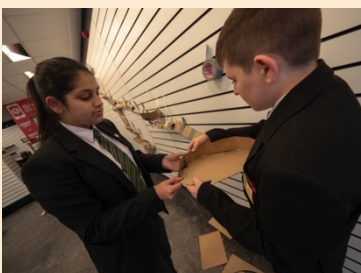
Run a simple workshop for a uniformed group e.g. Guides, or offer to support them with badges.

### Medium term

Hold a proportion of your events or activities in informal (education) venues such as museums, libraries, or visitor centres.

### Long term

Use personal or local links to collaborate with groups and develop activities that will help them with their aims (e.g. biomechanics workshop for local running club).



### Case study: NUSTEM Pop-up Shops

NUSTEM holds [Pop-up Shops](#) in small local shopping centres during half-term holidays. The activities are STEM themed and career-linked, and designed to appeal to the casual passing family. The shops also provide an opportunity for parents and children to meet people who are studying STEM subjects.



## Promoting a positive, compelling and authentic view of engineering, and showcasing the breadth of opportunities.

### Provide communication training for anyone doing engagement which includes awareness of unconscious bias and language use.

**Why:** It's important those involved in STEM engagement know how to communicate well with an audience. It's easy for the language used to be affected by unconscious biases, unwittingly excluding some groups.

Short term	Medium term	Long term
Encourage staff to become STEM ambassadors and complete the STEM learning online training resources <sup>13</sup> .	Offer communication training to staff to increase the quality of activities <sup>14</sup> .	Incorporate unconscious bias training in staff personal development and recognise this in career progression.

### Include attributes needed to be successful in engineering as part of activities

**Why:** This helps children, young people and families to see engineering as something done by 'people like me'. If their self-concept matches their concept of an engineer, they are more likely to think of engineering as personally achievable.

Short term	Medium term	Long term
Ask activity presenters to talk about the personal qualities that help them to do well in their job e.g. NUSTEM Attributes <sup>15</sup> or Engineering Habits of Mind <sup>16</sup> .	Use attributes to challenge stereotypes about engineering and engineers e.g. STEM Person of the Week <sup>17</sup> .	Develop activities which allow participants to experience using different attributes as part of the activity.

### Focus on the utility of engineering. Use interesting contexts and real-world examples.

**Why:** Using contexts to introduce science and engineering ideas can improve children and young people's attitude to science<sup>18</sup>, and mean that they are more likely to study STEM<sup>19</sup>.

Short term	Medium term	Long term
Ask activity presenters to talk about problems they have solved as part of their job.	Use, or develop, activities with a 'real-world' problem to solve e.g. Practical Action Squashed Tomato challenge <sup>20</sup> .	Develop a series of activities which include the breadth of engineering challenges faced by your organisation.



## Improving the monitoring and evaluation of programmes and activities to develop a shared understanding of what works.

To evaluate the impact of programmes and activities you first need to understand what you want the programme to achieve, and then identify **WHY** and **HOW** the activity will lead to that impact. Only then can you design tools to measure the impact.

At NUSTEM our aim is to increase the number and diversity of young people choosing a STEM career. Our Theory of Change encompasses the attitudinal and behavioural changes needed in key stakeholders to achieve this aim. Those stakeholders are children and young people, families and schools/teachers. We can then use the Theory of Change to evaluate the impact of activities against the intended outcomes<sup>21</sup>.

Ultimately, this pledge requires organisations to work together to develop good practice and an evaluation toolkit that can be used to collect and share more standardised data.

However, there are actions that can be implemented in the shorter term:

- Use feedback to improve your activity e.g. ask participants whether it was pitched at the right level, what could be done better next time, and if they would recommend it to their friends.
- Think carefully about what you would like your engagement to do, and then use that to measure how successful it was<sup>22</sup>. For example, you might want parents to know about more careers in engineering, or if they would be happy if their child became an engineer.

## Next Steps

NUSTEM supports organisations and companies to develop their own STEM engagement offer.

We can help you to:

- plan engagement strategies and develop an organisation-specific Theory of Change.
- develop bespoke activities and resources for companies to deliver themselves.
- provide training in communication skills, public engagement and unconscious bias.

To discuss how NUSTEM can support you to make an impact with your STEM engagement, contact us on:

[nustem@northumbria.ac.uk](mailto:nustem@northumbria.ac.uk)

# References

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- <sup>1</sup> <https://www.mckinsey.com/business-functions/organization/our-insights/delivering-through-diversity#>
- <sup>2</sup> Phillips, K.W. et al., 2008. "Is the Pain Worth the Gain? The advantages and liabilities of agreeing with socially distinct newcomers' [Personality and Social Psychology Bulletin](#). 35(3) pp336 – 350
- <sup>3</sup> Ito Emembolu et al. (2020) Using action research to design and evaluate sustained and inclusive engagement to improve children's knowledge and perception of STEM careers, [Int. Journal of Science Education](#), 42:5, 764-782,
- <sup>4</sup> Davenport, C., Dele-Ajayi, O., Emembolu, I. et al. A Theory of Change for Improving Children's Perceptions, Aspirations and Uptake of STEM Careers. [Res Sci Educ \(2020\)](#).
- <sup>5</sup> Encouraging children and their parent/carers to work together to solve an engineering challenge can give them a positive impression of engineering, and support familial conversations about STEM.
- <sup>6</sup> <https://nustem.uk/blog/news/supporting-home-learning-with-stem-activities/>
- <sup>7</sup> See for example the NUSTEM STEM person of the Week, which had a long term effect on children's use of stereotypical words to describe people working in STEM careers: <https://nustem.uk/stem-person-of-the-week/>
- <sup>8</sup> For example, NUSTEM Careers postcards link a career and a company to physics topics taught in Secondary School. They can be used as part of careers fairs, or as a follow-up after an activity. <https://nustem.uk/careers-postcards/>
- <sup>9</sup> Sonia Exley. 2013. "Making working-class parents think more like middle-class parents: Choice Advisers in English education." [Journal of Education Policy](#) 28 (1): 77 - 94.
- <sup>10</sup> <https://get-information-schools.service.gov.uk/> provides information about the percentage of free school meals, and ethnic diversity of a school.
- <sup>11</sup> If asked to provide a group of participants for an externally-delivered event, schools will often choose higher attaining or already interested students. This excludes students whose opinions might be more open to change.
- <sup>12</sup> Institute of Physics have prepared [10 Inclusive Tips for Teachers](#). Although aimed at teachers, they are helpful for those designing or delivering activities for children and young people.
- <sup>13</sup> For more information about becoming a STEM Ambassador see <https://www.stem.org.uk/stem-ambassadors>
- <sup>14</sup> NUSTEM – and many other providers – offer bespoke science communication training for organisations. This can be linked to particular engagement activities, or look at communication skills more broadly.
- <sup>15</sup> The [NUSTEM Attributes](#) are a set of 16 personal attributes used by people working in STEM to describe themselves:
- <sup>16</sup> [Engineering Habits of Mind](#), developed by the Royal Academy of Engineering, looks at ways of thinking that support success in engineering.
- <sup>17</sup> <https://nustem.uk/stem-person-of-the-week/>
- <sup>18</sup> Bennet, Judith, Fred Lubben, and Sylvia Hogarth. 2007. "Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching." [Science Education](#) 91: 347 - 370.
- <sup>19</sup> Reiss, Michael J, and Tamjid Mujtaba. 2017. "Should we embed careers education in STEM lessons?" [The Curriculum Journal](#) 28 (1): 137 - 150.
- <sup>20</sup> <https://practicalaction.org/schools/squashed-tomato-challenge/>
- <sup>21</sup> You can read how NUSTEM have used the Theory of Change to evaluate STEM activities in [our Impact report](#)
- <sup>22</sup> The Ogden Trust has a [helpful evaluation guide](#) that explores this further. Although aimed at physics activities, the ideas are directly applicable to other STEM sectors.