

NUSTEM ANNUAL REPORT

September 2019





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Executive Summary

This report provides an overview of the work of NUSTEM in the academic year 2018 – 2019, highlighting some of the successes and outlining how we are achieving our objectives.

This year we have expanded the number of primary schools that we are working with, from 15 to 34, and recruited a new member of staff to support the additional primary delivery work.

We have obtained further funding for public engagement projects from external sources including Science and Technology Facilities Council (STFC), UK Space Agency, The Royal Academy of Engineering, Reece Foundation, Ogden Trust and SHINE Trust. We regularly support faculty academic colleagues to embed 'Pathways to impact' activities in their research, and a strong culture of outreach and public engagement is developing within research groups in the faculty.

Our influence with the wider STEM engagement community locally and nationally continues to grow. We have shared our Theory of Change (section 3.1) with a range of external organisations that have similar aims to NUSTEM. For example, we have collaborated with Museums Northumberland to develop STEM outreach programmes which combine heritage and STEM careers. We have also worked closely with North of Tyne Combined Authority to embed the outcomes from the Theory of Change in their STEM and Digital Skills investment fund. We host the STEM Engagement Network twice a year to bring together those people in the North East who have a strategic overview of STEM engagement in companies, professional institutions and sector bodies amongst others.

I hope that you enjoy reading about the work we have been doing.

Dr Carol Davenport

Director, NUSTEM

"With the support of NUSTEM, Carville Primary School has focused on broadening awareness of STEM careers to the children and families of Carville.

Through weekly science lessons, a range of family workshops and STEM weeks, which have provided a clear focus on STEM careers, children have been introduced and exposed to a greater range of careers available to them in the STEM fields.

Children ask thoughtful and inquiring questions about the STEM careers to extend their own understanding, can discuss in more detail different careers that are available and compare them to one another creating a deeper, richer conversation around the STEM careers that are available locally and globally."

Mark Storey, Science Coordinator, Carville Primary School

The year in numbers

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.



During 2018/2019 NUSTEM has revisited the vision and objectives of the group to represent the breadth of work, influence, and ambition that we have.

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 believe that by supporting children, families and teachers to identify how their personal characteristics align with the characteristics of people that work in STEM, children (and their influencers) will 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. Together these should lead to an increase in the number and diversity of young people choosing a career in STEM once they leave compulsory education.

Objectives

In order to realise this vision, NUSTEM will:

- Develop, deliver and enable high-quality STEM interventions for key stakeholders.
- Support and influence STEM outreach and widening participation work within Northumbria University
- Influence STEM careers and engagement policy at local, national and international levels.
- Work in partnership with organisations (in the North East) to develop, disseminate and embed effective practice in STEM engagement.
- Produce high quality research on topics related to young people's STEM learning and career choices.
- Produce evidence of impact of the work of NUSTEM
- Contribute to Teaching and Learning in Engineering and Environment & Health and Life Sciences.

Underpinning principles and values

Underpinning principles

- **Sustained Engagement:** Interacting with key stakeholders from our partner schools, and the wider North East region, on an ongoing basis from early years to sixth form and beyond. We are not concerned with 'one off' activities in their own right.
- *Holistic approach:* Children and young people do not make career decisions in isolation; they are influenced by those around them families, teachers and the wider community. We therefore work with these wider circles of influence.
- **Targeting 'under-represented' groups and communities:** Resources are limited, and so we choose to target those groups and communities that have traditionally been under-represented in science, technology, engineering and maths, particularly girls and those from lower socioeconomic backgrounds.
- **Gender Inclusive:** Our approaches and methods are designed to support females whilst still ensuring a gender inclusive approach.
- **Career Inspired:** Resources and activities incorporate careers and work-related attributes to ensure that young people are made aware of the pathways that science can lead to.

- **Partnership working:** the challenge of improving diversity and increasing inclusion in STEM must be tackled by organisations working together. NUSTEM seeks to work in partnership, formal and informal, with others who share the same goal.
- **Research Rich:** NUSTEM's work is informed by the latest research thinking and practice, our own and others. Additionally, we work with colleagues to bring academic STEM research into the classroom.

Values

- **Teamwork**. We believe that each member of the team brings talent and skills that enhance the work of the team and allow us to be greater than the sum of our parts. Working together as a team also allows us to share the load and to develop individually.
- **Partnerships and relationships.** Diversity in STEM will only be improved by system-wide action at all levels. NUSTEM is outward looking and works with a range of partners including education, industry, public sector, and professional bodies. Building relationships across these sectors will ensure that we have a broad view of the STEM ecosystem.
- **Evidence based.** Our ideas, actions, and interventions are underpinned by research and informed by social science and education research methodologies. Theory may be drawn from our own research programme, from the literature, and through action research.
- **Transferability.** It is our intention that ideas, research and initiatives developed through NUSTEM can influence and inform practices in other organisations and sectors. Disseminating our ideas is key to this influence.
- **Adaptability.** We appreciate the ability to respond quickly to circumstances, whilst recognising the growing importance of developing flexible processes as the group grows to ensure quality in all we do. We trial our activities and approaches, and adapt our work as a result of testing and review.

1 Develop, deliver and enable high-quality STEM interventions for key stakeholders



The following case studies represent some of the activities with children and young people taking place this year. In addition, we continue to work with teachers through in-school CPD, and by the half-termly Primary Science Coordinators Forum for those who are leading science in primary schools. We are also co-developing more family focussed workshops with our primary partner schools, and supporting schools to lead the delivery of the family workshops themselves.

1.1 STEM Person of the Week

'STEM Person of the Week' is a five-week programme of carefully designed subtle careers education, developed in partnership with primary teachers. Each week, a school introduces a STEM role model via postcards (example, *right*) and presentations. The role model's work is discussed, with a focus on three personal attributes which help them in their jobs (e.g. 'Observant', 'Patient', 'Curious', 'Tenacious'). In science lessons throughout the week, those attributes are explored, with teachers commending the children for demonstrating them.

Our research reveals that the intervention has a strong effect on children's vocabulary when thinking about, and describing, scientists. From stereotypical descriptions before the intervention, children use more positive, and less stereotyped, words to describe people who work in STEM. The impact remained detectable a year afterwards.



https://nustem.uk/spotw

1.2 Primary Careers Tool



This year we have developed the Primary Careers Tool: a database of over 100 STEM careers sorted by National Curriculum topic. By clicking on the topic a selection of careers will be randomly presented.

Each career includes a simple explanation of the job, a link that searches for counter-stereotypical images of that type of STEM worker and three attributes that are needed by people who do that job. It doesn't take long to put this information into a presentation slide to use in a science lesson. Teachers can ask the children if they think they could do the career and whether they

share any of the attributes, enabling discussions about the career. Using counter-stereotypical images also allows the teacher challenge current stereotypes held in the class.

Using the Primary Careers Tool allows teachers to find out about careers that may be new to them, and introduce those careers simply in their lessons. Over time, children will come to realise that studying science opens up a whole world of possibilities to them.

<u>https://nustem.uk/primarycareers/</u>

1.3 Careers in the Curriculum

The Gatsby Careers Benchmarks¹ are now part of the statutory guidelines² for secondary schools. As part of the benchmarks, subject teachers are expected to embed careers information into their lessons. This is a challenging target, and one which schools in the pilot of the benchmarks found most difficult to meet. NUSTEM have created a teacher CPD session for science and maths departments that starts them thinking about why and how they can put careers links in their lessons. These sessions have also been adapted for use in whole school CPD.

We are also creating classroom resources for secondary schools. These are question sheets which put GCSE science and maths topics into a careers context. These resources showcase companies based in the North East such as Polyphotonix, Kromek and GlaxoSmithKline. The development of the classroom resources was supported with a grant from NECOP.

https://nustem.uk/careers/



1.4 Work Experience Week

Work Experience Week aims to provide about sixteen Year 12 students with an understanding of university study and research. As well as attending a first year lecture, and having a tour of the university facilities, the



school students read papers and produce a poster about research carried out at Northumbria, supported by the University researchers and PhD students who are doing the research.

The benefits are two-fold: the school students learn research and presentation skills that help them when applying for their next step in life; the PhD students develop communication skills to explain their research to others who do not have a background in the science topic.

¹ <u>https://www.gatsby.org.uk/education/focus-areas/good-career-guidance</u>

² <u>https://www.gov.uk/government/publications/careers-guidance-provision-for-young-people-in-schools</u>

2 Support and influence STEM outreach and widening participation within Northumbria University

NUSTEM included in 22 University research funding applications





NUSTEM has continued to support academics with public engagement and outreach. At the early stages of bid preparation, NUSTEM staff meet with the researcher to find out about their research, and suggest how it could be disseminated to children and young people. These ideas can then be included in the funding bid. When academics are successful, we then work with them to bring those ideas to fruition. We also provide general support for science communication and outreach to our academic colleagues. The following case studies give an insight into how NUSTEM works with other colleagues in the faculty.

2.1 Geography: Past, Present and Future

This suite of four workshops has been developed in collaboration with geography researchers in the Engineering and Environment faculty. These workshops are designed to engage primary-aged children with our dramatically changing climate through 4 geography careers: palaeontology, environmental planning,

"I've found the sessions with NUSTEM to be both enjoyable and rewarding. In creating workshops, their expertise in bringing science into the classroom is excellent and hugely improved the quality of the workshop content. In workshop delivery, NUSTEM are also highly supportive in the classroom."

Dr Holly East

environmental modelling and environmental science. Each workshop explores its topic through hands-on activities which showcase the skills and attributes that working climate scientists needs to model, predict and analyse our changing climate. The workshops have been delivered by NUSTEM staff, supported by researchers and PhD students.

2.2 Sixth Form Evening Lectures

The NUSTEM Sixth Form Evening Lectures take place every Thursday evening from early October to late November. This year's Lecture Series saw 214 students and teachers attend seven lectures on a wide range of STEM subjects.

2018 was the Year of Engineering so the inaugural lecture was



delivered by Dr Madeleine Combrinck³. She spoke about her research to improve the energy efficiency of aeroplanes and spacecraft. We also heard from Dr Kate Winter⁴ about how the harsh weather conditions of Antarctica makes everyday tasks challenging; and from Dr Matteo Sommacal⁵ on how fractal geometry can mimic patterns in nature.

³ <u>https://www.northumbria.ac.uk/about-us/our-staff/c/madeleine-combrinck/</u>

⁴ <u>https://www.northumbria.ac.uk/about-us/our-staff/w/kate-winter/</u>

⁵ <u>https://www.northumbria.ac.uk/about-us/our-staff/s/matteo-sommacal/</u>

3 Influence STEM careers and engagement policy at local, national and international levels.

The NUSTEM model is multi-faceted and looks at a young person's career decision making process in the context of their lived experience, rather than as an isolated individual. By widening the focus of our work beyond the individual, we are able to support and challenge the different influences on the young person.



Appendix 1 shows in more detail the intermediary steps that link the

short-term outcomes with the long term aim for the three key stakeholder groups: children and young people; parents and families; teachers and school community.

The breadth of the Theory of Change, and the underpinning literature, makes it transferable to other situations and organisations that share similar goals. Whilst it is likely that most organisations will not wish to deliver the breadth of interventions that NUSTEM does, or work in depth with the same number of schools, organisation can use the Theory of Change to ensure that their intervention is supporting the overall careers journey of a young person.

Over the past year, NUSTEM has used the Theory of Change as the basis of discussions around policy, intervention design, and support for a range of organisations: locally, nationally and internationally. The following two case studies illustrate this approach.

3.1 Implementing the NUSTEM model: Exploring Extreme Environments

Exploring Extreme Environments (E3) is an education project that supports children's STEM education journey by engaging them with the science, poetry and art linked to the extreme environments found in the Sun and Antarctica. Simultaneously, their teachers will be exposed to a range of real-world STEM applications that highlight the benefits of integrating STEM careers examples and language into everyday classroom practice. This three year STFC-funded project (ST/000070/1) is working with 8 primary schools in areas of deprivation in the North East until July 2021.

The aims of E3 are to: showcase STFC research and facilities through repeated and sustained interactions with children, families and teachers; build aspects of science capital for the participants in E3; increase the confidence of primary school teachers to teach science and technology and raise their awareness of careers within STFC and STEM; develop the public engagement capacity of researchers and academics at Northumbria University.

Working in collaboration with the schools, children and their supporters are introduced to STFC science and careers in STEM more widely. These aims are realised through eight different activities involved in the project: STEM storytime for nursery and reception families; polar and solar workshops for years 3 and 5 children; afterschool family workshops for KS1 and KS2 families; STEM person of the Week; assemblies; teacher CPD. In addition, towards the end of the project, there will be an Antarctica-inspired community performance of poetry and sounds by Katrina Porteous (poet) and Peter Zinovieff (composer).

3.2 Learning from NUSTEM: Ekiti State, Nigeria

As a UK based organisation, NUSTEM recognises that the Theory of Change may not be applicable in other countries and other cultures. However, we believe that the process that was used to develop the Theory of Change, and the literature behind it, do allow a level of transferability.

One international context where this has been trialled is in Ekiti State, Nigeria. Although the culture around STEM careers is different in this area, the NUSTEM model of interactive workshops and simple equipment being used to teach science concepts is seen as very valuable. As such, NUSTEM has been a key contributor to the development of a World Bank funded STEM outreach education programme in the Ekiti and Ondo states

of Nigeria working with young people and their teachers, providing 2400 STEM Education 'kits' to a range of local schools across the state. Care was taken to use cheap, locally-available products for these boxes and their roll out was accompanied by a team of outreach officers who worked with the teachers to train them on the use of the 'kits' and demonstrate them in a classroom setting.

"... initially, students were running away from science because ... it's too hard. But thanks to your work they bring the theoretical concept to practical activities, it makes students develop much more interest than when you are just teaching them in abstract."

> Mr Farotimi, Orinsunbare Community Secondary School, Nigeria



In June, NUSTEM and Northumbria University staff visited Ekiti state and Ondo state in Nigeria. During the visit they met with officials from both states to discuss further possible links, and also worked with teachers in both states. The visit provided much food for thought for NUSTEM and our partner in Nigeria, STEMRES.

3.3 North of Tyne Combined Authority STEM and Digital Skills Call

The North of Tyne Combined Authority was formed in 2019. NUSTEM worked with staff at the Authority to help develop the scope and objectives for a STEM and digital skills call, which is part of the 'Leaders of Tomorrow' pillar of the Authority's economic vision. The call was for STEM enrichment activities for young people and families, and CPD opportunities for teachers using both the North East's heritage and current key sectors (Ageing and Life sciences; Digital, Tech and Data; Energy, Subsea and Offshore; Culture, Tourism and Creative industries), alongside digital skills programmes to support young people to develop higher level digital and technical skills, and raise awareness of digital career opportunities with young people and key influencers. The call invested £1.25 million over three years.



3.4 Supporting external organisations

The Theory of Change, and NUSTEM research tools, have been shared with a number of external organisations including the Institute of Physics, The Common Room of the Great North, Royal Academy of Engineering and STFC. Carol Davenport has been invited to be on the Steering group of the STFC Wonder initiative as a result of the similarities in aims of that initiative with NUSTEM's long-term focus of areas of deprivation. This major initiative by a UK research council is influencing UKRI as a whole.

4 Work in partnership with organisations to develop, disseminate and embed effective practice in STEM engagement



Location of organisations engaging with NUSTEM during 2018 – 2019

4.1 STEM Engagement Network

NUSTEM hosts, and acts as secretariat, for the STEM Engagement Network in the North East. This is a network with the strategy leads for STEM engagement in organisations and companies, providing a community of practice focussed specifically on increasing the uptake and diversity of STEM careers. The group has met twice a year for the past two years. To improve continuity, it will be meeting three times a year from September 2019.

The aims of the network are:

- To provide a community of practice for those involved in managing STEM engagement.
- To share good practice in increasing the diversity of young people entering a STEM career, drawing on local and national projects and reports.
- To share relevant research findings and to discuss their implications for STEM engagement.
- To work together to avoid duplication of effort, to leverage the most effective use of time and funding and to improve the quality of STEM engagement in the North East.
- To explore community and family engagement strategies and opportunities.

4.2 Museums Northumberland

NUSTEM have been working with Museums Northumberland to develop a STEM learning programme for a second round application to the National Lottery Heritage Fund for the conservation of the Union Chain Bridge near Berwick. The proposed programme would work with up to 19 schools within 10 miles of the bridge in the Berwick and Borders area.

The programme is based on NUSTEM's primary partnership model of repeated and sustained interactions with key stakeholders over the project lifespan. The Union Chain Bridge would act as a focus and driver



of activity to support teachers in developing and improving their STEM practice; engage families in supporting their children's learning; and introduce STEM careers ideas in accessible ways.

At stage 1, the primary school programme was seen by the assessment panel as a major contribution towards the quality of the overall (£7m) proposal. If the bid is successful, the programme will be delivered by a member of Museums Northumberland staff, with development and quality control by an external STEM consultant, which may be NUSTEM.

Additionally, Museums Northumberland and NUSTEM have used the NUSTEM primary partnership model (and programme outlined for the Union Chain Bridge) as part of a successful funding bid to the North of Tyne Combined Authority STEM and Digital Skills Funding Call: *Our past, your future*. This three year project will see NUSTEM supporting Museums Northumberland to develop heritage based careers inspired workshops and resources for primary schools in the North East.

5 Produce high quality research on topics related to young people's STEM learning and Career choices.

Produce evidence of impact of the work of NUSTEM



NUSTEM continues to evaluate the impact of the work that we do with schools, and disseminate key findings to different audiences. This year we have written up the Theory of Change for publication in an academic journal, currently in peer review. In addition, we have submitted a paper looking at the change in career aspirations, attitudes to science and self-concept between 2015 and 2017 in partner primary schools, which is also undergoing peer review. Our data show a positive impact on the gendered choice of potential careers, alongside an increase in the number of children saying that they would like to be an engineer.

We have been disseminating the NUSTEM approach through conference presentations to teachers and other STEM engagement professionals, as well as writing articles for teachers about the importance of a careersinspired approach. Appendix 3 gives full details of NUSTEM papers, practitioner articles and conference presentations.

We are also analysing the data from a sample of partner secondary schools collected in 2015 and 2017. The level of engagement from these schools varied, so these data show less of an impact on cohorts of pupils, but do provide a snapshot of student's views on science and science careers over time.

As well as evaluating the longitudinal impact of NUSTEM, we are also carrying out research and evaluation of individual projects.

5.1 Family Space Explorers

Family Space Explorers⁶ was funded by UK Space Agency and ran between October 2017 and March 2018. It was aimed at families with children under 4 years old, and was delivered in libraries and other cultural venues in Newcastle, Gateshead, North Tyneside and Durham. Together, children and their carers read a story and did a simple activity linked to space exploration. Families were also gifted a copy of the book they read to take home with them.

The project was evaluated using a pre- and post- session survey, with a smaller follow-up phone survey 6 weeks after the session.



⁶ <u>https://nustem.uk/family-space-explorers/</u>

The majority of carers reported that they felt more comfortable to talk about space and science with their children after the session. 96% of carers said that they would re-read the book with their child at home and the follow-up survey confirmed that the book was re-used after the session.

Discussions are in progress with a commercial publisher for the wider circulation of the book produced for the project.

5.2 Exploring Extreme Environments evaluation

The aims of the E3 project (see section 3.1.1) are being evaluated using a mixed methods approach over the three years to investigate changes in children's understanding of STEM careers, parents' engagement with STEM activities, and teachers' confidence to teach primary science. We are using the E3 project to extend the use of our research tools to track individuals over the three years of the project. Baseline measures have been collected from a sample of children and teachers in project schools, and these will be revisited at the end of the project.

5.3 Impact of Academic Research through Northumbria's physical sciences, technology and engineering outreach activities on improving the uptake of STEM disciplines by young people

Itoro Emembolu, PhD student with NUSTEM, has been investigating at the impact on children of workshops delivered by, or on behalf of, academic researchers. She has worked with researchers from Computing, Mechanical Engineering and Geography to evaluate their workshops using a theoretical framework of engagement. Itoro is currently writing up her thesis for submission in October, and has presented interim findings at two conferences this year.

6 Contribute to Teaching and Learning at Northumbria University

NUSTEM staff continue to contribute to Teaching and Learning within the University. Carol Davenport is Programme Leader for the Mathematics and Physics Foundation year, and she leads one of the modules 'Applications of Physics'. Antonio Portas also teaches on that Module.

Joe Shimwell has helped develop a new module for the Geography and Environmental Studies Foundation Year which links undergraduate students with primary schools to develop communication skills. The undergraduates produced a leaflet or activity sheet for the children about an environmental issue. The children then give written feedback to the undergraduates about the quality of their leaflets. Joe also continues to provide support for trainee teachers as part of their enrichment weeks, for example about careers in the primary classroom.

Working at NUSTEM events, such as pop-up shops or Think Week, helps undergraduate and postgraduate students to develop communication skills. Each year NUSTEM hosts a placement student who works as an Engineering Outreach Assistant between year 2 and year 3 of their degree.

In addition, colleagues who work with NUSTEM as part of the 'Pathways to Impact' on their grants have said feel that they are more able to explain their research to a non-specialist audience. Collaboratively developing workshops allows them to identify the 'why should you care' points about their research.

NUSTEM also provides unconscious bias training for colleagues across the university.

7 External funding

We continue to bid to external organisations for funding to support or extend our work.

7.1 NUSTEM led bids

Successful bids led by NUSTEM in 18/19 were:

Organisation	Amount	Project summary
Reece Foundation	£179000	Supporting NUSTEM primary partnerships (Jan 19 – Dec 20)
		and Placement Students (Aug 19 – July 2021)
North of Tyne Combined	£102661	Partner in Museums Northumberland 'Our past, Your future'
Authority		project. (Sept 19 – July 22)
SHINE Trust	£60761	Me, You, and Science Too. Family storytime sessions in
		partner school to increase parental engagement and support
		development of literacy for pupils. (Sept 19 – July 21)
Royal Academy of	£19791	'Tales of Engineering' – storytime sessions with professional
Engineering		engineers in nursery schools. (July 19 – July 20)
UK Space Agency	£12899	'Family Space Explorers 2' Extending the earlier Family Space
		Explorers into other North East cultural venues, providing
		resources for delivery of the sessions, and training venue staff
		to deliver the sessions. (Sept 19 – Mar 21)
Northumberland County	£7949	Support Museums Northumberland to write STEM learning
Council		programme for National Lottery Heritage Fund Union Chain
		Bridge. (Sept 19 – March 19)
Total	£383,061	

7.2 Faculty led bids

Faculty Member	Outreach costs	NUSTEM activity		
Paul Mann (NERC)	£13741	Cocoon – delivery of 30 workshops in primary and secondar		
		schools. Workshop co-created with researcher, NUSTEM and		
		external artist (May 18 – Apr 21)		
Glen McHale (EPSRC)	£3600	Supporting undergraduate interns to create a school activity		
		(Nov 18 – Nov 21)		
Richard Morton (EU)	£21086	Training in public engagement for SOLARnet participants.		
		(Jan 19 – Jan 23)		
Neil Beattie	£26230	Equality, Diversity and Inclusion support and outreach for		
(EPSRC)		Centre for Doctoral Training in Renewable Energy North East		
		Universities.		
		(Sept 18 – Aug 28)		
Total	£64,657			

Appendix 1 Theory of Change

The development of NUSTEM's Theory of Change started in 2014, as we explored how best to target and prioritise our work. Founded as a project with ambitions regarding gender representation in the physical sciences, we drew on early research regarding 'science capital'⁷ to identify children's 'key influencers' (i.e. their families and teachers) as audiences of particular value. An emphasis on interventions at primary was also implied by science capital approaches, along with thinking about the challenge holistically, as later endorsed by the Institute of Physics Improving Gender Balance⁸ work. Epstein's work exploring overlapping spheres of influence⁹ also encouraged thinking about the challenge more broadly.

Initial Steps

Our initial expression of an overarching model centred on the perspective of the individual child, and tentatively suggested stages of STEM identity development. Although a simple model, it allowed us to map individual interventions within an overall plan. It also prompted us to explore how the objectives and approach of interventions might differ with participant age, and for different audiences.

Formal Model Development

As we gained confidence with the initial model, its limitations became clear. Convinced of the value of the approach, we invested in the development of a full, formal Theory of Change model (pending publication). This provides a "comprehensive description and illustration of how and why a desired change is expected to happen in a particular context'¹⁰.

The developed Theory of Change provides the theoretical underpinnings and context for the complex mix of interventions necessary to lead to a significant change in the number and diversity of young people choosing STEM careers. Through 2017–8 (and subsequently) exploring and applying the model has challenged our thinking, prompting changes to our practice at both macro- and micro levels. The development process has also been highly iterative, as we've tested the model against our delivery approach and incorporated amendments to work around limitations.

⁷ Archer et al. 2015 "Science Capital": A conceptual, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital beyond the Arts Journal of Research in Science Teaching, 52 (7) pp 922-948 ⁸ IOP, 2017, Improving Gender Balance: Reflections on the impact of interventions in schools

⁹ Epstein, 2011, "School, family and community partnerships" 2nd Ed. Westview Press: Boulder

¹⁰ The Centre for Theory of Change, 2017, 'What is Theory of Change'



Appendix 2 Yearly Interactions

Total Interactions to date

	Interactions	2014 – 2015	2015 – 2016	2016 – 2017	2017 – 2018	2018 – 2019	Total to date
gunc	Pre-school and Primary	4877	9322	10573	6033	12542	43347
n and ye	Secondary school	6497	10754	5883	4501	4438	32073
Childre people	Community events	3054	2145	1018	803	570	7590
S	Teachers	447	1410	873	951	1220	4901
luencer	Parents and Families	818	2055	1480	1409	1116	6878
Key Inf	Wider community	1277	891	706	550	464	3888
	Totals	16970	26577	20533	14247	20350	98677

Interactions by primary school project

School Project	Children	Teachers	Families
Original schools	4438	207	157
Widening participation schools	3878	138	96
Exploring Extreme Environments	3710	263	221

Individual children

We are also able to estimate how many individual children we have seen in partner primary schools using our records of activities in each school. Since 2014 we have worked with approximately 12600 children, with many of them taking part in NUSTEM activities several times over a number of years. For example, a child joining one of our partner primary schools in reception in 2014 will have experienced the following activities:

Academic year	Child in school year	activity
2014/15	Reception	Bubbles workshop
2015/16	Year 1	Naval Architect workshop
2016/17	Year 2	Botanist workshop
2017/18	Year 3	Mechanical Engineer workshop
2018/19	Year 4	Palaeontologist. Materials Scientist. STEM person of the Week

Additionally support is provided to primary teachers and science coordinators to allow them to embed the NUSTEM approach into their own teaching – amplifying the impact that we have in the school.

Appendix 3 NUSTEM Publications

Research publications

Emembolu, I., Padwick A., Shimwell, J., Sanderson, J., Davenport, C., Strachan, R. (submitted) 'Using Action Research to design and evaluate sustained and inclusive engagement to improve children's knowledge and perception of STEM careers', International Journal of Science Education

Davenport, C. et al., (submitted) 'A Theory of Change for improving Children's perceptions, aspirations and uptake of STEM careers', Research in Science Education

Shimwell, J., Davenport, C., Padwick, A., Sanderson, J.J., Strachan, R. (in preparation) 'Scientist of the Week: the long-term effects of a medium-term, teacher-led STEM intervention to reduce stereotypical views of scientists in young children', Research in Science and Technology Education

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