

# Annual Report 2022 - 2023

**NUSTEM** 

w: nustem uk

e: nustem@northumbria.ac.uk



### **Executive Summary**

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.



NUSTEM's vision is broad and this year we have been reflecting on our activies and how they contribute to the realisation of that vision.

A key part of our work is to develop, deliver and enable high-quality STEM interventions for key stakeholders. This includes children and young people in 33 partner schools, their teachers and their families. In section 1 we describe some of the activities for children but also how we provide ongoing support for teachers to help them develop their teaching practice and embed STEM careers and attribute ideas into everyday lessons.

This is also the year that Northumbria University was awarded Times Higher Education (THE) University of the Year for the strength of its research and the opportunities it provides for students from widening participation backgrounds. NUSTEM supports STEM outreach and widening participation at the university. We focus on primary schools serving areas of deprivation in the North East. We encourage academic colleagues to work with similar audiences, and run public engagement training for them to increase their confidence when speaking about their research to children and adults. In section 2 we describe three projects which took researchers into primary and secondary schools.

Collaboration with other universities and organisations allows NUSTEM to share our approach to STEM engagement. We work in partnership to develop, disseminate and embed effective practice. Section 3 describes two of our partnerships with cultural organisations.

As well as being an outreach group, NUSTEM prides itself on the strength of research and evaluation that we also do. It's important that we produce high quality research and evaluation on young people's STEM learning and career choices, and share our findings with the wider STEM community. In Section 4 we highlight our recent research about the state of careerrelated learning in primary schools, and two evaluations of projects with recommendations for other STEM organisations.

I hope that you enjoy the report, and if you have any questions or would like to work with NUSTEM, then please do get in touch with us.

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Dr Carol Davenport, Director, NUSTEM.







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

NUSTEM's work with partner schools has continued apace this year. We have facilitated 269 activities with schools. For primary schools there were workshops where children develop their skills as botanists and geologists, career-inspired loans boxes for all year groups, family storytimes for children and their adults, and teacher CPD. Secondary school pupils took part in evening lectures, STEM assemblies, and Maths and Physics Experience weeks. These activities, along with other those for teachers, families, science communication professionals and others have meant that we have delivered over 1000 hours of activities during the year. We have had over 15,000 interactions with a range of audiences this year as shown in the diagram below.

In the rest of this section we highlight some of our schools activities.





#### 1.1 STEM Person of the Week

The STEM Person of the Week resource won the 'Science, Technology, Engineering & Mathematics (STEM) Initiative' award at Educate North 2023.

STEM Person of the Week (SPOTW) is a five-week teacherled resource that aims to reduce children's stereotypes about people who work in STEM, and help them to see themselves as being similar to a 'STEM person'. We use the 15 NUSTEM attributes on each set of cards so that over the 5 weeks children are able to consider how they already use these attributes in school and beyond, and how they could be useful to them in the future.

As well as developing SPOTW cards featuring Northumbria University staff, we have also worked with other organisations such as British Ecological Society, STFC, Museums Northumberland and Manchester University to create their own SPOTW cards to use with schools.

We are delighted that this award recognises SPOTW as a highquality activity with real impact.

This is a great idea for making STEM relatable. The initiative effectively addresses many of the challenges facing the promotion of STEM subjects to students, while inspiring them to further their knowledge in these areas. Educate North Judges

Weblinks: Press release and NUSTEM SPOTW page

4





#### **1.2 Family Storytimes**

This year we have been developing the in-school family story time aspect of the Early Years and Foundation Stage (EYFS) STEM units and have led 15 well attended sessions. During the sessions, adults joined their children in school to listen to a story and complete an activity related to a STEM career.

Activities included making windsocks and magnet mazes, rescuing animals trapped in ice, and completing a robot programming game. The sessions have encouraged parents to return to post-covid in school activities. Teachers have said that children and adults were really engaged with the activity and that the sessions support the development of the children's vocabulary and encourages parents to do the same.



Tweet from New York Primary School showing family storytime activities in action

#### 1.3 Secondary Assembly: Apprenticeships

The theme of this year's STEM careers assembly was 'STEM apprenticeships in the North East'. The assembly highlighted the benefits of pursuing apprenticeships, provided examples of jobs adverts and, most importantly, directed schools and pupils to local employers who offer apprenticeship schemes including Arriva, Sterling, NHS, Northumbria Water Group, and the SAGE group.

The assembly has been presented to 1500 students from Year 7 to Year 13 in NUSTEM partner schools and beyond.



Weblink: Assembly webpage





#### 1.4 Teacher support

#### 1.4.1 Early Years and Foundation Stage Forum

NUSTEM have started a forum for Early Years and Foundation Stage (EYFS) practitioners from our partner schools. This covers the 3 - 5 age group in primary schools or other settings including nurseries and playgroups.

Through the forum we are supporting EYFS staff to trial our STEM in Early Years units in their settings. Early years settings have lots of adults who work with the children, many of whom are not teachers and don't have a science background.

The STEM in Early Years units help these adults to increase their confidence when talking about science and STEM with young children. The units include a link to a story and different activities for children and adults to do. Each unit is based on a career and links with the Early Learning Goals. Teachers and adults can use these resources in different ways, tailoring the unit for their own setting

The EYFS Forum members are also helping to develop a new STEM in Early Years unit and will be trying out the activities in their own settings during the summer term.

Weblink: STEM in Early Years



Resources from an STEM in Early Years unit in action

#### 1.4.2 Art and Science CPD

NUSTEM have had a number of cross-curricluar projects including Giant Waves in the Ocean, Imagining the Sun and Exploring Extreme Environments

Our primary teacher CPD explored how using the arts to explore and communicate science topics develops and deepens children's understanding and supports observation and recording skills. During the session we linked objectives from the science curriculum to those from Art and Design Technology to show how this can provide motivating and creative ways to interpret and communicate results.

Teachers also had the opportunity to develop their own skills in sketching and observational drawing and modelling, and were challenged to think of ways they can use art-based activities in their science lessons.



## 2. Support STEM outreach and widening participation



#### 2.1 Climate Change: It's in our hands

Climate Change: It's in our hands is a board game to help children aged 9 - 11 explore climate change and its impact. The game explores this complex topic in a nuanced way.



Eco Club pupils testing the game

The game was developed with Dr Emma Hocking and Dr Matt Pound, graphic designers at Roots and Wings, and with support from the Eco Club at New York Primary School. The project was funded by NERC.

Weblink: Climate Change: It's in our hands

#### 2.2 Careers learning in chemistry

The Careers Learning in Chemistry project is working with two schools to showcase different careers in chemistry. A new cohort of Y7 students from the schools has joined the project, bringing the total number of students to 560.

We have developed another STEM Person of the Week set with a chemistry focus, and have adapted a Royal Society of Chemistry worksheet to include a careers focus by providing a 'wrap around' sheet for teachers to use. We have also given meteorites to both schools to bring the career and the chemistry to life. The project is funded by Royal Society of Chemistry.

Weblink: CLIC Webpage

#### 2.3 Encounters assemblies

This year over 1000 children and more than 50 adults in our partner primary schools have experienced an NUSTEM Encounter assembly delivered by Northumbria researchers.

Before the Encounter, the schools are sent a little bit of information about the researcher and the children think of questions about the person's career that they would like to know more about. We then support the researcher to use these questions as the basis of the assembly presentation, helping to ensure that the content and level of the answers is suitable for the children in the audience.

The children loved the talk, we are going to go outside this afternoon on a worm hunt! Teacher, Primary School



Professor Esther Akinlabi



Dr Tim Duckenfield





3. Work in partnership to develop, disseminate and embed effective practice

NUSTEM has continued to collaborate with a range of other organisations on local projects and national projects. Through these collaborations we have been able to reach more children and families with career-inspired activities, and support organisations to embed the NUSTEM approach to STEM engagement in their work.

#### **3.1 Connect**

Connect is a partnership project with the Life Science Centre, bringing together their expertise in 'making and tinkering' activities and NUSTEM's understanding of digital technologies. 'Digital tinkering' is a relatively unexplored topic, and the project has developed and tested a subtle set of approaches which support children and their families as they explore mechanisms and attach motors to make animatronic puppets. They then code sequences of movements for their puppets, which share 'moods' over the internet.

Workshops have taken place at Life and in schools and libraries in Northumberland, North Tyneside, and Newcastle. We have prioritised spaces for less-served communities: remote, in areas ranked highly in the multiple indices of deprivation, or with particular personal circumstances. Schools have used the project to reconnect with less-engaged families, and Life's workshops have recorded a relatively high proportion of applications from families with neurodivergent children.



The invitation to "make a daft animatronic puppet" has a broad appeal. The appeal of collaborative craft-based play does not seem to be dimmed by the inclusion of servo-motors, microcontrollers, and coding. The block-based programming interface is deliberately similar to most schools' approach to coding for this age group.



Participants continue to surprise us with ingenious, imaginative, ambitious, beautiful and often ridiculous constructions. There is enough challenge and complexity that families feel a genuine thrill when their creation finally springs into 'life', and delight when it first responds to another puppet's message. Families are proud of their builds when they take them home.

Connect was funded by the North of Tyne Combined Authority.

Weblink: Connect webpage







#### 3.2 Northumberland Archives Project

We have been supporting Northumberland Archives with a project called 'Blyth to the Future'. They have been working with a cluster of 4 primary schools in Blyth, helping the children to think about what Blyth was like in the past and what it might be like in the future. The children are 3D printing their designs and creating an exhibition of their ideas.

The children have also visited Northumbria University to learn more about careers in the Building Information Modelling (BIM) sector. The visits included a campus tour and a workshop where the children experienced being a system engineer. The children also met two Northumbria researchers who talked about how their research linked to the design of towns and cities: James Charlton, an architectural technologist, and Kay Rogage, a computer scientist who studies the interaction between people, technology, and buildings.

Thank you once again for organising and hosting. You have gone above and beyond to support Blyth to the Future, and we can't express enough how much we appreciate it.

Megan Wilson, Northumberland Archives



Dr James Charlton (left) and Dr Kay Rogage (right) talking about their jobs and research with children from Blyth schools

#### 3.3 I'm a Space Person

NUSTEM has been working with Dr Martin Archer from Imperial College on a project which aims to showcase the broad range of careers that are available in the growing space sector in the UK.

The I'm a Space Person website and postcards build on NUSTEM research on attributes used by STEM professionals. Children are encouraged to think about what interests them or what qualities (attributes) they already have. After choosing a quality, children are then shown a selection of jobs related to space where that quality would be useful. Each space job is linked to three of the NUSTEM attributes and together they encompass a very broad range of different careers.

Weblink: I'm a Space Person



#### I COULD WORK IN... **Business Development** Management



Business development build a relationship with other organisations such as the government or space agencies. They make sure the company receives grants and investments so that they can develop new technology and prepare for more missions. They must go to events and network with other people to make sure that they know about new opportunities. Routes

ww.spaceperson.co.ul

Can have any degree. Technical understanding is needed, but can be gained through experience. Learn more

#### Example UK employers Surrey Satellite Technology

Imperial College Share on socal media using #spaceperson





# 4. Produce high quality researchand evaluation on young people'sSTEM learning and career choices

#### 4.1 Career-related learning in Primary Schools

We have been collaborating with the North East LEP to explore what career-related learning (CRL) is taking place in primary schools in England.

We surveyed over 1600 primary school teachers across England in July 2022. Only 9% of teachers said that they had good knowledge of how to delivery CRL. However, we did find that there was a lot of good practice across England, but that it was patchy and the type of activity depended on where the school was. When asked about barriers to delivering CRL, teachers' identified time, lack of resources and curriculum pressure.

Our recommendations were that primary teachers should be supported to develop their understanding of CRL, to have careers leaders in each primary school, and to provide a national framework of best practice benchmarks to ensure a structured approach to career-related learning.

The project was funded through the Capacity in Policy Engagement (CAPE) project funded by Research England.

Weblink: Career-related learning in primary schools report

#### 4.2 Creativity Clubs

Creativity Clubs was a STEM Outreach project for children aged between 4 and 7 years old developed by Success4All and NUSTEM. The project took place at Meadow Well Connected community centre.

The year long project involved a series of 6-week after-school sessions themed around a broad area of STEM linked to STFC science and a picture book. Club sessions were filled with different STEM-linked activities.

In March 2023 we published a report on the key learning from the project reflecting on our prior assumptions at the design stages, the adaptations we made to the programme, and the result these adaptations had on the engagement of children and families with the club.



Our recommendations are:

- Build in time to work with community centres at the project design stage
- Investing in positive relationships with children provides a foundation for successful work
- Outreach and engagement should be responsive to children's needs and interests
- Evaluation outcomes, strategies and instruments may need to be adapted to respond to project changes and stakeholder needs

We believe this report will be of value to practitioners delivering, or thinking about delivering, meaningful STEM engagements with children in non-school settings, such as community centres.

The project was funded by a Science and Technology Facilities Council Spark award (ST/W002027/1)

Weblink: <u>Delivering equitable and effective STEM engagement in</u> community settings.





#### 4.3 Learning from the original 'Think Physics' project

As a team, we think that is important is to be honest with ourselves and others about lessons learned from projects, particuarly if they haven't gone quite as we expected them to.

NUSTEM was originally called Think Physics, and was set up in 2014 to develop and deliver a three-year project with 15 primary and 15 secondary schools.



To evaluate the project, we created

what (at the time) seemed like a fairly sensible evaluation plan. We were focussing on outreach activities so we selected a small subsample of partner schools to become evaluation schools.

We collected data from young people in Year 7, Year 9 and Year 11 in those schools at three timepoints: at the start in 2015 to get a baseline, then in 2017 and finally in 2019 at the end of the project. We also used comparator groups to account for the effects of the development within young people as they get older. The evaluation tools we used were specifically designed to measure the science capital of young people.

However, when we analysed the data in 2019 – 2020, we found that our work in the evaluation secondary schools had not produced the intended impacts. In fact, the young people in our comparator group seemed to have higher science capital than the young people that had taken part in the programme. Finding this, we struggled to know how best to report this result.

We spent a lot of time reflecting on the design of our schools offer and our evaluation plan, and conducted new analysis of the implementation of the programme. In doing this, we identified a number of learning points:

1. Ensure your evaluation matches your delivery:

Some of our evaluation schools didn't do many of the activities offered to them, or include the year groups that we were measuring in the activities. Reviewing the evaluation regularly would have picked this up sooner;

2. Be aware that there is more going on in schools than your project:

There were a lot of changes in the school curriculum starting in 2015 with new GCSEs being introduced which limited the capacity of science teachers to support extra-curricular activities.

3. 'Science capital' is a really useful design framework ...

The idea of science capital was helpful when designing activities and targeting them on potential predictors of young people's future participation in science.

4. ... but 'science capital' is not a useful quantitative outcome measure:

It's tempting to think that we can run activities to 'build science capital' in an individual and measure the change, but the concept is so multifaceted that such a change is not the best measure to use.

By publishing our findings in a paper, we are also addressing the critique that outreach programmes often focus on shortterm and positive findings. This will help develop a constructive evaluation environment of STEM education, where we can learn from one another and develop skills and knowledge about what works, based on robust evidence.

Weblink: Evaluating a complex and sustained STEM engagement programme through the lens of science capital







#### 4.4 Other NUSTEM Publications

In addition to the reports and paper outlined in 4.1 - 4.3, NUSTEM have also published other papers this year.

Elimination before imaginination: How children's early understanding of scientists may limit aspirations for broader STEM careers

Annie Padwick, Carol Davenport, Rebecca Strachan (2022) IEEE Frontiers in Education Conference, Uppsala, Sweden doi: 10.1109/FIE56618.2022.9962471

Imagining the Sun: Using comparative judgement to assess the impact of cross-curricular solar physics workshops Carol Davenport, Richard Morton (2022) JCOM 21(06), AO6 doi: 10.22323/2.21060206

### People like me: identifying personal attributes of STEM professionals

Carol Davenport, Melanie Horan, Bethany Willis, Annie Padwick, Rebecca Strachan (2022) IEEE Frontiers in Education Conference, Uppsala, Sweden

doi: 10.1109/FIE56618.2022.9962471

#### 16 key skills and attributes for a successful career in Physics

Carol Davenport (2022) Physics World, 25(10)

https://physicsworld.com/a/16-key-skills-and-attributes-for-asuccessful-career-in-physics/



## 5. Looking ahead



As NUSTEM approaches its 10th year of operation the team will be writing a new strategy for the next 3 – 5 years. We recognise that we have experienced a range of changes since we started back in 2014, and so feel that it is a good time to review what we have done, what we have learned, and consider what we would like to achieve in the future. This fits well with the development of the new Northumbria University Strategy, currently underway, and we are looking forward to seeing how NUSTEM can support the work of the university, particularly around widening participation.

Before the pandemic, the team had been thinking about how to help primary schools embed the NUSTEM approach to science and careers across the school, and had been ready to review how we worked with primary school. During the pandemic, these plans were put on hold. However, we believe that we, and schools, are now in a position to review our work with schools. The next academic year will be a transition period as we develop our plans with primary schools.

Similarly, we are reviewing our secondary school programme, and will be exploring how we can involve more schools, teachers and students in our activities.

The team continue to develop links with external organisations, act as consultants on a range of projects, and support companies to improve their STEM engagement activities.

If you would like to collaborate with NUSTEM, do get in touch with any member of the team.

nustem@northumbria.ac.uk







## **Appendix 1: Yearly interactions**

As part of our monitoring, we track the number of interactions that we have with different audiences each year. This table provides an overview of our interactions from 2014 to the present day. To make the text readable we have amalgamated some of the time periods.

	Audience	2014 - 2019	2019 - 2021 (lockdown years)	2021 - 2022	2022 - 2023	Total
Children and young people	Pre-school and primary	43347	12490	8934	8159	72722
	Secondary school	32073	6158	3593	2711	44535
	Community and family events	7590	526	160	1261	8732
Adults	Teachers and student teachers	4901	1441	1193	992	8527
	Parents and families	6878	1147	231	1231	8688
	Other adults	3888	1223	564	725	6400
	Totals	98677	22985	14675	15079	151416



## Appendix 2: Current NUSTEM projects



Project	Duration	Notes
Our Past, Your Future	Sept 19 –June 23	Collaboration with Museums Northumberland to develop and support the delivery of the Heritage-
Museums Northumberland (North of Tyne Combined Authority)		STEM project.
Union Chain Bridge	July 20 – Dec 22	Collaboration with Museums Northumberland to develop a STEM learning offer based around the
Northumberland County Council (Heritage Lottery Fund)		refurbishment of the Union Chain Bridge outside of Berwick.
Let's do Engineering	Jan 21 – Dec 22	Providing consultancy support on a project to engage children aged 3 – 7 and their families with
Heriot-Watt University (EPSRC)		engineering activities.
connect	Sept 19 – July 23	Extension due to covid. First pilot courses have taken place, and delivery to families is underway in a
North of Tyne Combined Authority		range of venues
Chemistry for All	Sept 21 – Feb 24	Working with two schools to create resources, and run activities to broaden young peoples'
Royal Society of Chemistry		knowledge and understanding of chemistry careers.
Capabilities in Academic Policy Engagement (CAPE) - Primary careers	May 21 – Dec 22	Working with NELEP and TeacherTapp to explore primary schools teachers understanding of primary
UKRI		careers.
'I'm a space person' postcards	June 22 – Aug 23	Working with Dr Martin Archer on the development of a resource which showcases a broad range of
Imperial college / STFC		careers in the space industry using NUSTEM attributes.

Project	Duration	Planned activity	
TIPPACS	Aug 19 – July 23	Public engagement training for collaborating organisations and development of classroom activity	
Professor Hilmar Gudmondson		and training linked to TIPPACs research.	
Fungi in a warming world	Jan 21 – Dec 23	Develop a ludic pedagogy climate change workshop. This will be translated into Spanish and	
Dr Matt Pound		Afrikaans to enable distribution in project countries.	
Revealing the pattern of Solar Alfvénic Waves (RiPSAW)	Nov 20 – July 2024	Supporting Dr Morton to develop an outreach programme for a rural community.	
Dr Richard Morton			
Renewable Energy Northeast University (RENU)	Apr 19 – Sept 27	NUSTEM provides training for students and supervisors, along with EDI support for the CDT as a	
Professor Neil Beattie		whole.	
Maya Archaeology and palaeoecology partnership project (MAPPP)	Nov 21 – Oct 23	Outreach training for 10 Belizean students – 5 in first year and 5 in second year of project. Simple	
Dr Bronwyn Whitney		evaluation of workshop, and longitudinal follow up with students to explore longer term impacts.	
Carbon Emissions under Arctic Snow (CEAS)	July 21 – July 23	Creation of primary workshop. Materials created in 21/22 and delivery in UK (and Inuvik) in 22,	
Dr Nick Rutter			
Nuna: Effective mitigation and adaptation to changing ground	May 22 – May 25	Working with community and school in Tuktoyaktuk, Canada to create resources which explore the	
conditions for resilient coastal futures		findings from the wider project. Also includes costs for NUSTEM travel, consumables and design	
Prof Mike Lim		work in each of the 3 years of the project.	

Event	Organisation
Athena Space Camps Summer 2022	Athena Group / Lockheed Martin Space
Supported National Space Centre to evaluate the activity weeks for primary and secondary	
pupils.	
STEMFest 2023	RTC North
<u>3 day</u> careers festival for children aged 8 – 14.	
North Tyneside Science Ambassadors	British Science Association / Promoting Women in STEM
Project to support girls to become science ambassadors and run STEM clubs in their school,	
or in primary schools.	

