Northumbria University
NEWCASTLE

Image Credit: New York Primary School via Twitter

ANNUAL REPORT

July 2022

Contents

Executive Summary

Following on from two years of disrupted education, we weren't sure if schools would want external visitors during the academic year 2021/22. However, during the course of the year we found that schools were keen to be involved with NUSTEM activities to support their pupils and teachers, as is shown by the number of interactions that we have recorded this year (Appendix 1). In this report we highlight a number of activities that have helped NUSTEM to continue to work towards our vision for STEM:

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.

This year we have taken the opportunity to revisit our provision for the youngest children we work with, updating our loans boxes to ensure that they have a strong career focus throughout (section 1.2).

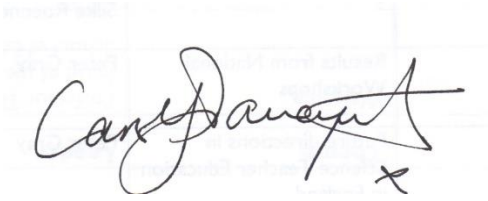
Working with colleagues in the Mathematics, Physics and Electrical Engineering department, we have expanded our Work Experience Week to include a maths component, and it was great to see and hear the buzz of studious excitement as year 12 students (16 – 17 years old) got to grips with Northumbria University research, and interviewed the postgraduate students and lecturers about their research (section 2.2). We've also strengthened our work with other academic colleagues developing projects in Applied Sciences (section 2.3) and Geography and environmental science (section 2.4).

As well as working closely with colleagues at Northumbria University, we've also been able to work with other organisations across the UK to embed NUSTEM research and activities. These organisations include the Life Science Centre, British Science Association, SEERIH at Manchester University, and Museums Northumberland (section 3).

Research and evaluation are key to understanding the effectiveness of STEM engagement activities, and an important part of NUSTEM work. This year we have been investigating the attributes that STEM professionals feel that they have with a paper about our findings due to be published in October 22, and also extending the STEM Person of the Week into secondary schools (section 4.2).

NUSTEM team members have also been bringing their subject expertise and knowledge of science communication to undergraduate and postgraduate teaching across the Faculty of Engineering and Environment, making our work with children and young people span from 'cradle to career'.

I hope that you enjoy reading more detail about what NUSTEM has done in 2020/21



Carol Davenport

Director, NUSTEM

nustem

Working for a vibrant and sustainable STEM sector which meets the needs of learners and employers, reflecting the diversity of wider society.

The year in numbers 2021 - 2022

12687
interactions with Children and Young People

1988
interactions with the wider community, including families, teachers and science communicators.

66 SCHOOLS
partner schools and schools linked through collaborative projects

363 EVENTS
events and activities delivered by NUSTEM, from early years to post-16

36
Northumbria University rstaff and postgraduate students participated in NUSTEM activities during the year

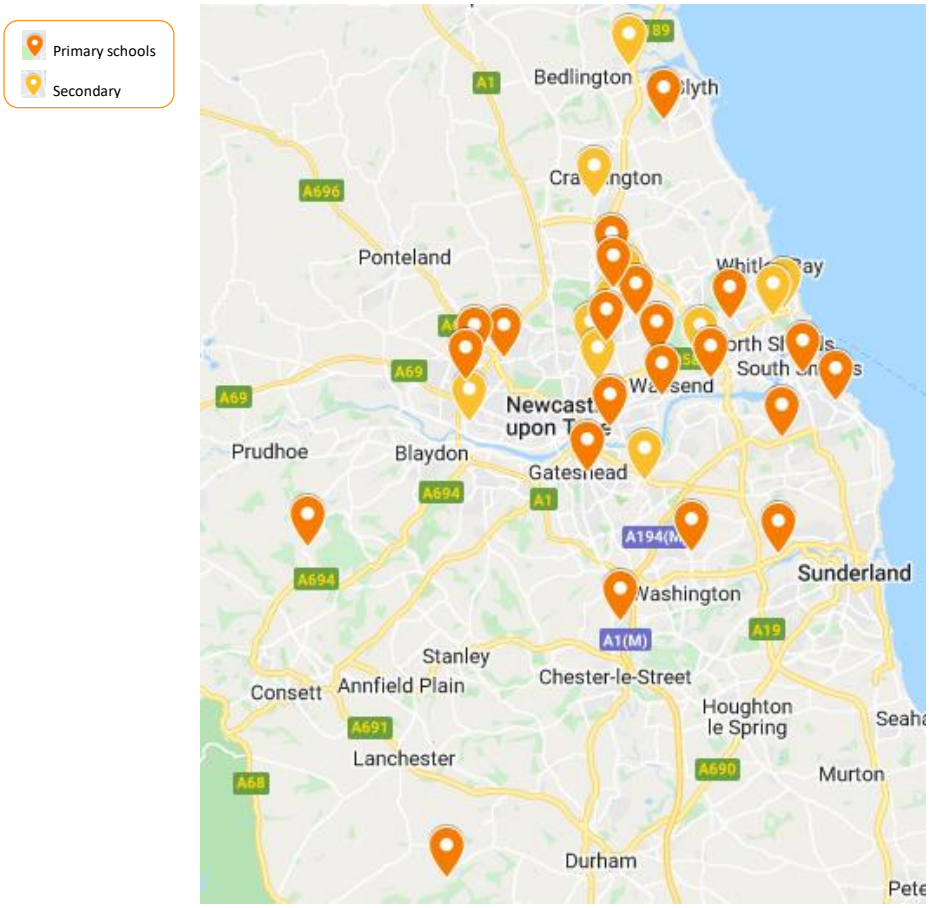
18 PROJECTS
Externally funded projects delivered locally, nationally and internationally

Since 2014, NUSTEM has worked with 14,490 individual primary school children, and had over 136,300 interactions with children,young people and the wider community.

Find out more at nustem.uk
nustem@northumbria.ac.uk

Northumbria University NEWCASTLE

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



Map showing location of NUSTEM partner schools in 2021/22

Appendix 2 contains a detailed breakdown of interactions by different audiences.

1.1 Return to in-person activities

We have been delivering a mix of in-person and online workshops this year.

Primary schools have been very keen to have activities in-school and we have delivered workshops to all 22 primary partner schools. Years 1 and 2 (aged 5 – 7) have been naval architects, materials scientists and systems engineers. Years 3 and 4 have been geologists and mechanical engineers and Years 5 and 6 have been ice core scientists in the Underneath the Ice workshop. Nursery and reception classes have been very keen to try out the activities for our new EYFS (Early years and Foundation stage) units, with some buying recommended books and reporting that the children have continued to engage in and develop related play in the weeks after they've tried out the initial activities.

> *Thank you for all your effort this year - the children have learnt so much from your workshops and loan boxes – and most importantly it has increased their love of science.*
>
> *Year 5 teacher*

Secondary schools have preferred a mix of online and in-school activities. The theme for the careers assembly this year was the circular economy. It was linked to North East companies and the Accelerating Circular Economy (ACE) incubator project to show young people how STEM jobs can support future reduction in resource use.

Weblink: Assembly https://www.youtube.com/watch?v=bV8f3M83J3M

1.2 Redesigned loans boxes

Loans boxes have been part of our offer to primary schools for many years. This year we have revamped the boxes to relate more closely to curriculum topics, and to include more careers links.

We now have 23 different loans boxes suitable for different key stages.

Contents of the 'Water' box

The boxes contain photographs of each piece of equipment and book, copies of related STEM person of the week posters and links to appropriate PSTT 'A Scientist just like me' PDFs.

Teachers can use the boxes to introduce different careers for children from age 3 and up.

The boxes also contain prompts or challenges for use in class or at STEM clubs to help teachers make best use of the boxes.

There is online support with a teacher's webpage which contains curriculum and career links, along with a full list of what's in the box.

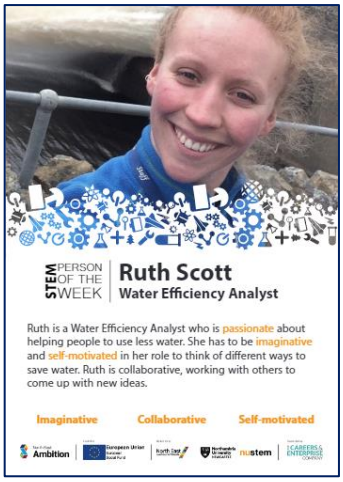
As well as supporting teachers, each loans box now has a parent/carer page with links to appropriate STEM at home activities. The link to this page is shared with parents via a postcard which is taken home by the children. Some teachers also share the link directly using their digital communications with parents.

It helped me to run an after-school STEM club for children and their families. The books + career links were very helpful.

KS2 Teacher, Structural Engineer Loans Box

I really liked the challenge boxes as the challenges really provided the children with the opportunity to discuss through their thoughts and process.

Early Years Teacher, Cubetto (programmable robots) Loans box



Example of one of the career posters in the Water box

Weblink: https://nustem.uk/loans-boxes/ and https://nustem.uk/activity/water-loans-box/

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

NUSTEM continue to work with other academic colleagues to support outreach and public engagement with their research. This might be through development of workshops or other activities, or by providing opportunities for them to visit local schools to meet pupils and teachers. We also continue to work with undergraduates to support their communication and employability skills through outreach.

Dr Juna Sathian and undergraduate Bethany Willis at Kenton Bar Primary School STEM Fair

2.1 REF2021 IMPACT case studies

NUSTEM were part of the Northumbria University submission to the Research Excellence Framework (REF). The REF is a way for universities and research funders to carry out an analysis of the quality and quantity of research being done in all UK universities. In REF2021 Northumbria University had the biggest rise in research power of any university (for the second REF in a row). As part of the REF the University submitted a number of case studies which showed how Northumbria research was having a positive impact outside of the university, in the UK and abroad. NUSTEM were part of two case studies linked to our research on a Theory of Change. These were "*Utilising engineering research to transform STEM aspirations and education-engagement strategies in North East England and Nigeria*" and "*Informing choices and building aspirations – STEM careers in the North East*". As well as this, NUSTEM contributed to the 'environment statements' for research and public engagement across the faculty.

2.2 Maths experience week

After organising a Physics Experience Week for the past 5 years, NUSTEM supported colleagues from the Mathematics Team to organise a "Mathematics Experience Week" during the February half term. Both Physics and Mathematics strands ran in parallel on campus. The Maths Experience Week involved 12 academic colleagues offering 12 mathematics projects to 17 students (age 16 - 17) from local schools. NUSTEM Experience Weeks allows students to engage with different elements of undergraduate academic life such attending a real lecture and designing a research poster.

The Mathematics and Statistics team was delighted to have taken part in the 2022 edition of the experience week. Staff were very impressed with the enthusiasm of students, the quality of the posters and the breadth of mathematical topics explored, from artificial intelligence and game theory to fractals and tsunami modelling. This has been an overwhelmingly positive experience and the team looks forward to the next edition.

Dr Matteo Sommacal and Dr Benoit Huard

2.3 Careers Learning in Chemistry project

The Careers Learning in Chemistry (CLiC) is an outreach project funded by the Royal Society of Chemistry and delivered by NUSTEM over 2 years between January 2022 and December 2023. Over this period 300 pupils (starting in Y7) will engage with chemistry-focused, careers-linked activities as part of their school science lessons. Since the start of the project pupils from two of our partner schools, Bedlington Academy and John Spence Community School, have had an opportunity to "Meet a Chemist" during a school assembly and have been introduced to specially designed STEM Person of The Week set of cards which showcases 5 STEM workers and their chemistry-related jobs.

Weblink: https://nustem.uk/clic/

2.4 Geography and Environmental Science projects

This year we have been working closely with a number of academics in the geography and environmental science department to develop and deliver outreach and science communications activities as part of their research. As our work develops, we are becoming more integral to the research teams. The table below gives a broad overview of the projects and NUSTEM's work within them.

Project and lead academic	*Project timescale*	*NUSTEM contribution*
Tipping points in Antarctic Climate Components (TiPPACS) *Professor Hilmar Gudmundsson*	Aug 19 – July 23	Public engagement training for collaborating organisations and development of classroom activity and training linked to TIPPACs research.
Fungi in a warming world *Dr Matt Pound*	Jan 21 – Dec 23	Develop a climate change workshop based on a board game. This will be translated into Spanish and Afrikaans to enable distribution in project countries.
Carbon Emissions under arctic snow (CEAS) *Dr Nick Rutter*	July 21 – July 23	Creation of primary workshop. Materials created in 21/22 and delivery in UK (and Inuvik) in 22/23
Maya Archaeology and palaeoecology partnership project (MAPPP) *Dr Bronwyn Whitney*	Nov 21 – Oct 23	Outreach training for 10 Belizean students – 5 in first year and 5 in second year of project. Simple evaluation of workshop, and longitudinal follow up with students to explore longer term impacts.
Nuna: Effective mitigation and adaptation to changing ground conditions for resilient coastal futures *Prof Mike Lim*	May 22 – May 25	Working with community and school in Tuktoyaktuk, Canada to create resources which explore the findings from the wider project.

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

NUSTEM has continued to work with a range of other organisations. The projects range from smaller local projects to national projects. Through these collaborations we have been able to reach more children and families with career-inspired activities.

Reach/numbers of interactions with collaborating organisations:

- BSA packs downloads (Early years – 22,514; Primary – 54,815; Secondary – 17,638; Community – 5318)
- Great Science Share (2156 schools took part)
- Museums Northumberland (workshops and activities with 3421 children, 188 parents/carers, 343 teachers)
- Success4All (Six six-week after school clubs with 390 interactions with children)
- Reading Agency (400 science reading bags issued through 10 library services in England).

3.1 Creativity Clubs

This year NUSTEM started a formal collaboration with Success4All, a charity aimed at improving educational outcomes in the North East of England, to develop Creativity Clubs. This collaboration has been made possible by a STFC Spark Award. In this partnership we have explored models for building parental engagement into after-school sessions.

Creativity Clubs is a yearlong programme of weekly afterschool sessions and one summer holiday session for children aged 5-7 delivered at Meadow Well Connected, a community centre in North Tyneside. Each half-term block is themed around an area of STEM, with three of the themes directly related to the research of STFC funded researchers at Northumbria University. Children are gifted a science book linked to the theme of each block, take part in linked hands-on activities during the 2-hour session each week, before taking home a bag of follow-on activities to complete with their parents/carers.

Through this partnership we have renewed our belief in the need for long-term engagements to build trust and rapport, and realised the real need for flexibility of approaches, models, and outcomes through the delivery stage to ensure the best outcomes are achieved for the children in the clubs.

"I want to come and do more experiments with you."

Creativity Club participant

"[Child] has learnt so much from the girls on a Monday. We look forward to getting our activity bags and get lots of fun out of them. I also look forward to getting them too".

Parent of Creativity Club participant

3.2 connect

connect is a digital making project funded by the North of Tyne Combined Authority as part of their STEM and Digital Skills fund and is a collaboration between NUSTEM and Life Science Centre. The project introduces children aged 8 – 11 and their parents/carers to simple digital and physical mechanisms which allows them to build their own automated puppet which can 'interact' with other puppets. The project began in 2019 and was promptly paused for the duration of the pandemic.

At the start of 2022 connect emerged from the pandemic and (finally!) made it in front of families. We've piloted a range of delivery models, tested and refined the workshop approach, and as this report goes to press are in a good position to scale up delivery to the rate we'll need to reach the intended audience within what's now a very compressed schedule. We're thrilled that the tools we developed over lockdown seem to be working as intended, and families are already using them to create highly inventive, personal robot puppets. We've a long way to go, but it's good to see all the preparation starting to pay off.

We're delighted with the response we're seeing from schools, and the conversations Connect is prompting. Teachers are recognising the possibilities for a positive family experience and encouraging us to explore how the project supports emotional understanding post-pandemic. Even the logistical challenge of finding spaces to hold workshops has turned into a collaboration opportunity, with Newcastle Libraries hosting us over the summer.

Elin Roberts, Head of Public Engagement, Life Science Centre

4 Produce high quality research and evaluation on young people's STEM learning and career choices

4.1 Collaboration with Dr Martin Archer

Over the past year we have been collaborating with Dr Martin Archer, Stephen Hawking Fellow at Imperial College to develop KS3 space careers resource underpinned by our research in STEM attributes and our career postcards. We have also contributed to a journal article about the diversity of roles in the space sector.

One of the findings of Dr Archer's study is the fact that current UK space-careers resources still do not reflect the breadth roles in the space sector and in some cases reiterate misconceptions about the usefulness of science.

This study has helped to create a more balanced set of space careers and these going are to be the basis of the new careers resource which will be rolled out to schools in the Autumn.

Research paper: Archer, M. O., Waters, C. L., Dewan, S., Foster, S., and Portas, A.(2022) GC Insights: Space sector careers resources in the UK need a greater diversity of roles, Geosci. Commun., 5, 119–123, https://doi.org/10.5194/gc-5-119-2022

Weblinks: https://nustem.uk/careers-postcards/

4.2 STEM Person of the Week in Secondary Education (SPOTWISE)

Our STEM Person of the Week activity is now very popular with schools and external organisations. The original activity was aimed at primary school children. This year we have begun a research study which extends the STEM Person of the Week into secondary schools.

We're working with teachers and careers leaders in two partner schools who are delivering the five-week STEM Person of the Week activity to year 7 (age 11 – 12) pupils. The postcards have been adapted slightly from the original 'Scientist of the week' research, and the back of the postcard now includes space for young people to write down examples of when they have shown the same attributes as the STEM Person of the Week.

The aims of the study are to look at how the use of the SPOTWISE resource affects young people's use of stereotypical words associated with people working in STEM; if the use of attributes influence young peoples' perceptions of characteristics they share with people working in STEM; how their career aspirations change during the project; and if secondary school teachers find the resource useful in their teaching.

So far, we've collected baseline data using a simple survey to find out the views of the students towards people who work in STEM as well as their own career aspirations, and the five-week intervention has taken

place. We'll then repeat the survey during July, and then again next year when the students are in year 8 (age 12 – 13).

Initial results

There were 317 year 7 students who were included in the data set. The majority of students named at least one possible job, but there were 12% of students who didn't have any career aspirations (22 boys, 16 girls).

Overall, there were 173 different jobs given by the students, and the jobs named by 10 or more students are given in the table below.

Job	Number of responses
teacher	43
footballer	41
engineer	28
vet	27
artist	23
lawyer	17
doctor	15
scientist	15
police officer	14
architect	12
business person	11
pilot	10

Linked to this study, another partner school is helping us to carry out a pilot study to compare if the words young people use when asked to describe 'a scientist' are different from the words used if they are asked to describe 'a person who works in STEM'.

5 Contribute to Teaching and Learning in Engineering and Environment & Health and Life Sciences.

Members of the NUSTEM team have contributed to teaching at both undergraduate and postgraduate levels. The team's contribution ranges from delivering individual lectures on a module, being part of a module delivery team to being a module tutor.

NUSTEM staff have contributed to the following modules during the academic year 2020/21:

- KL3004 Applications of Physics (NUSTEM-led module)
- KL3013 Introduction to Mechanics and Energy (NUSTEM-led module)

- KB3018 - Foundational Engineering Approaches
- KE3005 - Understanding and Communicating Environmental Issues
- KF4009 Web programming
- KF5002 Web technologies
- KE6033 - Translating Environmental Science into policy, outreach and decision making.

- KE7033 Communicating Geoscience

- TE0488 Educational placements 1
- TE5509 Educational placements 2

In addition to this, NUSTEM have delivered their 'Celebrating Diversity' session during induction week to students in two departments: Maths, Physics and Electrical Engineering and Computer and Information Science. They have also provide unconscious bias sessions to staff and students across the university.

6 Looking Ahead

In the coming academic year, the NUSTEM team will be looking to continue to develop their offer for schools. This will include developing our early years provision and working with schools to develop resources to support parents with science and career conversations. Over the years, we've recognised that influencing family members is one of the more challenging aspects of our vision, and so we hope to explore this area in collaboration with our partner schools. We will also be working more closely to support Northumbria University's Access and Participation Plan to support a diverse range of students into university.

We will also develop our research further and will be looking to submit a number of funding bids to support this, looking particularly at aspects of community support for careers as well as the influence of role models on children's career aspirations.

Finally, we are looking forward to welcoming Year 5/6 pupils back to Think Lab on a regular basis and giving them a taste of University.

Appendix 1 Yearly Interactions

Total Interactions to date

	Interactions	2014 – 2019	2019 – 2020 (Covid Year 1)	2020 – 2021 (Covid Year 2)	2021 – 2022	Total to date
Children and young people	Pre-school and Primary	43347	8019	4471	8934	64771
	Secondary school	32073	3266	2892	3593	41824
	Community and family events	7590	526	*	160	8276
Key Influencers	Teachers	4901	875	566	1193	7535
	Parents and Families	6878	1049	98	231	8256
	Wider community	3888	356	867	564	5675
	Totals	**98677**	**14091**	**8894**	**14675**	**136337**

* NUSTEM supported a number of online community events, but do not have data on the number of viewers for the events.

Appendix 2 Current NUSTEM projects

Project	Duration	Notes
Inventive Podcast *Salford University (EPSRC)*	July 20 - June 22	NUSTEM are developing classroom career materials and science and English worksheets linked to the engineers and stories in the podcast. https://nustem.uk/inventive/ Evaluation of the worksheets with teachers will take place in the Autumn term
Reading Sparks *Reading Agency*	July 21 – July 22	Providing consultancy support for the development of resources linked to reading bags used by libraries.
Creativity Clubs *STFC*	Sep 21 – Aug 22	Working with Success4All to create and deliver a series of afterschool clubs based around science and technology
Our Past, Your Future *Museums Northumberland (North of Tyne Combined Authority)*	Sept 19 – ~~Dec 22~~ July 23	Collaboration with Museums Northumberland to develop and support the delivery of the Heritage-STEM project. Request made to funder for extension of project to complete delivery
Union Chain Bridge *Northumberland County Council (Heritage Lottery Fund)*	July 20 – Dec 22	Collaboration with Museums Northumberland to develop a STEM learning offer based around the refurbishment of the Union Chain Bridge outside of Berwick.
Let's do Engineering *Heriot-Watt University (EPSRC)*	Jan 21 – Dec 22	Providing consultancy support on a project to engage children aged 3 – 7 and their families with engineering activities.
connect *North of Tyne Combined Authority*	Sept 19 – July 23	Extension due to covid. First pilot courses have taken place, and delivery to families is underway in a range of venues
Chemistry for All *Royal Society of Chemistry*	Sept 21 – Feb 24	Working with two schools to create resources, and run activities to broaden young peoples' knowledge and understanding of chemistry careers.
Capabilities in Academic Policy Engagement (CAPE) - Primary careers *UKRI*	May 21 – Dec 22	Working with NELEP and TeacherTapp to explore primary schools teachers understanding of primary careers.

Academic Led Projects including NUSTEM

Project	Duration	Planned activity
SOLARNET *Dr Richard Morton*	Jan 19 – Dec 22	Public engagement training for the solar physics community along with development of activities that can be used by solar physicists for outreach.

Non-Newtonian Slippery Liquid Infused Porous Surfaces (NN-SLIPS) *Dr Ciro Semprebon*	Apr 20 – Mar 23	Development of a primary school workshop and supporting two undergraduate summer interns. NUSTEM involvement in the project will be complete July 2022.
TiPPACS *Professor Hilmar Gudmondson*	Aug 19 – July 23	Public engagement training for collaborating organisations and development of classroom activity and training linked to TIPPACs research.
Fungi in a warming world *Dr Matt Pound*	Jan 21 – Dec 23	Develop a ludic pedagogy climate change workshop. This will be translated into Spanish and Afrikaans to enable distribution in project countries.
Revealing the pattern of Solar Alfvénic Waves (RiPSAW) *Dr Richard Morton*	Nov 20 – July 2024	Supporting Dr Morton to develop an outreach programme for a rural community.
Renewable Energy Northeast University (RENU) *Professor Neil Beattie*	Apr 19 – Sept 27	NUSTEM provides Unconscious bias training for students and supervisors, along with EDI support.
Maya Archaeology and palaeoecology partnership project (MAPPP) *Dr Bronwyn Whitney*	Nov 21 – Oct 23	Outreach training for 10 Belizean students – 5 in first year and 5 in second year of project. Simple evaluation of workshop, and longitudinal follow up with students to explore longer term impacts.
Carbon Emissions under Arctic Snow (CEAS) *Dr Nick Rutter*	July 21 – July 23	Creation of primary workshop. Materials created in 21/22 and delivery in UK (and Inuvik) in 22/23.
Nuna: Effective mitigation and adaptation to changing ground conditions for resilient coastal futures *Prof Mike Lim*	May 22 – May 25	Working with community and school in Tuktoyaktuk, Canada to create resources which explore the findings from the wider project. Also includes costs for NUSTEM travel, consumables and design work in each of the 3 years of the project.