Science Activities and NERUPI

Dr Andrew Ross

Bath Taps into Science

- Week long festival
- 60 events , 4,471 attendees
- Schools and Public Programme

Aims of festival

- Work in conjunction with schools and colleges to contextualise learning of their students through STEM (Science, Technology, Engineering and Maths)
- Engage and stimulate the general public with STEM
- Promote the STEM undertaken across Bath
- Develop links across the wider STEM community
- Provide an opportunity for researchers to show the impact of their research to the wider community
- Develop University of Bath undergraduate postgraduate students' Science Communication skills

Schools Programme

- 2,300 school students across 32 events for schools
- 52 different schools involved across the week

Schools Science Fair

- 1,400 year 5/6 (primary school) students
- From 33 schools
- Interact with 40 stands from researchers, industry and secondary schools

Schools Science Fair Evaluation

- High Profile
- Intense level of activity
- Large numbers of participants

Schools Science Fair Aims

- Level 0
  - Understand
    - Broaden students' understanding through positive learning experiences
  - Know
    - Experience a positive introduction to Higher Education and a campus HEI

Other aims

Work in conjunction with schools and colleges to raise attainment and contextualise learning of their students through STEM (Science, Technology, Engineering and Maths)	Expand students' understandings of the possibilities and applications of science they study at school	(SF) Science Fair, interacting with stands and researchers	Increase in students understandings of how science taught at school can be used in a 'real life' context
Develop awareness of Higher Education among all students, with an emphasis on underrepresented groups	Provide students with first-hand experience of a university setting	(SF) Tour of the University campus	Positive student Feedback
	Develop students understanding of what university is and where it comes in their educational career	(SF) Introduction presentation	Students can answer questions about university

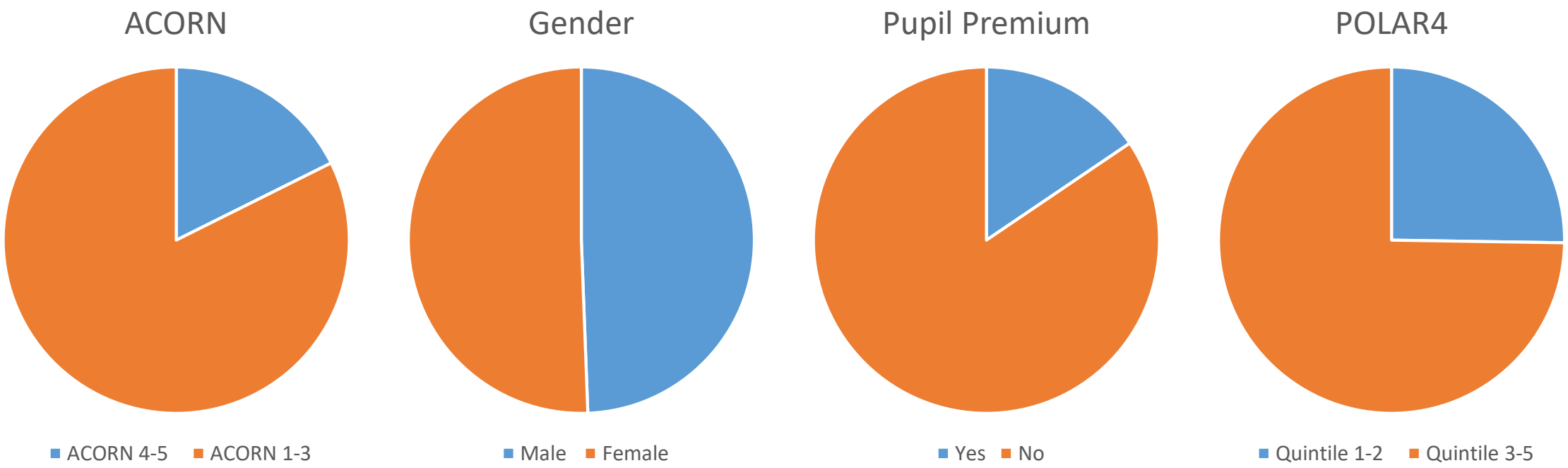
Monitoring

WP characteristics

Postcode, FSM, PP, disability, learning difficulties collected from teachers

Targeting

All schools are invited, preference given to schools with high % of FSM/PP



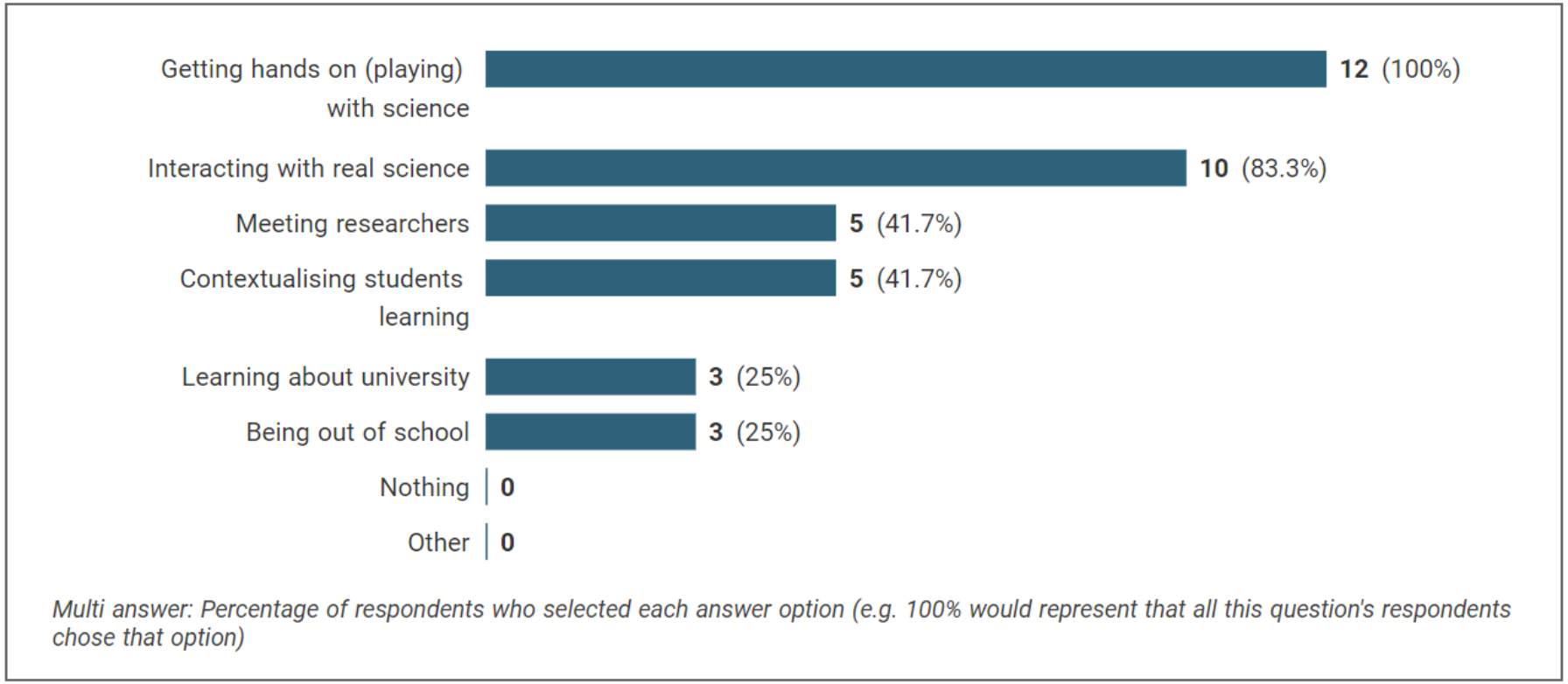
30% of students met at least 1 WP criteria

Evaluation

- Students record number of stands interacted with
  - Students given cards and they receive a ‘stamp’ (stand presenters write the number of their stand) for every stand they visit. Numbers of stamps on each card will be recorded number of interactions each student had
- (Pre &) post questionnaire for teachers
  - (Teachers given online pre questionnaire with initial information pack and asked to complete it before the event.) Post event questionnaires will be online and sent out at the end of the event teachers asked to complete them within one week
- (Pre &) Post questionnaire for Science researchers running stands
  - (Science Researchers given online pre questionnaire with initial information pack and asked to complete it before the event.) Post event questionnaires will be online and sent out at the end of the event and researchers asked to complete them within one week
- (Pre &) post event questionnaire for schools presenting
  - (Schools sent online pre questionnaire with initial information pack and asked to complete it before the event.) Post event questionnaires for teachers are online

Feedback from teachers (attending schools)

5 What were the best things about your visit? (please select all that apply)



Multi answer: Percentage of respondents who selected each answer option (e.g. 100% would represent that all this question's respondents chose that option)

Feedback from Teachers

"It's [the schools science fair] raised their awareness of the widespread application of science and put university on their radars."
-teacher (Schools Science Fair)

"Fabulous; an incredible, worthwhile, informative and important event. A must for all primary school children."
-teacher (Schools Science Fair)

"They loved it. It developed their learning, communication skills and confidence as most of our children would not have the experience of visiting a university or meeting grown-ups and undergraduates - interacting with them."
-teacher (Schools Science Fair)

Previous things tried

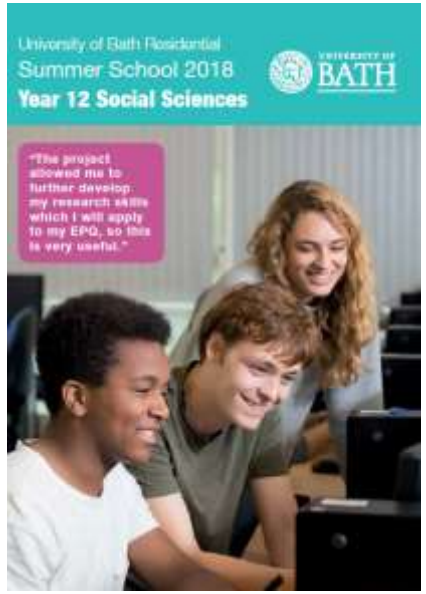
For students:

- Video interviews
  - Best bit, describe the day in 3 words
- Word wall
  - Students write one word to describe the event
- Quick fire questions
  - Volunteers with ipads asking questions

All ok, but didn't demonstrate impact. Showed students enjoyed it and they could talk about something they had engaged with

Summer Schools

- 3 summer schools
  - Science
  - Engineering
  - Social Sciences
- For Y12 students
- 5 days, 4 nights residential
- Focused on academic project

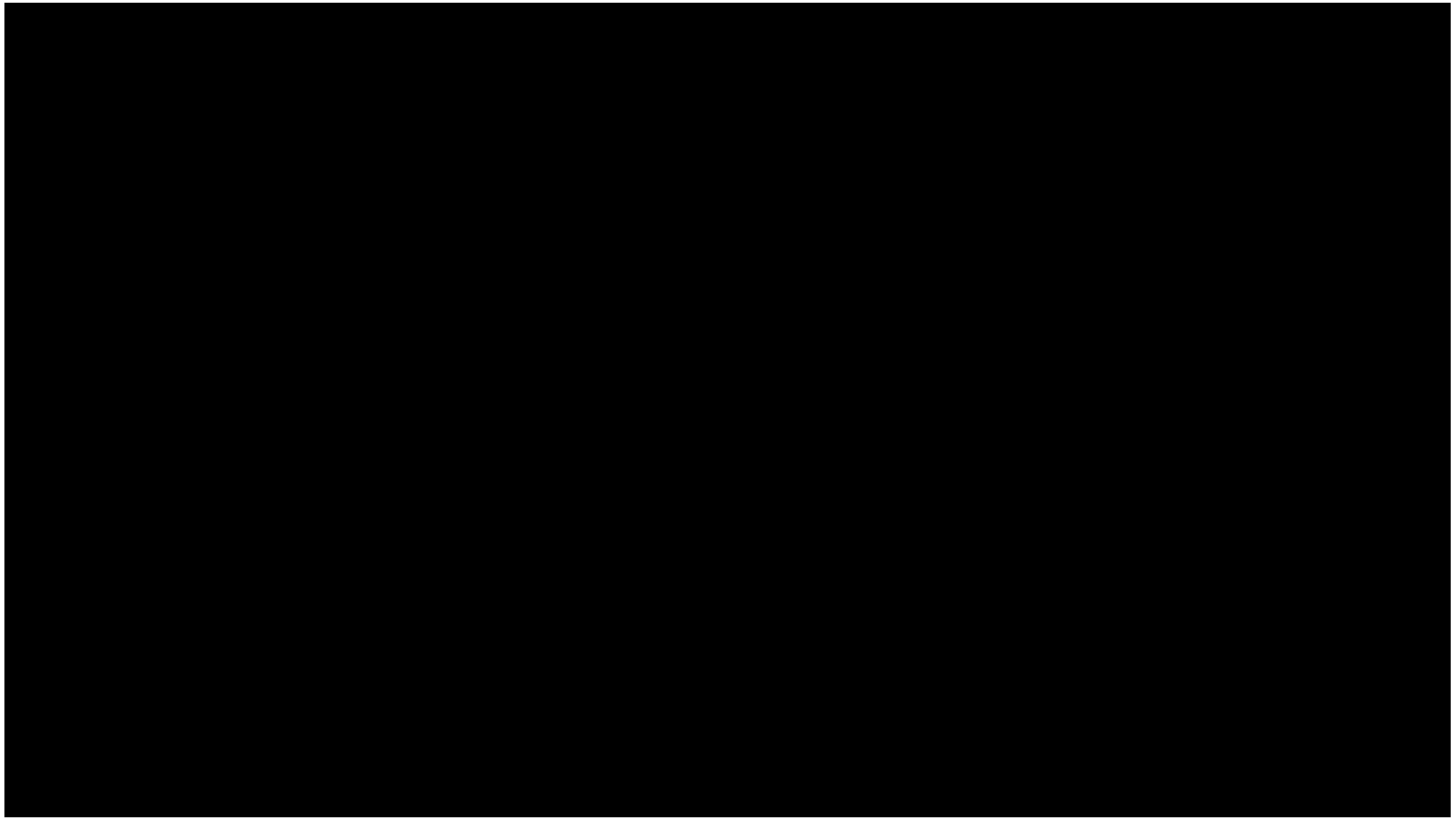


Summer Schools

Each summer schools consist of:

- Academic Projects
- Academic Lectures
- Information and Guidance sessions
- Social Activities
- Celebration

Science Summer Schools



Eligibility & Monitoring

Academic

Requirements based on the offer for relevant courses at Bath:

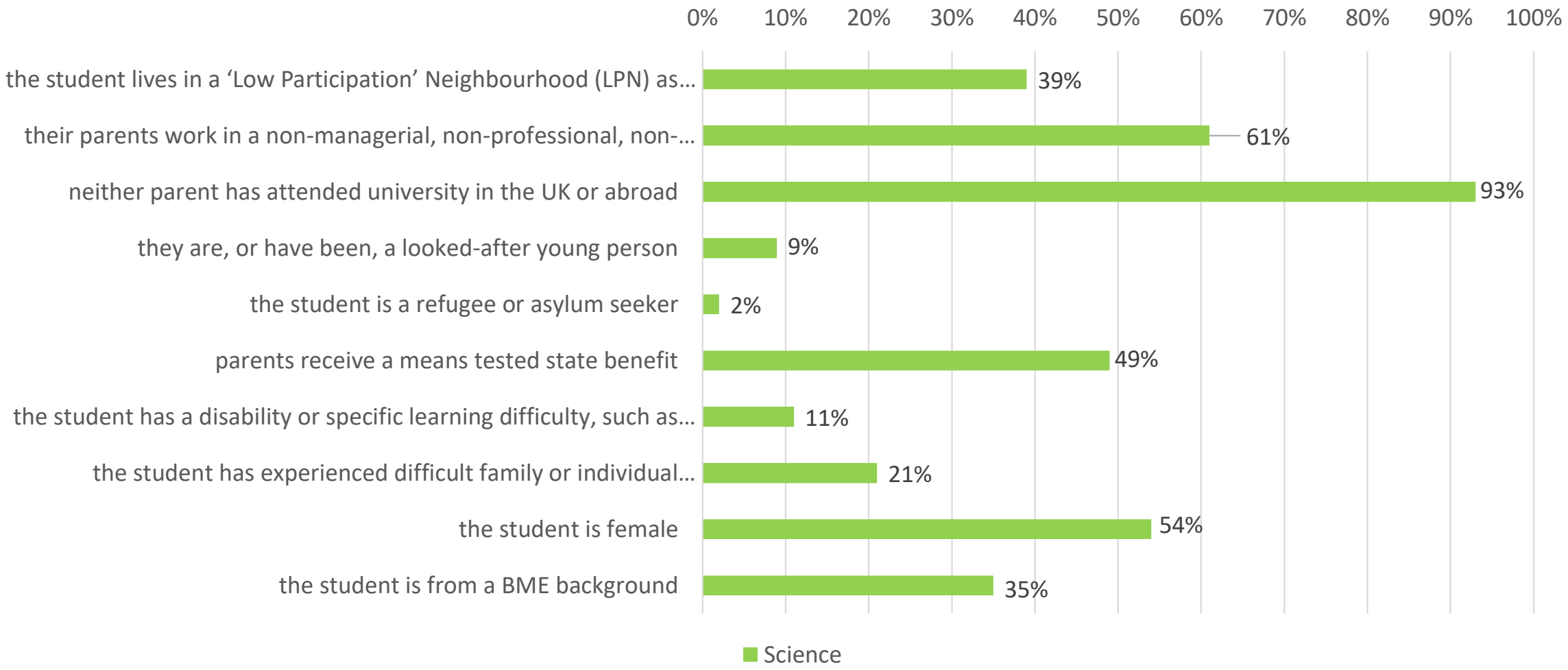
- *Science:* 'high achieving' (mostly A*s, As and Bs at GCSE),studying the subject of the project plus another Science or Maths

Widening Participation

Students must meet at least one of the following criteria:

- the student lives in a 'Low Participation' Neighbourhood (LPN) as defined by home postcode
- their parents work in a non-managerial, non-professional, non-technical occupations
- neither parent has attended university in the UK or abroad
- they are, or have been, a looked-after young person
- the student is a refugee or asylum seeker
- parents receive a means tested state benefit
- the student has a disability or specific learning difficulty, such as dyslexia

Monitoring data



Evaluation

- Pre and post questionnaires
- Evidence of attainment
  - such as research posters and questions about learning outcomes
- Reflective discussions with students
- Observation by experienced evaluators
- Feedback from staff, academics and ambassadors

NERUPI evaluation FRAMEWORK

UNIVERSITY OF BATH

Aim 1 KNOW	Enable students to	Summer School content
Develop students' knowledge and awareness of the benefits of higher education and graduate employment	Investigate social & leisure opportunities at the University of Bath & other universities	Social activities in cafes and Sports Training Village, sleeping in University accommodation
	Discover course and placement opportunities at the University of Bath and opportunities at other universities	Admission Tutor talk and Q+A session, Liaising with Summer School Ambassadors Talk about placements
	Find out about research areas, expertise and facilities at the University of Bath and new areas of development	Welcome Talk, Lectures from academic staff, working with PhD students on project, Liaising with Summer School Ambassadors
	Explore social and leisure, and extra-curricular opportunities at the University of Bath	Extra-curricular activities, Student Union Talks
	Discover career benefits of Higher education and the employment opportunities for University of Bath graduates.	Talks about placements and choosing and applying to university, Finance Talk, Liaising with Summer School Ambassadors
	Find out about academic and information services, facilities and resources at the University of Bath	Welcome Talk and Tour, Liaising with Summer School Ambassadors

Know

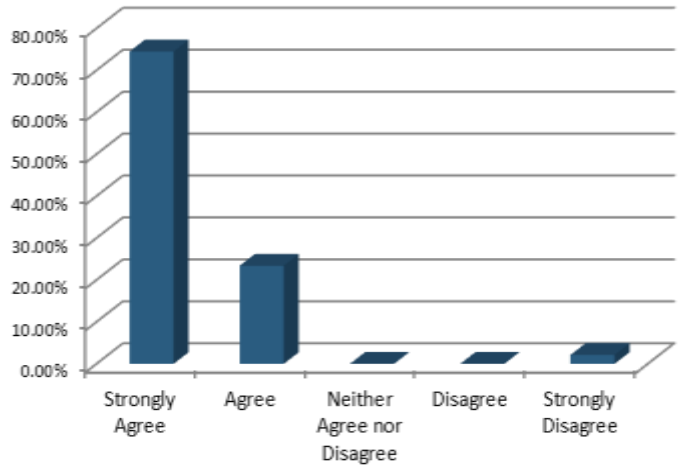
- Questions are asked to measure increases in knowledge of HE – understanding of the processes and structures.
- Example question to students: How would you rate your knowledge about the social aspects of university life?

Evidence of Impact

- **Aim 1: Develop students' knowledge and awareness of the benefits of higher education and graduate employment**

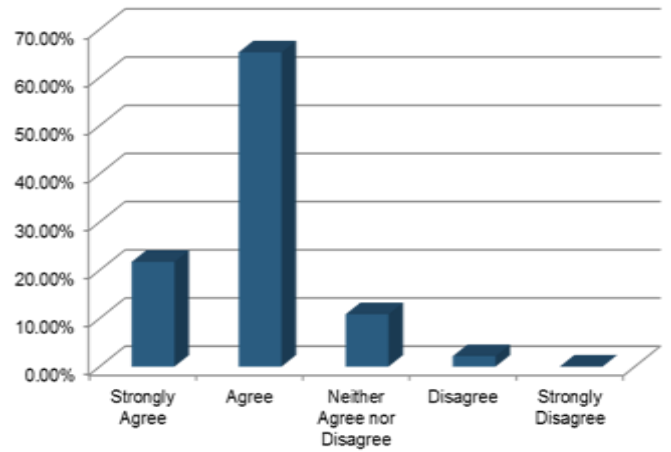
Evaluation Question:
I now know more about opportunities in Higher Education and for university graduates

STEM Summer School



"It was good to be learning something new. It showed you where you could go if you continued doing Chemistry and it was really interesting."

HSS Summer School



"This has really confirmed that I want to go to university and I want to study Social Science."

NERUPI *evaluation* FRAMEWORK

UNIVERSITY OF BATH

Aim 2 CHOOSE	Enable students to	Summer School content
Develop students' capacity to navigate Higher Education and graduate employment sectors and make informed choices	Evaluate course, student finance & graduate opportunities and make informed choices that align with personal interests and career aspirations	Student Finance and budgeting talk
	Evaluate different types of Higher Education Institution in terms of personal interests and career aspirations	Choosing and Applying Talk
	Compare degree courses and study options across a range of universities	Engineering at Bath Talk
	Engage effectively with the UCAS process and generate and submit a strong university application	Personal Statements Talks/workshops incl. Choosing and applying
	Compare student finance, budgeting support and student employment opportunities across a range of universities	Finance Talk

Choose

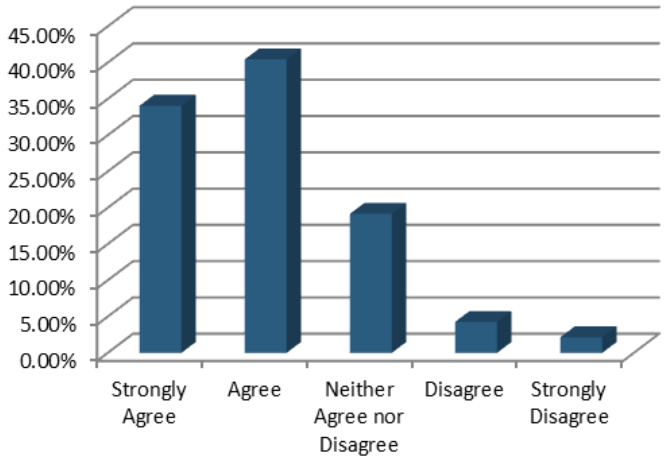
- Questions are asked to measure students' ability to evaluate their options and choose the right course for them.
- Example statements - students are asked how much they agree or not with questions like the following: "The Summer School has helped me to decide which course I want to study."

Evidence of Impact

- **Aim 2: Develop students' capacity to navigate Higher Education and graduate employment sectors and make informed choices**

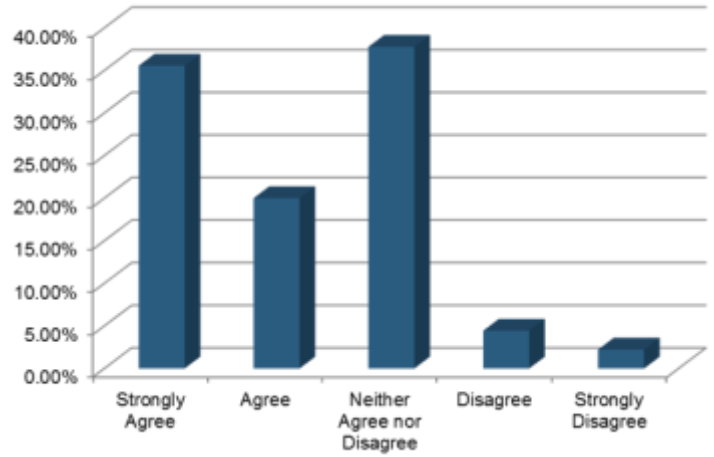
Evaluation Question:
The Summer School has helped me to make an informed choice about university and my future

STEM Summer School



"The Summer School really strengthened my knowledge of what course I want to do. I wasn't sure if I wanted to take a Science or Engineering course, but now I definitely know what course I want to do."

HSS Summer School



"Coming on the summer school has really helped me work out what I want to do."

NERUPI evaluation FRAMEWORK

UNIVERSITY OF BATH

Aim 3 BECOME	Enable students to	Summer School content
Develop students' confidence and resilience to negotiate the challenge of university life and graduate progression	Anticipate challenges they will face in Higher Education and make a successful transition to university	Experience of academic and social uni life
	Gain a positive first-hand experience of student life and a university environment	Students live on campus for a week
	Become familiar with learning and teaching approaches in Higher Education	Lectures from academic staff, Undertake Research Projects in undergraduate facilities
	Engage with academic and personal support mechanisms at the University of Bath	
	Interact with academic staff and other university employees	Lectures from academic staff, Undertake Research Projects, Work closely with academics and PhD students
	Interact with other students on programme, Student Ambassadors and current University of Bath students.	Students all live in halls, eat and socialise together, Students work in Research groups, Liaise with Summer School Ambassadors
	Participate in challenging educational activities which are stimulating and motivating	Interactive lectures, Research project groups led by academic/PhD student
	Celebrate in the achievements of students from similar backgrounds who have progressed to the University of Bath	Contact with WP ambassadors
	Access the information, advice & guidance they need to make a successful transition to the University of Bath	Talks include outline of services provided, supplementary information given to students, follow up support through social media

Become

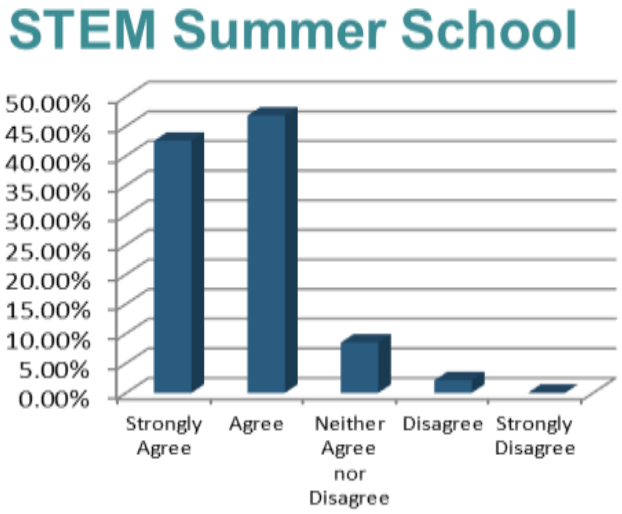
- Students are asked a range of questions designed to measure the development of their ability to imagine themselves succeeding at a high tariff university.
- For example, to measure their understanding of how teaching and learning works at a university students were asked to rate their knowledge pre and post the event.

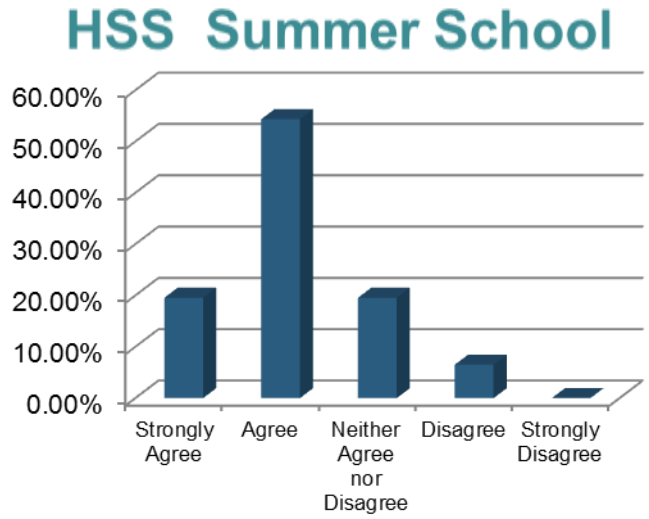
Evidence of Impact

- **Aim 3: Develop students' confidence and resilience to negotiate the challenge of university life and graduate progression**

Evaluation Question:

The Summer School has helped me to feel more confident in my ability to succeed at University





"I had never done anything like this before, and university just seemed really scary. Doing this has made me feel much more confident about going and like I really want to go to university."

"This has shown me that university study and the course work isn't really that daunting. I didn't know what to expect, but this has shown me it is something that I can do."

NERUPI *evaluation* FRAMEWORK

UNIVERSITY OF BATH

Aim 4 PRACTISE	Enable students to	Summer School content
Develop students' study skills and capacity for academic attainment and successful graduate progression	Enhance academic skills through collaborative projects that develop capacity for critical thinking, independent research and self-directed learning	Research Projects
	Enhance capacity for independent learning, self-directed study and enterprise	Research Projects
	Enhance capacity for creative problem solving and decision making	Research Projects
	Enhance communication and presentation skills using different mediums.	Research Projects, presentation at exhibition
	Enhance critical thinking skills through experimentation, reflection, analysis, synthesis and evaluation	Research Projects, Academic Lectures
	Enhance research skills and gain experience of independent research	Research Projects
	Enhance project planning skills and expertise in designing, implementing and evaluating a small-scale project	Research Projects
	Enhance group work skills and capacity to lead and work collaboratively	Research Projects

Practice

- Students develop a range of study skills throughout the summer schools such as critical thinking, problem solving, independent research, analysis and evaluation skills.
- Academics are consulted to collect their views on the skills students have developed in the sessions they have designed in conjunction with WPO staff.

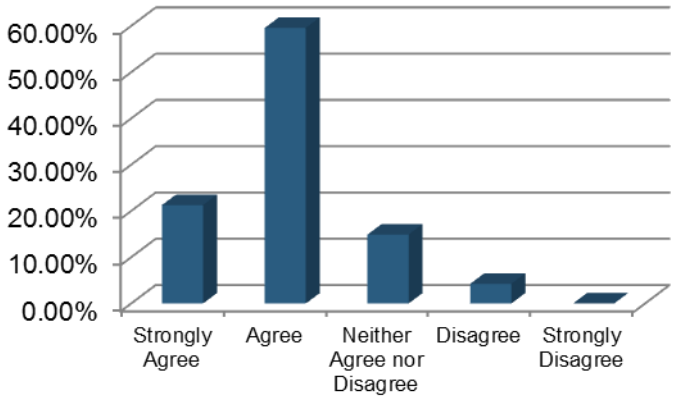
Evidence of Impact

- **Aim 4: Develop students' study skills and capacity for academic attainment and successful graduate progression**

Evaluation Question:

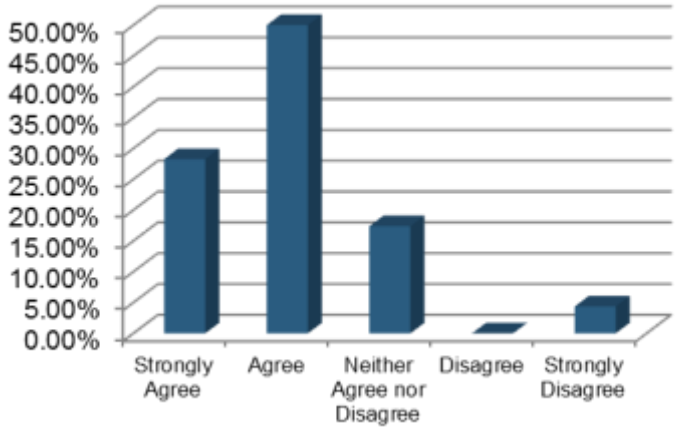
The summer school has given me skills that will help me to succeed in my studies

STEM Summer School



"The experience has certainly fuelled my enthusiasm to continue to study hard and get the grades that I need for taking a chemistry degree. Within this I will be looking at Bath as an option."

HSS Summer School



"I have learned loads of things about how to do research, and simple things like referencing. We don't have to do that really at college, so it has been really useful to get this experience."

NERUPI evaluation FRAMEWORK

UNIVERSITY OF BATH

Aim 5 UNDERSTAND	Enable students to	Summer School content
Develop students' understanding by contextualising subject knowledge and supporting attainment	(a) Situate existing knowledge within wider fields of knowledge and apply to other contexts	
	Extend awareness of the wider applications of knowledge	Research Projects, Academic Lectures
	Locate existing knowledge within wider fields of knowledge and other contexts	Research Projects, Academic Lectures
	Enhance understanding through collaborative projects, which extend knowledge and challenge assumptions	Research Projects, Academic Lectures
	(b) Situate existing knowledge & interests within the context of university degree programmes and academic disciplines	
	Relate existing knowledge and interests to university subject areas and degree programmes	Research Projects, Academic Lectures
	Understand how knowledge can be developed within university subject areas and academic disciplines	Research Projects, Academic Lectures
	(c) Supporting attainment	Links with AS and A level curricula

Understand

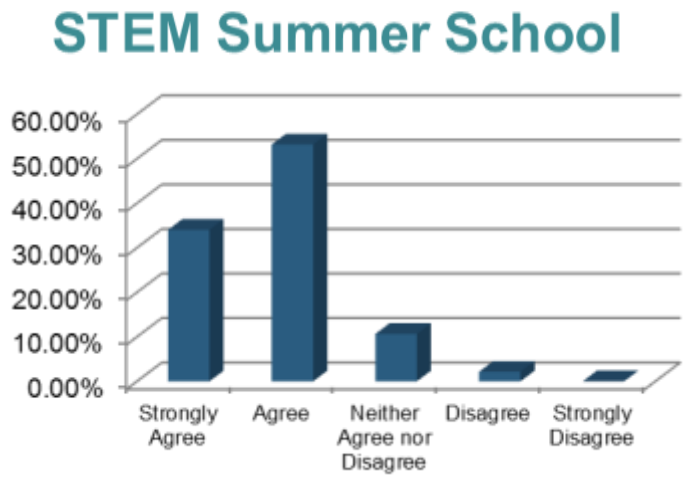
- This area is the main area of focus for our summer schools.
- Each summer school includes a substantial component of project work.
- Projects are graded by academics at the end of the Summer Schools and prizes awarded to the best projects.

Evidence of Impact

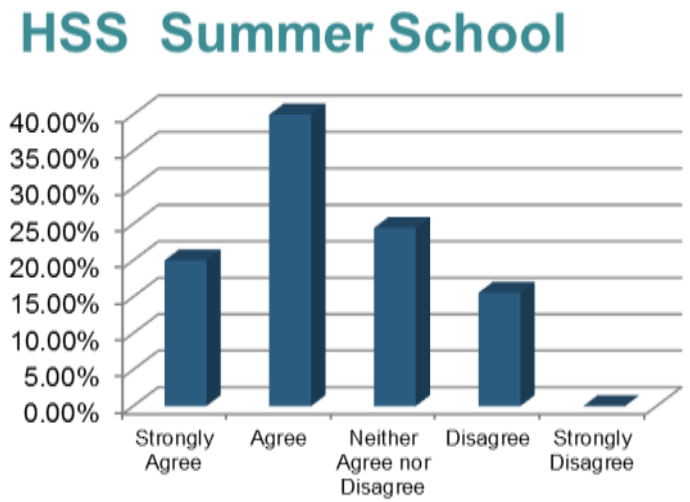
- **Aim 5: Develop students' understanding by contextualising subject knowledge**

Evaluation Question:

The Summer School has increased my understanding of my subject area



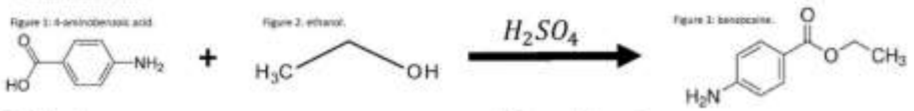
"The Biology project gave you a real insight into how Science really works. With GCSEs you don't really go down to the source of the information. The lecturer gave us a real insight into her work. You feel much more exposed to the scientific world that you do in a school classroom."



"I definitely know that I want to do Social Science. I didn't know that much about it until the summer school, but now I know it is what I want to do."

Synthesis and Analysis of Benzocaine

Benzocaine has been found in 1890 but was introduced to the market in 1902. It is used by the public as a local anaesthetic. It is found in antiseptic lotions and sore throat and mouth sprays, to relieve pain and discomfort. The organic name known for benzocaine is ethyl 4-amino benzoate.



Method

We used 4-aminobenzoic acid and ethanol, with sulfuric acid as a catalyst (*a substance which increases the rate of reaction without getting used up or effecting the product*). These are set up in a heating mantle with a condenser where it is left to reflux between 1-4 hours. (*reflux is a process of constant boiling and condensing to ensure all the organic material has been reacted and we can produce a maximum yield*).

Figure 4: reflux apparatus

We left the solution to reflux for 3 hours then let it cool. Once cooled we added sodium carbonate in small portions where we observed effervescence (which showed the release of CO_2) , and the formation of a precipitate. The precipitate was collected using a vacuum filtration system.

Figure 5: vacuum filtration system

Results

Melting point of pure 4-amino benzoic acid /°C	193°C
Melting point of pure benzocaine /°C	90°C
Melting point of our product /°C	88°C

Table 1: Recordings of melting points.

Mass of 4-amino benzoic acid /g	1.3658g
Theoretical mass of product /g	1.6449g
Mass of product obtained /g	1.2362g
Yield of benzocaine /g	75.15%

Table 2: Recording of masses use and produced, with the calculated yield.

Infrared Spectroscopy:

This is a process used to identifying the product, as different bonds absorb different frequencies of radiation which, using the wavenumber (cm^{-1}), allows us to see which bonds are present in the molecule.

Figure 6

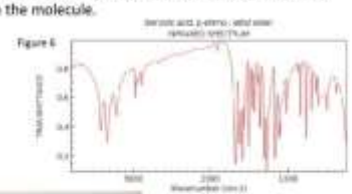



Figure 7

When comparing our Infrared Spectroscopy (figure 7) to that of pure benzocaine (figure 6) , we can identify that the peaks are in very similar spaces, showing we have synthesised benzocaine.

Nuclear Magnetic Resonance

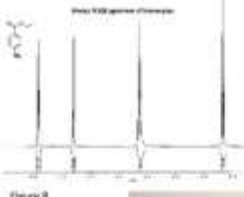


Figure 8

NMR allows us to identify different functional groups and the position of them in the molecule.

Figure 8 shows the NMR of pure benzocaine, and when we compare this with our NMR of our product (figure 9) we can observe that the peaks are have very similar ppm to that of benzocaine.

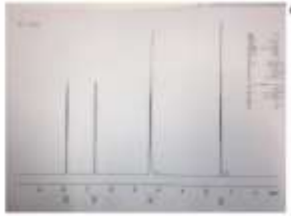


Figure 9

References
Figure 1:https://commons.wikimedia.org/wiki/File:4-aminobenzoic-acid-skeletal.png
Figure 2:http://www.emdmillipore.com/US/en/product/Ethanol-96%25,MDA_CHEM-159010
Figure 3:http://www.sigmaaldrich.com/catalog/product/sial/112909?lang=en&region=US
Figure 4:http://www.organicchem.org/oc2web/lab/exp/tp/prreflux.html
Figure 5:http://www.tobecta.com/forums/archive/index.php/t-51946.html
Figure6:http://www.chemistry.mcmaster.ca/~chem2o6/ir/ir_temp/old_old_labmanual/2001_expt4.html
Figure8: http://webbook.nist.gov/cgi/inchi?ID=C94097&Type=IR-SPEC&Index=4

Alessandra James and Olivija Norvilaite

Exploring the Practical Uses of Potential Dividers in Heart Rate Monitors

Aut. Kelechi Stewart, George Vernon
AH. STEM Summer School 2016

UNIVERSITY OF BATH

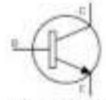
Introduction:

Potential divider circuits are an essential part of any circuit, in that they allow potential to be split variably at any given junction, as according to the resistances of each path through the circuit. This is described by V1/V2 = R1/R2. The project designed and built for this exploration consists of two parts: the detector circuit, based on an ARM-MBED computer which processes the input from a photodetector as the perceived intensity of the infrared LED varies with blood flow, and the amplifier circuit, which amplifies the output voltage from the ARM-MBED to a level suitable for the speaker. (~5 V peak, ~80 mA pulses.)

Method (Amplifier):

Before selecting any particular resistor values for the potential divider circuit, we had to ensure that certain values were constant, and this involved calculating the exact resistance which would ensure that the voltage across the base and emitter* of the BC337 transistor were 0.6V. We selected this transistor at this stage of the circuit because it is low cost and produces low electrical noise, which is essential as any interference at this stage would be exponentially amplified through the speaker. The amplifier circuit is shown to the right.

** The purpose of a BJT (Bipolar Junction Transistor) is to convert a very small amount of current transmitted to the base into a very large amount of current which is collected through the collector pin and "pushed out" through the emitter when the transistor is powered across the base and emitter.*
The diagram labels the base, collector and emitter as B, C and E respectively.


[1]. See references.

Method (Detector):

The detector circuit consists of an infrared LED and phototransistor which detects the fluctuation in received wavelengths from the LED when blood pulses through a finger placed on the detector. This result is a sine wave of voltage with peaks that are processed by the ARM-MBED. *Right: Complete circuit with detector and amplifier.*

The ARM-MBED runs a simple program that detects when the sine wave is at a peak by comparing the amplitude of the wave to the average amplitude, and when the difference exceeds a certain value of 0.03 V, a voltage sine wave is applied to the amplifier circuit via the output pin, powering the speaker. The program then waits for a short while (10 ms) before continuing so that it does not apply multiple sine waves to the speaker during the same heartbeat while the input sine wave is still higher than the average.

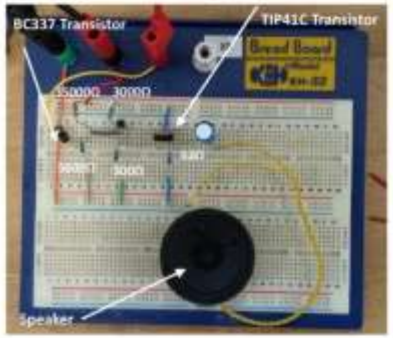
The phototransistor operates in a very similar way to the power transistors in the amplifier circuit, except for that instead of being enabled when a small voltage is produced across the base and emitter, the phototransistor is enabled by photons of light. The transistor, of course, is binary in nature, so to receive a continuous wave (technically a simulated continuous wave represented with discrete data points) the circuit employs the use of a capacitor which receives charger when the transistor is disabled, and dissipates its charge when the transistor is on. The amount of charge released depends on for how long the transistor is on or off, and therefore the characteristics of the wave. The ARM-MBED interprets this by turning on a different number of LEDs (shown in blue on the board) to correspond with the total charge released. *Right: Phototransistor.*

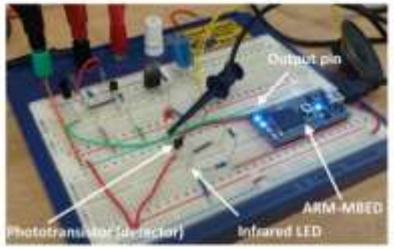
Conclusion:

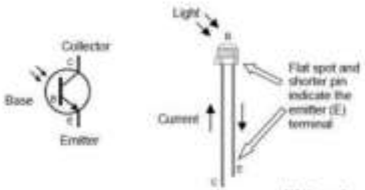
Over the course of a few hours we were able to use potential dividers to control voltage over a circuit and precisely drive active components. We programmed an ARM controller using mathematical methods in C++ to process the wave data continuously and output a discrete signal useful to a human in the form of sound and light.
We came to these conclusions:

- Using basic concepts ranging from Ohm's law to Kirchoff's laws we were able to build a complex device with real world applications.
- We used our mathematical and physical understanding of circuits to debug errors in the circuit with the multimeter probes seen in the picture of the complete circuit.

Ve+ Ve- Ve+ *
**(Sine wave generator simulated input)*







[2]. See references.

References:
[1] http://www.engineersblogsite.com/what-is-a-transistor.html
[2] http://learn.parallax.com/tutorials/robot/shield-bot/robotics-board-education-shield-arduino/chapter-6-light-sensitive-15

	Science
I have enjoyed the Summer School	98%
I have learned more about course and/or placement opportunities at uni	96%
I have learned more about the social aspects of university life and facilities, clubs and societies at the University of Bath	94%
I did not enjoy the social activities	2%
I have improved my knowledge about HE and can make more informed choices about my future	88%
I think my UCAS application to uni will be stronger as a result of me coming on this Summer School	92%
The Summer School has helped my confidence in feeling I would fit in at uni	88%
I found the project work interesting and engaging	73%
I applied things I had learned at school/college to the project I was working on	85%

Engineering Summer School