Connect Physics 2021-2022 Evaluation Report

O.Keenan and C.Thorley, July 2023

Introduction

A full, in-depth evaluation of SEPnet's Connect Physics schools' outreach programme was planned for the academic year 2019-2020. The full evaluation was composed of evaluation forms for participating students (baseline, midline and endline), student focus groups and classroom observations. Due to the disruption caused by the COVID-19 pandemic and ensuing lockdowns the programme delivery, and evaluation, was halted in March 2020 and only evaluation forms were collected. Data from these forms was reviewed and feedback gathered from outreach officers which allowed us to assess whether the forms were fit for purpose and enabled us to use them going forward. The next year in which Connect Physics was able to run in full in schools was 2021 – 2022. Evaluation was conducted alongside the programme which consisted of the evaluation forms, student focus groups and classroom observations as described above. Connect Physics was run by three SEPnet partner universities (Queen Mary University of London, the University of Hertfordshire and the University of Portsmouth). Nine schools participated in the first set of workshops, with six participating in the full programme. Student focus groups were carried out at two schools, and session observation was carried out for each of the three connect physics workshops across sessions at the same schools.

What is Connect Physics?

Connect Physics is a school outreach programme aimed at increasing numbers of Year 8 students considering physics as a pathway to their future. It takes the form of a set of three workshops aimed at students, in particular those with medium to high science capital. The workshops were developed with these students in mind as they are the most likely to have some level of science aspiration which the workshops aim to support. The workshops aim to answer the questions:

What is physics?
Why do physics?
How do we do physics?

The workshops are suitable for students of all science abilities and to be accessible and enjoyable for students in mixed ability classes. The workshops encourage students to think of the bigger picture through connecting different ideas, such as topics from KS3 science, the latest physics research or their everyday lives. They are able to find out about careers that are available after studying physics and they are given a chance to develop their skills using the scientific method and the peer-review process by tackling an open-ended problem with no given solution.

By the end of the workshops all students should have explored their thinking around the following:

- Anyone can do physics.
- Physics is exciting, relevant & important; it goes beyond the classroom.
- Studying physics further broadens career possibilities.

The workshops are based on the recommendations from the ASPIRES research[1] and were developed by Science Theatre on behalf of SEPnet.

Background Research

The concept of science capital was introduced through the ASPIRES research project[22] which explores on young people's science and career aspirations. Science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job). The report discusses how science capital is unequally distributed across societal groups with many factors playing a part in an individual's level of science capital. Groups currently underrepresented in science are likely to have low levels of science capital as they are less likely to know scientists in the family or wider community, or have the opportunity to engage in informal science learning. This will in turn influence the level of science aspiration an individual has, as those with high science capital are more likely to aspire to further study and a career in science. Science capital was shown to vary across gender, ethnicity and social class. The ASPIRES work shows that Asian students expressed the strongest science aspiration, followed by Black and then White students. However, the aspirations of Black students do not translate to longer term science participation due to the multiple inequalities this group faces in society. Similarly, girls are less likely than boys to aspire to science careers, even though a higher percentage of girls than boys rate science as their favourite subject.

In this report we explore the science linked aspiration of students and disaggregate this data by gender and ethnicity. This will allow us to measure the effect of the connect physics programme on the aspiration of the participating students. This report covers one set of data exploring this with a group of students.

Pilot Evaluation

A pilot evaluation was carried out by hope-stone research over the 2017-2018 academic year. This evaluation was two-fold; its aim was to measure both how well the workshops worked, and were received by students and teachers, and it also aimed to measure the impact of the workshops on the pupils. The evaluation demonstrated that the workshops worked well as a set and were well received. In terms of science capital the evaluation showed no measurable change over the course of the workshops. This could be for a multitude of reasons. Firstly, one year is a short period of time to attempt to measure a change in science capital accross. The initial evaluation was conducted when science capital was a relatively new concept, and the understanding of it, and how to measure it and over what time scales has evolved in the intervening years. Secondly, the sample sizes in the pilot evaluation were relatively small, with patchy return rates from individual schools – only one set of students completed all questionnaires (with only five students completing the endline survey). Thirdly, the students taking part already had reasonably high levels of science capital therefore this was unlikely to increase due to the three one-hour Connect Physics workshops. This aim was re-framed after the pilot to focus on increasing the students science related aspiration instead of science capital. Lastly, the data in the pilot evaluation were not disaggregated by demographic information. More specifically we know that a person's gender and ethnicity is a factor in their

[1] https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/aspires-research
[2] "Science capital": A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. L Archer et al. 2015.

science capital and their experience of science learning and science identity (see background research section above).

Evaluation Methodology

Based on the outcomes of the pilot evaluation, some significant changes were made when designing the new evaluation programme:

- We are now attempting to measure changes in science capital indicators, rather than in science capital itself.
- We are using paper forms during sessions to collect evaluation data and setting aside time for these to be completed and collected live. The aim of this is to increase the return rate.
- We are collecting demographic data of the students, so that results can be disaggregated.

The new evaluation is comprised of several elements: questionnaires, student focus groups and classroom observations. The design and implementation of this evaluation is being assisted by an external evaluation consultant, Dr Charlotte Thorley.

Questionnaires: We are collecting data from students using three questionnaires – baseline, midline and endline. These are paper forms to be competed and returned during the sessions. The baseline form is conducted at the start of session one, the midline at the end of session two and the endline at the end of session three. On the baseline form demographic data is collected. For all forms the students generate a unique identifier code which both anonymises them, and allows us to link together their forms.

Control Data: We had aimed to collect control data for year 8 students not taking part in the connect physics programme, which would have helped to isolate the effect of Connect Physics on science aspiration, and opposed to other factors year 8 students experience. Baseline control data was collected for one group however, due to the officer in post leaving during the year, it was not possible to collect endline data. If this is something which the results of this evaluation shows would have been beneficial we could collect control data during another year of connect physics workshops.

Student focus groups: Focus groups were conducted with participating students during the weeks following the delivery of the third workshop. We aimed to run 2-3 focus groups at different participating schools across the SEPnet region. Each group had 8-10 students and a guided conversation was led by SEPnet outreach staff.

Classroom observations: Classroom observations of a small number of sessions will be conducted by SEPnet outreach staff. These staff will be separate to those involved in the delivery of the session. This will allow us to observe how the students are responding to the workshops and what interactions and conversations the session is sparking.

Evaluation Data

The evaluation data was collected between September 2021 and July 2022. Data was collected across nine schools (baseline) and six schools (endline) and workshops were conducted by three SEPnet partner universities: Queen Mary University of London, the University of Hertfordshire and the University of Portsmouth. A breakdown of number of survey responses is below.

Survey	Number of Student Responses	Number of schools in each survey
Baseline	1038	9

Midline	904	9
Endline	649	6

Table 1. Number of responses and schools for each phase of the evaluation.

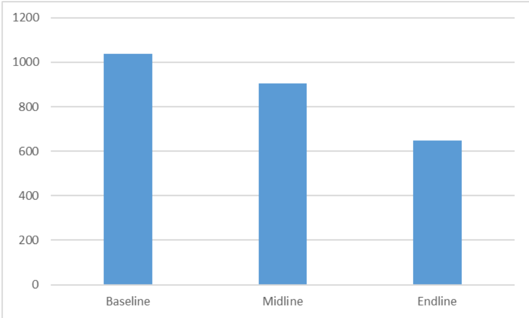

Figure 1. Number of individual student responses for the baseline, midline and endline questionnaires.

Below is a breakdown of responses by gender and, separately, by ethnicity. These are given for baseline and endline survey data. For endline data we only collected gender and ethnicity data where we could link the endline form to a corresponding baseline form via the student's personal identification code.

	Gender	Number of responses	Proportion of responses
Baseline	Male	317	35%
	Female	545	59%
	Prefer not to say	38	4%
	Other	17	2%
Endline	Male	109	29%
	Female	242	65%
	Prefer not to say	14	4%
	Other	8	2%

Table 2. Number of responses to baseline and endline questionnaire broken down by gender.

	Ethnicity	Number of responses	Proportion of responses
Baseline	Asian	306	31%
	Black	141	14%
	Mixed	109	11%
	White	428	43%
	Other	18	2%
Endline	Asian	136	33%
	Black	26	6%
	Mixed	44	11%
	White	202	48%
	Other	10	2%

Table 3. Number of responses to baseline and endine questionnaire broken down by ethnicity.

We had 418 full responses from individual students (the same student having completed the baseline, midline and endline questionnaires).

Science Capital Indicator Questions

In the baseline questionnaire we asked three questions designed to get a measure of the students' level of science capital. We did not re-ask these questions in the follow up surveys as these are not measures we will realistically aim to change over the course of the three intervention programme. Instead, these give us as measure of the science capital of the students we are working with at the start of the programme.

The questions asked were:

- Does anyone you know work as a scientist or in a job using science?
- When you are NOT in school, how often do you talk about science with other people?
- How often do you do science things when you are NOT in school (e.g. visit science museums, watch science TV shows, read about science, look at science videos on YouTube, do science experiments or use kit such as a telescope)?

For the first of these questions we gave tick box options (Siblings, Parents or guardians, Extended family members, Friends or neighbours, Someone I know from my community, Other). For data entry this was then recorded as a number based on how many categories had been selected.

	Know scientist
Whole Cohort	1.69
Female	1.67
Male	1.67
Asian	1.91
Black	1.57
Mixed	1.83
White	1.51

Table 4. Mean scores for number of scientists or those in science jobs students know. Presented for the whole cohort and broken down by gender and ethnicity.

Across the whole cohort students on average knew between 1 and 2 people who are scientists or who work in jobs using science. On average male and female students knew the same number of scientists. The results varied a little more across the ethnic groups with students identifying as Asian or Mixed reporting knowing more scientists than those identifying as Black or White.

For the other two questions we gave frequency options of: Never or rarely (once a year), A few times a year, About once a month, About once a week, Almost everyday. When entering this data these were equated with a numerical value from 1-5, with 1 being Never or rarely, and 5 being Almost everyday. This allowed us to produce a mean score for the science capital (based on these measures) of the students as a group, and broken down by gender and ethnicity.

	Talk about science	Do science things
Whole Cohort	2.65	2.41
Female	2.73	2.37
Male	2.66	2.42
Asian	3	2.65
Black	2.5	2.45
Mixed	2.77	2.4
White	2.45	2.24

Table 5. Mean scores for science capital indicator questions for the whole cohort, and broken down by gender and ethnicity.

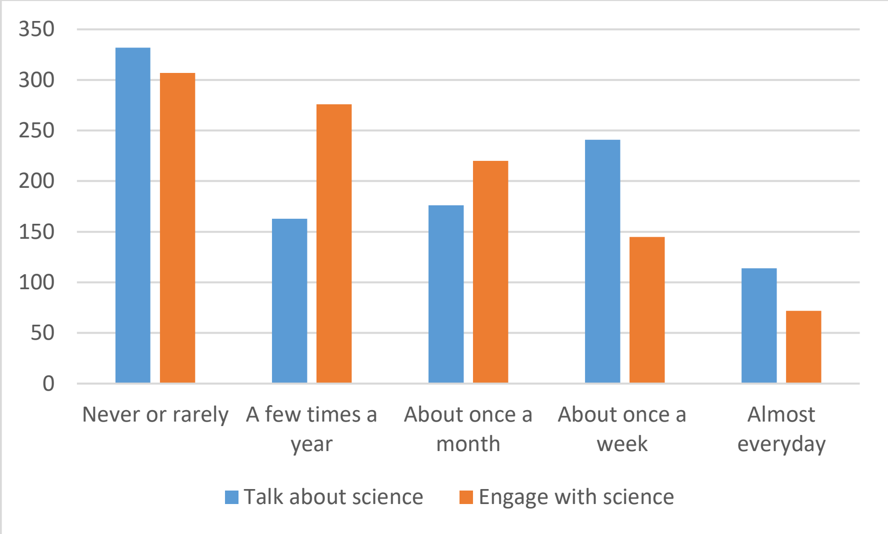

Figure 2. Frequency of responses to questions on how regularly students talk about science and engage with science outside of school.

The group as a whole has a reported a medium level of science capital, however the distribution of scores varied between the questions. When asked how likely they were to talk about science the majority of students fell into either the ‘never or rarely’ category or the ‘about once a week’ category. When it came to engaging with science we didn’t see this split, with the most popular response being ‘never or rarely’ and with responses decreasing as the reported frequency of engagement rose. This may be because there is a higher barrier to engaging with science, compared to speaking about science, especially as visiting science spaces generally costs money (in entry, travel, refreshments) and requires that a family member or adult has time to accompany the student.

There are some differences when we look at the demographic split. In this data set the average scores for those identifying as male and those identifying as female are similar. Looking at the scores split by ethnicity, those reporting their ethnicity as Asian had higher science capital scores on both questions, with other ethnicity groups being closer to the mean score. This is comparable to the findings of the ASPIRES report discussed above.

Science Aspiration Questions

To measure the change across the course of the programme we asked a range of questions linked to science aspiration. These were themed around the students’ feelings about physics, how students perceived themselves, and were perceived by others, in relation to science and around how they perceived the usefulness of science qualifications.

The questions were asked in the following groupings:

Group 1:

- People like me work in science
- Anyone can become a scientist
- I want to become a scientist
- I would like to have a job that uses maths or science
- When I grow up I would like to be a doctor or work in medicine
- I see myself as a science person
- A science qualification can help you get many different types of job

- It is important to study science even if you don't want a science job in the future

Group 2:

- Physics is for me
- Physics is interesting
- Physics is difficult
- I am good at Physics

Group 3:

- I know how to use scientific evidence to make an argument
- I am confident about giving answers in science lessons
- I know quite a lot about science
- Other people think of me as a science person
- Science has no personal meaning for me
- Doing science makes me unhappy
- I understand what is taught in my science lessons

These were all asked with the question 'How much do you agree with the following statements?' and the options: Strongly disagree, Disagree, Neither Agree nor disagree, Agree, Strongly agree.

Additionally we asked one final question:

- Although it may be a long way off, which of the following best describes you?

With the following options for responses:

- I would like to study a science subject or maths at university
- I would like to study one or more science or maths at A-level but not at university
- I do not want to study any science or maths after GCSE
- I don't know

	Work in Science	Can be scientist	Want to be scientist	Job uses science	Doctor/ medicine	Science person	Different jobs from science	Important to study science
Before	3.22	3.88	2.42	3.22	2.53	2.6	4.02	3.74
After	3.12	3.65	2.48	3.28	2.48	2.67	4.0	3.7

Table 6. Mean results for the whole cohort across group 1 questions.

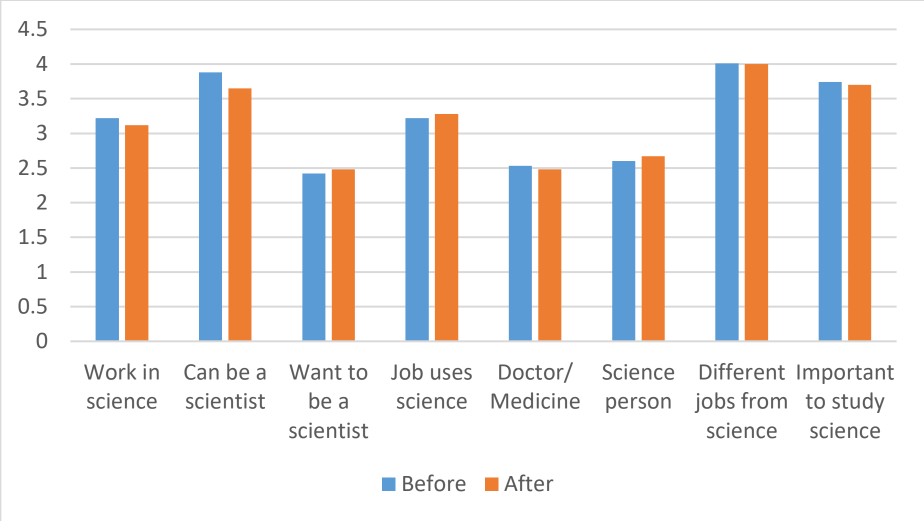

Figure 3. Mean scores for whole cohort for group one questions from baseline and endline surveys.

There are a range of scores across the questions in group one. The highest mean score is in response to the statement ‘A science qualification can help you get many different types of job’ demonstrating that students are aware of the value science qualifications can bring to future careers. It being important to study science and that anyone can be a scientist also score positively. The lowest scoring statements were ‘I want to become a scientist’ and ‘When I grow up I would like to be a doctor or work in medicine’. This may be an indication of a couple of different things. Firstly, that although the students agree with the statement ‘Anyone can be a scientist’ they don’t necessarily extend that to themselves. Alternatively, it may be a reflection that year 8 students don’t yet have a strong opinion on what they may want to do or be after they leave school.

Table 6 shows no variance in question scores between the baseline and endline surveys for the whole cohort. This may indicate that the workshops in themselves aren’t enough to change the numerical scores for science related aspirations.

		Work in science	Can be scientist	Want to be scientist	Job uses science	Doctor/ medicine	Science person	Different jobs from science	Important to study science
Before	Female	3.33	3.97	2.41	3.18	2.69	2.58	4.05	3.76
	Male	3.24	3.9	2.43	3.24	2.53	2.62	4.01	3.74
After	Female	3.17	3.77	2.5	3.23	2.6	2.69	3.96	3.65
	Male	3.13	3.66	2.5	3.26	2.45	2.71	3.99	3.7

Table 7. Mean results for group 1 questions split by gender identity.

		Work in science	Can be scientist	Want to be scientist	Job uses science	Doctor/ medicine	Science person	Different jobs from science	Important to study science
Before	Asian	3.37	3.9	2.72	3.72	2.93	2.98	4.18	3.88
	Black	3.25	3.94	2.34	3.1	2.59	2.62	3.91	3.5
	Mixed	3.14	3.93	2.28	3.09	2.31	2.54	3.89	3.7
	White	3.15	3.89	2.27	2.93	2.24	2.35	3.96	3.7
After	Asian	3.34	3.72	2.94	3.64	3.04	3.15	4.2	3.8
	Black	3.27	3.69	2.54	3.38	2.35	2.85	3.88	3.73
	Mixed	2.98	3.44	2.34	3.14	2.19	2.51	3.83	3.35
	White	2.99	3.64	2.2	2.99	2.10	2.4	3.93	3.93

Table 8. Mean results for group 1 questions split by ethnicity.

Tables 7 and 8 show the results for the same questions as table 6 but split by gender and ethnicity respectively.

The results when split by gender show no considerable difference between before and after, or between Male and Female. Those that report their ethnicity as Asian tend to have higher scores than all other ethnicities in both the before and after data. Across all groups we see no significant difference in the scores at the start and end of the programme.

	Physics is for me	Physics is interesting	Physics is difficult	I am good at physics
Before	2.61	3.42	3.44	2.75
After	2.62	3.33	3.5	2.74

Table 8. Mean results for group 2 questions for the whole cohort.

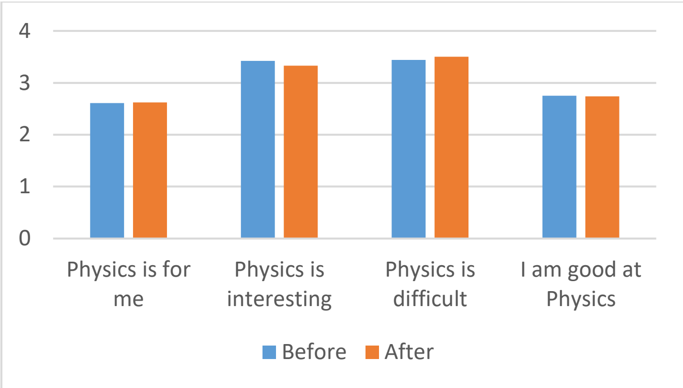

Figure 4. Mean scores for whole cohort for group two questions from baseline and endline surveys.

Across the cohort the statements 'Physics is interesting' and Physics is difficult' were scored the most highly. This is interesting as there is clearly a perception that physics is hard, but this doesn't stop the students agreeing that it is interesting, or perhaps there is a perception that difficult subjects are difficult because they are interesting. 'Physics is for me' and 'I am good at Physics' were scored close to the mid-point of possible scores. It would appear that on average the students are feel reasonably neutrally towards these statements.

As in the group 1 questions no significant change is seen between the pre- and post- intervention responses. This is an area in which we were particularly keen to have a control data set, as we wanted to compare attitudes to physics between year 8 students who were either taking part in connect physics or not taking part. This is data we will explore gathering in the future for comparison purposes.

		Physics is for me	Physics is interesting	Physics is difficult	I am good at physics
Before	Female	2.59	3.37	3.53	2.72
	Male	2.63	3.45	3.45	2.7
After	Female	2.53	3.3	3.52	2.74
	Male	2.63	3.37	3.47	2.89

Table 9. Mean results for group 2 questions split by gender identity.

		Physics is for me	Physics is interesting	Physics is difficult	I am good at physics
	Asian	2.78	3.59	3.39	2.97

Before	Black	2.6	3.41	3.19	2.85
	White	2.59	3.42	3.39	2.69
	Mixed	2.51	3.32	3.61	2.59
After	Asian	2.79	3.61	3.5	3.09
	Black	2.73	3.35	3.23	3.04
	White	2.42	3.14	3.67	2.83
	Mixed	2.52	3.19	3.54	2.7

Table 10. Mean results for group 2 questions split by ethnicity.

Table 9 shows there is no discernible difference between responses from female and male students, and nor do their responses vary by different amounts between the before and after surveys.

As has been seen from other questions those who give their ethnicity Asian tend to report a higher score on the science capital indicator questions than the other ethnic groups.

	Scientific evidence	Confident in science lessons	Know a lot about science	Others see me as science person	Science no meaning for me	Science makes me unhappy	I understand science lessons
Before	3.21	3.28	3.21	2.27	2.84	2.41	3.65
After	3.28	3.23	3.19	2.5	2.82	2.59	3.55

Table 11. Mean results for group 3 questions for the whole cohort.

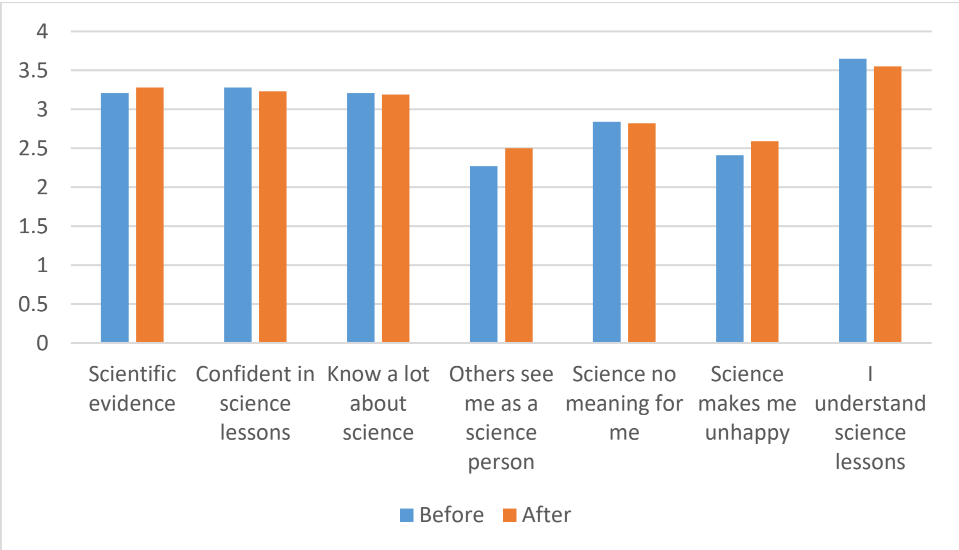

Figure 5. Mean scores for whole cohort for group three questions from baseline and endline surveys.

The highest scoring statement of the group 3 questions is ‘I understand science lessons’, followed by ‘I am confident in science lessons’ and ‘I know a lot about science’. It is positive that the students generally feel knowledgeable about science, and comfortable in lessons. The other questions scored closer to a neutral response, with the scores of ‘science has no meaning for me’ being a little higher than this. This may indicate that although the students feel they understand science and are confident in lessons, they do not feel invested in science or that it is something of particular interest to them.

As with previous question groups, the results of the before and after survey for the whole cohort do not show any significant change in scores across the programme.

		Scientific evidence	Confident in science lessons	Know a lot about science	Others see me as science person	Science no meaning for me	Science makes me unhappy	I understand science lessons
Before	Female	3.22	3.21	3.17	2.29	2.93	2.5	3.6
	Male	3.23	3.3	3.22	2.29	2.83	2.39	3.67
After	Female	3.33	3.19	3.13	2.53	2.87	2.68	3.54
	Male	3.33	3.24	3.19	2.55	2.84	2.62	3.59

Table 12. Mean results for group 3 questions split by gender identity.

Table 12 shows no notable difference between female and male responses either before or after the Connect Physics workshops had been run. There is some variance between the before and after responses, most notable with the scores for 'Others see me as a science person' increasing for both male and female respondents.

		Scientific evidence	Confident in science lessons	Know a lot about science	Others see me as science person	Science no meaning for me	Science makes me unhappy	I understand science lessons
Before	Asian	3.41	3.54	3.41	2.62	2.72	2.24	3.95
	Black	3.19	3.4	3.19	2.23	2.83	2.36	3.64
	White	3.19	3.21	3.1	2.21	2.88	2.6	3.54
	Mixed	3.09	3.09	3.12	2.06	2.96	2.5	3.47
After	Asian	3.61	3.49	3.34	2.85	2.66	2.4	3.92
	Black	3.62	3.46	3.23	2.62	2.73	2.62	3.58
	White	3.34	3.14	3	2.32	3	2.51	3.39
	Mixed	3.1	3.05	3.08	2.32	2.96	2.88	3.4

Table 13. Mean results for group 3 questions split by ethnicity.

Table 12 shows no large difference between scores of students from different ethnic groups across the group 3 questions, and no significant changes in before and after responses. As with other question groups the responses from Asian students show higher mean science capital scores. The largest variation in the before and after scores is in response to the statement 'Science makes me unhappy', with scores for both Black and Mixed students increasing in the endline questionnaire.

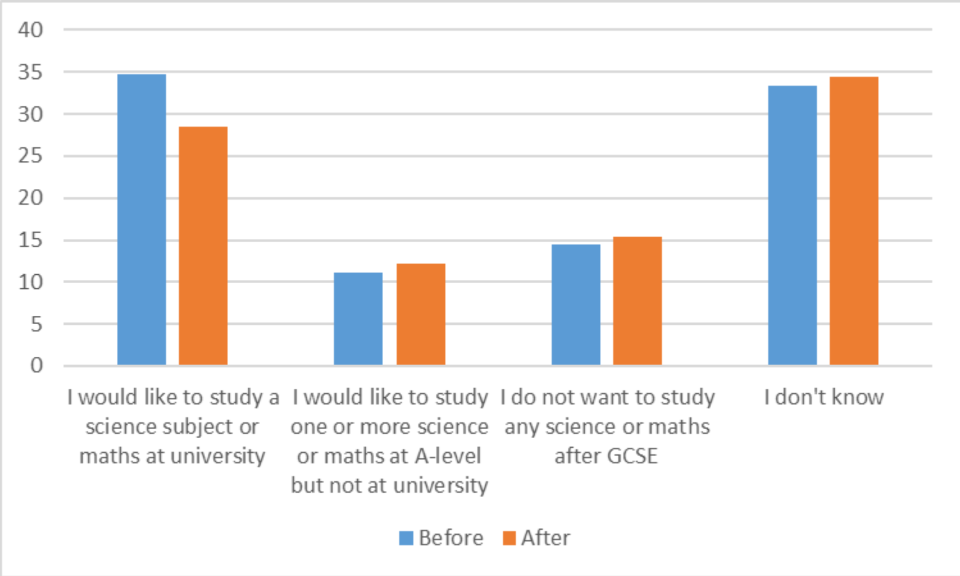

Fig 6. Percentage of students in the baseline (before) and endline (after) surveys responding to the question 'Although it may be a long way off, which of the following best describes you?'.

Finally, we asked students to what level they aspired to study science or maths. The comparison of before and after responses shows a decrease in the proportion of students reporting that they would like to study a maths or science subject at university, and a small increase in those only wanting to take science and/or maths to GCSE or A-Level. Similarly, there is a small increase in the percentage not wanting to study any maths or science after GCSE. This is a question which would particularly benefit from control data as it would allow us to compare the results to year 8s who have not participated in Connect Physics workshops. Without this data it is difficult to say whether the change seen here has been influenced by the workshops or whether we'd have seen a more positive or more negative trend from other year 8 students.

Statistical Analysis of Questionnaire Response Data

Our aim was to use the before and after responses to explore the significance of any measured change across different demographic groups. Basic statistical tests show white students as being less enthusiastic about physics after the workshops than they were before, but this is unlikely to be a significant finding.

Having looked at how to measure the statistical significance of the changes in this project we have come to realise that there is currently no statistical tool which is suitable to use on data of this nature, where the before and after samples are of different sizes and not exclusively from the same co-hort. This is something for others to consider when carrying out similar evaluations – it may be sensible to study a sub-set of participants where you can guarantee you will have access to the same respondents for before and after surveys.

Summary of Questionnaire Response Data

The questionnaire responses give some interesting insights into science capital and science related aspirations of the year 8 students we engaged with. Some of the demographic data shows similar trends to those identified in the ASPIRES work. The students we worked with as a whole display a mid- to high- level of science capital, with those reporting their ethnicity as Asian consistently scoring higher in science capital questions than those from other ethnic groups.

Broadly, across the group 1, 2, and 3 questions we see no significant changes between before and after responses. This may be because we are unable to make a material change across one year of interventions (across three sessions), or because we do not know how these scores would have changed in year 8 pupils not taking part in the Connect Physics programme. As mentioned above, it was our intention to collect control sample data for year 8s not taking part in the workshop. Unfortunately, although we collected baseline control data we were unable to collect endline control data due to the SEPnet officer working with the school we were collecting data from leaving, and being therefore unable to organise endline data collection with the school. This was further complicated by 2021-2022 being the first year during the COVID19 pandemic that we were able to go into schools to deliver workshops again, and therefore there were additional organisational difficulties. We are extremely keen to collect control data from year 8 students not taking part in the Connect Physics programme to compare to the results in this report, and will explore during this over the course of the next full school year (2023-2024).

Focus Groups

Two focus groups were held with students who had taken part in the Connect Physics workshops. These took place in June and July 2022, after all workshops had taken place. Teachers were asked to select eight students who had taken part in all three workshops and it was requested that they be from different friendship groups. The teachers were present for the sessions but were asked not to contribute to the discussion.

The first focus group was held in June 2022 at a school in Portsmouth, and the second on 14th July 2022 at a school in Hertfordshire. Both schools are mixed secondaries with academy status.

The sessions were audio recorded and transcripts were made using otter.ai, a free online transcription tool. Transcripts were then checked and corrected using the audio recording.

The participating students were shown a set of cards with statements on them and asked to share their thoughts on each statement. It was explained to students that there were no right or wrong answers, and we were just interested in hearing their honest opinions.

The statements shown to students were:

- Physics is for me
- Physics is Interesting
- Physics is difficult
- I am good at Physics
- A physics qualification can give you lots of different skills
- My future jobs might include physics in some way
- You have to study physics until you’re 16. How do you feel about this?
- It’s a long way off yet, but do any of you think you might like to study physics longer, after your GCSEs or even at university?

Data Analysis

The corrected transcripts were then analysed for key themes. The responses were studied line by line and emerging themes were noted. These were then grouped into three key themes across the two focus groups.

I'm not good at Physics

One theme was around how good the students perceived themselves to be at physics and maths, or these subjects being hard. This came up across both focus groups and in responses to multiple questions. We see a similar view expressed in the survey responses with 'Physics is Difficult' having a mean score of 3.44 (before) and 3.5 (after) the programme. The concept of physics being perceived as difficult, and of students not seeing themselves as clever enough to pursue the subject, is also a key theme explored by the ASPIRES2 report[3].

Following the 'Physics is for me' prompt some of the responses were:

"I feel that science isn't my strongest subject but I don't think that Physics is my favourite subject even in science."

"I'm just not good at it."

These students didn't articulate why they felt that they weren't good at physics in particular, but firmly stated that they weren't good at it. One states that although they don't feel that science is their strongest subject generally, physics is their least favourite of the sciences. They appear to be combining the ideas of not being good at something, and not liking it. Similarly, although we never used 'maths' in a prompt many comment on not liking or being bad at maths, showing that they perceive maths and physics to be linked, and that you need to be good at maths to be able to do physics.

Unsurprisingly this theme also emerged in response to the 'Physics is Difficult' prompt, for example:

"It's very difficult. If I had to like, list all out, physics would definitely be the most difficult than biology and chemistry."

"I feel like it is difficult because there's so much to remember in physics. I kind of forget anything."

The students often compared physics to the other science, generally saying that they found it harder than chemistry and biology, or that they preferred there subjects over physics. Some stated that physics got easier the more they did it, or when they got used to the calculations involved. However, equally some said they weren't interested by physics so had no motivation to put in this extra work that they perceived was needed.

On the other hand some responses were mixed, stating physics wasn't too hard even when still considering it the hardest science:

"I kinda agree. It's like the hardest of the three sciences but it's still not that hard. And it's kind of simple as well."

These attitudes demonstrate that even in year 8 the idea that physics is a particularly 'hard' or 'difficult' subject is embedded, and often amalgamated with a similar view of maths. This is also demonstrated in the ASPIRES work, with students in that study being shown to be more likely to see physics as difficult the further they progressed through school.

In spite of this, when given the statement 'I am good at Physics' many students had the opposite opinion:

"I get good test scores when I do tests on physics."

“I’m good at it but I don’t like it, but then I like biology but I’m not good at it. So it's kind of a love hate relationship.”

Although largely across the focus groups the students reported finding physics hard, or being bad at it, there were students who reported achieving well in physics. This is also reflected in the survey responses to the statement ‘I am good at Physics’ with mean scores of 2.75 (before) and 2.74 (after) indicating that generally the students rated their physics ability as above the midpoint of the scoring scale.

When asked questions about future jobs many students considered physics being seen as hard as a good thing for those with a physics qualification, as they would seem particularly clever/ highly skilled.

“If you can state you have a qualification in something that's difficult probably means you’re skilled at that thing.”

“Probably it can give you lots of skills? Because I'm pretty sure it's a really hard subject.”

Whilst many see their perception of physics as difficult as a barrier to pursuing it, many also see benefits which would arise from studying physics and gaining skills from physics.

Skills from Physics

Physics being valuable for the skills you can gain also came up across lots of responses. In spite of physics being perceived as difficult the students did comment a lot on its ability to lead to a good job, with many mentioning in particular that the jobs you can get from physics are well paid. This is also indicated more broadly for science by the survey responses with the mean score in response to ‘A science qualification can help you get many different types of job’ being 4 in the both the before and after surveys. This was the highest mean score across all questions and highlights that the students are aware of benefits to their future job prospects that can be gained from studying the sciences.

“Since science is a growing sector, if you have a job in like physics, you could get a lot of money due to high demand.”

“Probably I guess there's like physics jobs pay well kind of, yeah.”

“I like physics because I can potentially earn a lot of money. I like money.”

In response to the statements ‘A physics qualification can give you lots of different skills’ and ‘My future jobs might include physics in some way’ students in one of the focus groups had a conversation around the broad range of jobs that use skills from physics, and came up with a lot of suggestions. These included building and construction, teaching, neurosurgery, orthodontist, architecture and computer science. Where prompted, most students saw the relevance of physics to something they may want to do as a job when they are older.

Additionally, some students mentioned specifically needing to study physics for their desired future career path, in spite of not liking it. This was particularly common for students aspiring to study medicine, and was also mentioned by those wanting to work in aviation.

“Because a lot of people can get many jobs. I want to be a doctor so you have to have Physics. I’m not a fan of Physics but I have to learn it.”

"Like my future career is kind of revolves around physics. So I put yes, because I find it like I have to study physics, and I have to look at it. And maybe because personally, I kind of do find it interesting. But at the same time, I don't really."

However, some students were of the opinion that there was no point in studying physics unless you were good at in and needed it for a job. This could be picking up on a wider view that qualifications are something you do to reach the next step (whether that be A-levels, university, or a job), and that there is no purpose to learning a subject unless you will gain something tangible from it which will help achieve future goals.

"Because when if you want to qualify for a job, that includes science, you kind of have to have like a good grade in physics or something. But if you did, like do well in physics, and you have a job that doesn't involve that, there's no point in doing it."

Across the focus groups all students were able to express an appreciation that physics gives you skills that could be used in many different contexts and careers. For some they knew they needed to study physics to achieve their future aspirations, others thought it could be useful, whilst some saw no purpose in studying physics unless it was specifically needed for their future job.

I don't like Physics

Many of the students expressed the opinion that they don't like physics, or don't find it interesting. This then links into the above ideas that there's no point in studying physics unless you need to, especially as it is perceived as difficult.

"I just don't like it. It doesn't intrigue me in anyway."

"I don't really like physics. It's probably one of the aspects of science I like the least. I like some aspects of it, but mostly not."

Many students expressed not being interested by physics, and some explicitly said they found it boring. One reason given for this is that they saw physics as too every day, and that it only explores things students can already see. This appears to be a misnomer, especially as many say that they enjoy topics such as astronomy (see below). This could be an indication that year 8 students are not fully aware of which topics belong to each of the three sciences, and perhaps see physics as being mostly forces and electricity. The idea was also expressed that physics was less fun than the other sciences are there were fewer hands on experiments in class, with some students saying that if physics got more interesting at GCSE they may decide to go on and study it further.

Some students had a more balanced view of physics, and expressed liking some elements of the subject, but disliking others. In particular students said they enjoyed learning about energy and astronomy.

"Well I've always been interested in like different kinds of energy and stuff like that, because I'm always trying to find out the source of the energy, where it comes from with like, things that concern it, but at the same time, I find it hard, because like, I feel like the calculations that wrack my brain because I hate maths. So I feel like that's one of the reasons why I'd say no."

"I kind of agree with the statement, because sometimes is like most of like physics subjects are not interesting, though, the one I find interesting is about solar and stuff."

"The only cool thing we've done in physics is space."

This is also reflected in the responses to the survey question ‘Physics is interesting’ with the mean scores being 3.42 (before) and 3.33 (after). These scores are above the mid-point of the answers scale so indicate that most of the students do find physics interesting to a certain extent. They are also comparable to the scores for ‘Physics is Difficult’ (3.44 and 3.5) showing that although students tend to be quite interested in physics, they also perceive it as difficult.

Summary of Focus Group Findings

There were three core themes which came up through the focus group discussions: not being good at physics, not liking physics and skills you can gain from physics. Overwhelmingly the students considered physics as hard, and many said it was not one of their favourite subjects. There was discussion about what skills you could gain from physics that could lead to good, well paid jobs, but also the feeling that most wouldn’t study physics unless they needed it for their future careers. There were some in the group who felt they did well in physics, or were good at it, but this was generally alongside them stating that they didn’t enjoy the subject.

The focus groups demonstrated that by year 8 physics is already perceived quite negatively by most students. The Connect Physics workshops do aim to demonstrate the range of jobs available from physics, which was something the students demonstrated awareness of. The workshops also aim to communicate that ‘anyone can do physics’, however don’t explicitly aim to counter the narrative that physics is harder than other subjects. This may be messaging that we should consider explicitly building into the workshops to help counter the ‘physics is hard’ narrative.

Session Observations

Observations were carried out for each of the three Connect Physics workshops. The ‘What’ workshop (Connect Physics 1) was observed at a mixed secondary school with academy status in Hertfordshire, ‘Why’ (Connect Physics 2) at the same school in Hertfordshire, and ‘How’ (Connect Physics 3) at a mixed secondary school in Portsmouth with academy status. Observations were carried out in May and June 2022.

One of the SEPnet outreach staff observed each session. The staff members did not interact with the session or any of the students during the observation, and this was explained to the students at the start of the session. For the observations a pupil was chosen at random to observe, with the observer noting down the student’s behaviour, the behaviour of others in the class, and what was happening in the session at the time. During each workshop a number of different students were chosen to be observed over the course of the session.

‘What’ Session Observations

When asked what Physics is all students seemed to have an understanding of it and recognised the word ‘Physics’, although most needed some extra prompting to be able to explain what physics is to others. During the connection wall activity the students were engaged and seemed to be enjoying it, although some groups struggled and needed more support and encouragement to understand the connections. During the session the students weren’t disruptive and were on task for the vast majority of the time. At the end of the session the students gave the presenters a round of applause and one said it was the ‘best science lesson ever’.

‘Why’ Session Observations

When asked what jobs you can get with Physics the class offered a range of sensible suggestions and had some knowledge of jobs using skills from Physics. Similarly, when asked how someone goes about getting a job the class came up with good suggestions and clearly had an idea about how people find and apply for jobs. During the recruitment agency game most students were engaged and on task, with many getting quite invested in the outcomes for their candidates – groups booed when their candidate wasn't the one to secure a job, and whooped and cheered when their candidate did secure the job. Some students got a little distracted as groups needed different amounts of time to select their candidates, so some groups finished before others causing students to get bored while they were waiting. At the end of the session the energy in the room remained high after the enthusiastic reaction to the game, with some behaviour becoming a little unruly.

'How' Session Observations

The class were happy to share ideas when asked about the experimental method. It became clear from their responses that they hadn't done many experiments in science and needed more explanation about what scientific experiments are. The tubes were handed out and students were looking at them and playing with them. When the class was then given instructions on drawing their ideas of what was in the tube some were distracted and still playing with the tubes. The class were largely on task and all students/ groups drew something. When asked to discuss their drawings in pairs one student being observed didn't have anyone to discuss with which was not noticed by the presenters or class teacher. When asked to share ideas with others on their table some were discussing their diagrams but others were distracted or speaking to others. Students were then asked to feedback their ideas to the class which many were willing to do, and the others were listening. The students were generally very engaged during the model building exercise, for example by shaking the tubes and listening them, and by asking the presenters to go to their tables so they could share their ideas. At the end of the session were sharing their ideas about the solution on their tables, and some students came up to the presenters at the front and wanted to show them their models.

Summary of Session Observations

The session observations allowed us to get a different perspective on students' engagement with the Connect Physics sessions, and on their interactions during the sessions. Observing 'What' demonstrated that the students know the word physics and have a reasonable idea of what physics is. Similarly in the 'Why' session students were aware of a range of physics related jobs, along with jobs that use skills from physics. In the 'How' session students needed extra explanation about what experiments are and it became clear they had not had the opportunity to do many science experiments. This is something that we could add in more explanation around to support the student's understanding.

In the first workshop some students found the connections wall game easy and finished walls quickly with others struggling more. The recruitment agency game in the second workshop was well received, especially due to the competitive element, but it was also clear during this activity that some groups found the game easier to pick up than others. This suggests there is scope to develop different versions of the games in the workshops depending on the ability of the students. The mystery tube activity was received enthusiastically by the students, and they were very keen to try our solutions and share them with others and the presenters. Due to the fact that this is a busy, high energy activity it was missed that one student wasn't paired up for the discussion section – this is something that will be flagged to presenters in future to ensure all students are paired up.

Overall the sessions and activities were well received and enjoyed by students. At the end of the 'What' session students commented that it had been the 'best science lesson ever' and during the mystery tube activity in the 'How' sessions many of the students were keen to stay at the end to show the presenters their models. There are some lessons we can learn from the observations and these will be built into future workshops.

Recommendations

The evaluation process have been very insightful to flag some areas to gather further data, as well as areas in which we can improve the workshops themselves. The following recommendations are provided in order to better assess the impact of the programme, and as amendments to some of the sessions:

- Gather control data across the academic year from year 8 students not taking part in Connect Physics. This will provide a comparison point for the survey results.
- Broaden the messaging in the workshops to explicitly counter the 'physics is hard' perception, which was demonstrated through both the surveys and focus groups.
- Add in more explanation to the 'How' session of what experiments are in science and why we do them.
- Create different versions of the connections wall and recruitment agency games to make these more accessible across the range of student abilities.