Cardiff University School Science Club Project

Funded by the Waterloo Foundation

Evaluation Report

Revised

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Evaluation of Cardiff University School Science Club Project

1. Introduction

This report presents the evaluation findings of a science engagement and enrichment project for Year 6 students, which was developed and delivered by Cardiff University's School of Pharmacy. The evaluation of the Project was supported by independent evaluators Jenesys Associates Ltd, who analysed all evaluation data and feedback collected by themselves and the University project lead, and wrote this report.

1.1. About the Project

The Cardiff University School Science Club (hereafter the Project) was seeking to develop and deliver science activities for a cluster of 6 primary schools in the Newport area of South Wales, with funding support from the Waterloo Foundation[1]. Following consultation with teachers from all the participating schools, the University lead on the Project developed and delivered 3 sessions for each school during the autumn term 2017, covering aspects of biological sciences which were described in our briefing document as *'the skin and the brain, the body and sugar levels, and the body and bugs (bacteria)'*. Sessions 1 and 2 consisted of activities delivered in school and schools visited the University in session 3. The following table outlines some of the main content in each session

Project delivery process

Sep 2017 Session 1 held in schools	Nov 2017 Session 2 held in schools[2]	Dec 2017 Session 3 held in Cardiff University
Bacteria - Hand washing activity Antimicrobial honey Body and sugar levels- Reaction test	Recap of session 1 Swab your school - mapping of bacteria around each school site	Presentation of awards 'Blast a biofilm' tooth bacteria activity 'Brain Games' activities Presentations from researchers about their careers

1.2. About the evaluation

The evaluation support provided by Jenesys Associates encompassed the following:

- Advise the University lead about evaluation tools for obtaining feedback from school students, teachers and participating university staff or students.
- Conduct structured observations of:
  - Session 2 delivery at one school in November 2017
  - Session 3 visits by three schools to Cardiff University in December 2017.
- Interview a sample of students during session 3 visits.
- Capture post-project feedback from teachers at all schools, the University lead and students at the school where session 2 was observed and another where the teacher captured student feedback – January to February 2018.
- Collate, analyse and report all evaluation feedback.

[1] http://www.waterloofoundation.org.uk/index.html

[2] Following the introduction of antimicrobial honey in Session 1, one school requested more detail on this is Session 2. This topic was added to Session 2 for the particular school.

Evaluation methodology

Evaluation data and feedback were captured from all stakeholder groups using a mix of quantitative and qualitative methods as shown in the table below.

Evaluation Methods and Metrics

	Students	Teachers	University lead
Baseline	352 x baseline questionnaires		
Session 1	348 x post-activity questionnaires [3]		
Session 3 end of project[4]	5 x paired interviews (10 interviewees)		
Post-project	21 x post-project questionnaires 1 x whole class post-project focus group discussion 2 x paired interviews (4 interviewees) Ad-hoc student feedback reported by one teacher	5 x post- project reflective logs/ interviews	1 x post-project interview

Quantitative data for large numbers of respondents are presented as percentages, which have been rounded and when totalled may be slightly greater or less than 100. Quantitative data were analysed for all student questionnaire respondents.

Qualitative data such as responses to open questions in surveys and all interview feedback were analysed thematically. To fit within the evaluation budget we analysed qualitative data from student baseline and post-activity questionnaires for a random sample of 25% of respondents in each case. Where appropriate, representative quotes have been used to illustrate findings. All quotes have been anonymised to maintain confidentiality. Teacher quotes are shown in *purple italics* and students are in *orange italics*.

Section 2 of this report presents students' baseline data and teachers' motivations and expectations for the Project. Section 3 presents feedback about experiences, delivery process and the project structure. Section 4 reflects on outcomes for all stakeholders. Section 4 summarises some key learning points and Section 5 outlines a concluding statement.

[3] Baseline and post-activity student questionnaires were distributed and collected by the University lead, all other methods were conducted by Jenesys Associates.

[4] The full programme and tight timetabling in session 3 meant there was insufficient time for the University lead to distribute end-of-project questionnaires to all students. Instead, Jenesys Associates interviewed a sample of students across a range of abilities from observed schools.

2. Findings: baseline motivations and expectations

2.1. Teachers' motivations and expectations

Teachers described their reasons for taking part in the Project during post-project feedback. Generally these focused on the opportunity to continue to work as a cluster of schools to develop and improve science across the cluster, building on a previous cluster science project they had taken part in during academic year 2016-17, where the target audience was the same students, when they were in Year 5.

> *As a school, we were keen to continue the collaborative approach we had developed with outside science specialists in the previous academic year, when the current Year 6 class were in Year 5 as it had helped engage learners and had produced good standards in their science work.*
>
> *It was a school cluster project. We wanted an exciting project for pupils to participate in that would be delivered across our primary school cluster group. We wanted to be able to meet the skills included in the science curriculum and have a consistent approach to teaching science in our area. This would improve the moderation process of levelling pupils across this group of schools.*

Teachers also highlighted their expectations that the project would develop students' scientific knowledge, including their understanding the relevance of science to them and their lives beyond school.

> *I hoped that this enthusiasm for science would continue and that by working with outside providers, scientific knowledge and understanding would be improved and the children would feel that they had more purpose to their work.*
>
> *It is very important to us to develop our pupils' understanding of the world of work and variety of pathways available to them. The project would allow us to continue to expose the children to a range of role models and opportunities in STEM careers.*

Some teachers commented on anticipated impacts for them personally and for teaching in their schools more generally.

> *Due to changes in the cluster […] it was very important for me to take part in the project in a supportive capacity to continue to develop and embed the work carried out last year. In addition to this, working alongside [the University lead] and continuing to develop my own pedagogy and scientific knowledge was an invaluable opportunity.*
>
> *We wanted to develop sustainable links, resources and hands on experiential Science learning throughout the school. Taking part in the project would allow us to develop further ideas and strategies to embed good practice developed last year and disseminate with all teaching and support staff.*

2.2. Students' baseline attitudes to science

All students were asked in the baseline questionnaire to write down three words that describe what they think of science. This word cloud presents the words that appeared more than once in their answers. Notably, students almost unanimously used positive words, and when students used a negative word like 'boring' they also wrote a positive word like 'fun', suggesting different aspects of science are more enjoyable then others. Generally, the word cloud is consistent with other evaluations we have undertaken with this age group.

Students' words associated with science

Students were asked if they agreed with four statements designed to explore their baseline attitudes towards science:

I enjoy science

I would like to be a scientist

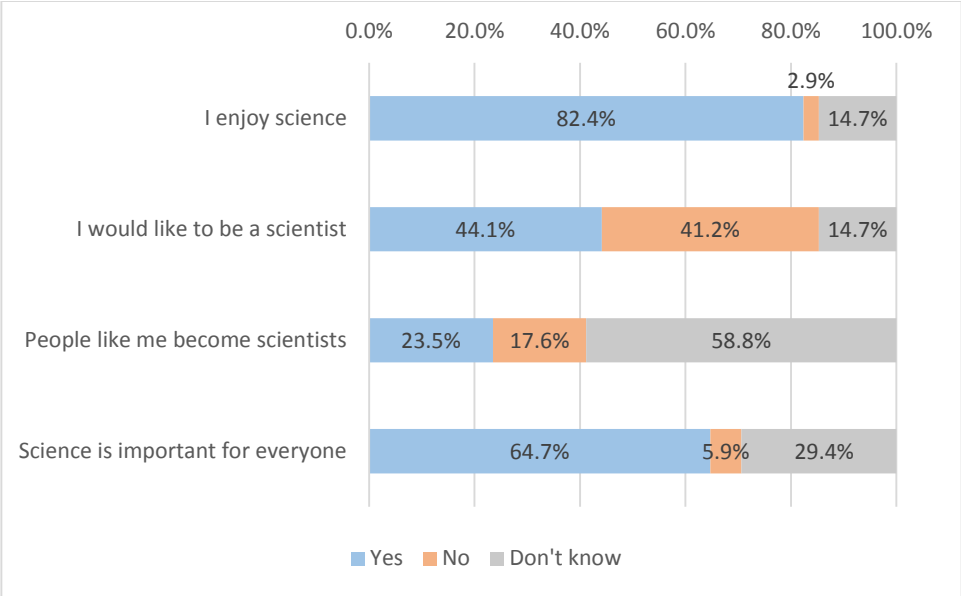
People like me become scientists

Science is important for everybody

As shown in the graph overleaf, most (82.4%) reported they *'enjoy science'*, which is consistent with the positive words they associated with science, and similar to other baseline data we have collected from Key Stage 2 students in other evaluations.

Across all six schools almost two-thirds (64.7%) of students thought that *'science is important for everyone'*. Fewer than half (44.1%) indicated would '*like to be a scientist'* and almost one-quarter (23.5%) thought *'people like me become scientists*'. These percentages present a picture of students recognising the wider importance of science but not necessarily relating this to themselves or their personal circumstances. The percentages reporting science is important for everyone and thinking people like me become scientists are consistent with other evaluations we have recently completed with Key Stage 2 students. However a higher percentage in this Project thought they would like to be a scientist, which may have been influenced by these students' participation in a cluster science project when they were in Year 5, but we cannot make a definite assumption on this.

Students' baseline views about science (n=352)



Further insight on students' opinions about science at the outset of the Project was captured by their drawings of a scientist. By far the vast majority of these were 'traditional' representations of a male figure wearing a white coat, with many also wearing spectacles or safety glasses. Hair was a significant feature on male and female figures, with over half of the drawings being labelled 'crazy hair' or 'mad hair'. Many of the drawings featured test-tubes or flasks and/or the label 'potion', with 'explosion' being another common label feature. A rudimentary analysis of these drawings suggests that whilst most of the students in this Project already enjoyed science and a majority also understand its importance, they have a limited view of contemporary scientists and what their jobs entail.

2.3. University motivations and expectations

Whilst the University did not share any specific written aims for the project, the University lead described their motivations, which can be summarised as wanting to covey that students from a wide range of backgrounds can go on to study or work in science and wanting to develop their own skills in communicating to and engaging with 'non-expert' audiences. Comments made by University staff in session 3 suggested that Cardiff University School of Pharmacy hoped the Project would provide them with learning to inform their future engagement work with schools.

3. Findings: experiences

This section explores experiences for students, teachers and participating University staff and students. It includes highlights and suggested improvements.

3.1. Teacher experiences

3.1.1. Overall opinions

Teachers rated the Project highly. The main explanations for these views were the enthusiasm of the University lead; effective communication between the schools and the University lead, including joint planning; and the provision of opportunities for students to participate in scientific investigations and activities that schools could not usually accommodate, particularly swabbing bacteria.

> *[The University lead] was very enthusiastic and was able to provide new opportunities for our pupils that we would not have been able to deliver. The pupils were able to explore bacteria in the school environment by swabbing different areas. [The University lead] was able grow the bacteria safely in the lab – something we are unable to do at school.*
>
> *The most successful and essential part of the project was the effective working relationship established between the schools and the university lead person. This was vital in the success of the project. The opening session to launch the project grabbed the pupils' attention straight away and they looked forward to the future visits from [the University lead].*
>
> *The children looked forward to [the University lead's] visits. I think he was ideal for the role of the 'face' of the University and everything was pitched at a suitable level for the children. Out of the investigations, the bacteria swabbing session and drawing of results etc. was definitely the one that generated most interest in the children.*

3.1.2. Highlights

Teachers also described some other specific aspects of the Project that they thought were particularly successful. They cited students being exposed to the wider significance of the science that was covered; an engaging and meaningful introductory session; and the curriculum relevance of activities and investigations.

> *The children were able to see that things that they were doing were impacting on and being used at the university by "real scientists" was really important in this project.*
>
> *The introductory session was good as it enthused the pupils ready for the project. We were also able to hit areas of the curriculum that have proven difficult in the past such as scientific bias.*
>
> *I feel that the simplicity of the investigations was also key as this meant that the investigations set by [the university lead] were both easy to facilitate and resource in a range of classroom environments with a mix of children.*

3.1.3. Project structure

The general structure of the project, i.e. 3 sessions across one term, was deemed a success and teachers emphasised the importance of themselves and the University lead being involved in planning.

> *[The University lead] was also a key member of our cluster working party, he really helped us to shape the project and plan where we wanted to go with it. This was very important for us in developing the collaborative nature of the project as it meant that he was*

"singing from the same hymn sheet" and we all approached the project with a shared goal for the children.

As a cluster, schools met with [the University lead] in September to devolve what the University had created in terms of structure and investigations and for the teachers to then go away and plan the sessions themselves. Mid-point and end of term visits were arranged at these meetings so all involved were familiar with the structure of the project; it was definitely well-organised and I always felt that things ran smoothly.

3.1.4. Suggestions

Teachers' suggestions to improve the Project focused on two main areas: aspects of the session 3 visit to the University and the nature of some of the investigations.

In terms of the visit to Cardiff University, teachers welcomed the inclusion of female scientist role models, but would have preferred a longer programme to avoid feelings of being rushed. From an evaluation perspective we would endorse this suggestion and advise that any longer programme should incorporate time to capture end-of-project feedback from all students. Teachers also highlighted the importance of ensuring all content, particularly presentations about scientific careers, is inspiring and matched to the age-group of students.

The pupils enjoyed the trip to the university but I think the structure of the day could have been slightly better organised with regards to timings and also ensure that the resources are appropriate to the pupil age (there was a soft toy bacteria of Chlamydia which was awkward when pupils questioned what it was).

It was useful for them to meet the different scientists, but this may have benefitted from [the presentations] being focused more on the travel aspects, 'disgusting', 'bizarre' things they do for a job, what they love about it and their time in school to help make it more accessible for the children; some of the information was a little too heavy for their age.

There were some organisational elements during our visit to the University which could have improved the day such as the organisation of the tooth brushing session- input using the stuffed microbes could have been completed before the practical element as it did not give enough time for the discussions that the children wanted to have to come to fruition. In addition, the length of the visit could have been slightly longer, … due to another school's session running over so we had to rush our session in the lecture theatre and the children missed some of the guest speakers.

When suggesting improvements to the investigations used in the Project, teachers emphasised the need to include more memorable content and to ensure that investigations are replicable and comparable, which would make it easier for teachers to focus on explaining scientific concepts and to explore in greater depth the science behind each investigation.

The investigations included allowed for some practical activities and decent written work to be produced by the children; it would have been nice to have some more 'wowy' investigations that really amazed the children to help generate greater love.

The investigations were appropriate for the topic that we were covering. It was tricky at times to accurately analyse the results due to the data they produced being so different between each child; finding the scientific knowledge to explain such differences could be challenging.

I think the children would have enjoyed some more hands on activities included and ones that were potentially a little more fixed in the possible results they'd generate (not all of them and given the topic, the body and brain, this is obviously an area that will generate results with potentially large variations due to us all being slightly different!), so that they

were able to draw conclusions with greater ease and refer to specific knowledge to support them.

We were provided with a few good quality investigations that met several aspects of the Year 6 skills, though the science behind the results was not always clear.

3.2. Student experiences

3.2.1. Session 1 feedback

Students from all schools completed a questionnaire at the end of session 1 in their respective schools. Their feedback indicates that this session was a very positive experience, which students could comprehend, and covered topics that they wanted to learn more about.

Almost all (96.4%) students enjoyed session 1. Those who answered 'don't know' included students who expressed a general dislike of science and others who described the session as 'OK' or 'alright'.

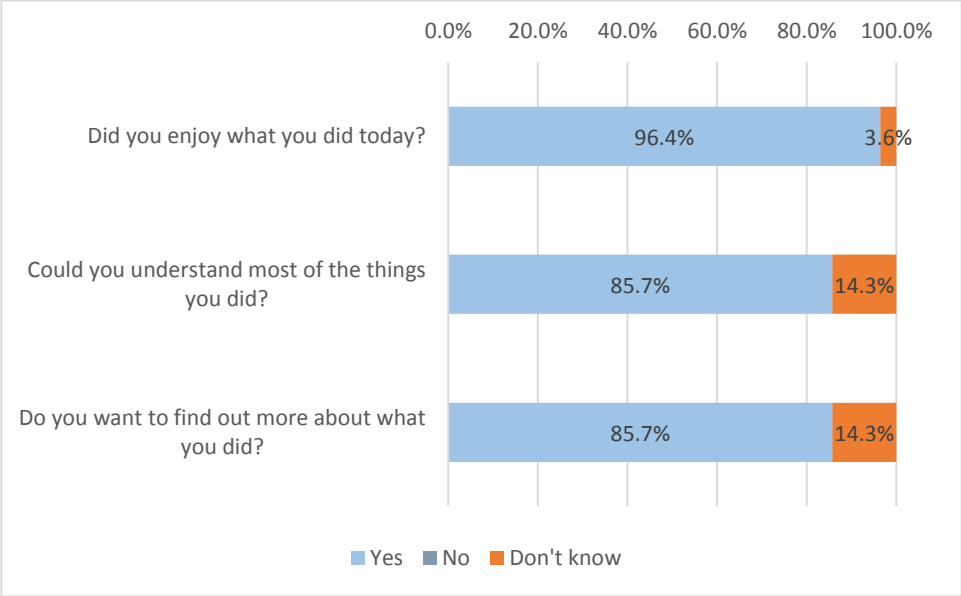
I don't like science anyway.

It was OK but not brilliant so I put 'don't know' about enjoying it.

It was OK, but I don't really like science.

Further evidence of positive experiences for most students were 85.7% reporting that they understood what they had done or heard about and the same percentage wanting to find out more about the specific topics that were covered.

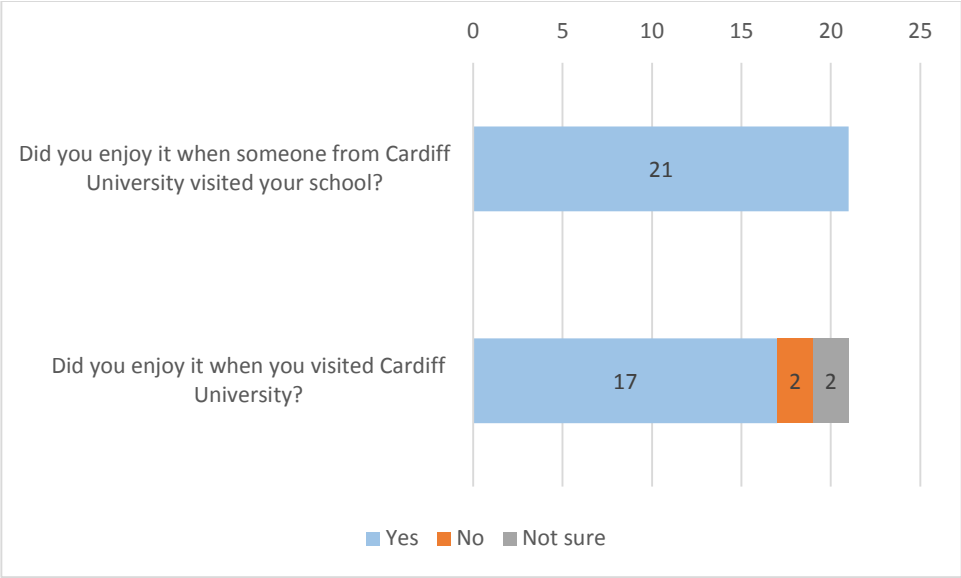
Students' opinions about Session 1 (n=348)



3.2.2. End-of-project feedback

Post-project questionnaire feedback was obtained from students at one school, it was supplemented by a focus group discussion with this cohort and interviews with students from three schools during session 3. As the graph overleaf shows all questionnaire respondents enjoyed the visits by the University lead to their school and most (80.9%) enjoyed their visit to the University. One of those who answered 'not sure' had not visited the University.

Students' enjoyment of the Project (n=21)



These responses are consistent with our observations, where we noted that all students, including a small number who told us they don't much like science, were attentive and appeared engaged throughout session 2. Generally, students were most engaged when they were involved in activities, as evidenced by their attentiveness to instructions and diligence when carrying out investigations. In contrast, we observed students being less engaged by some of the scientists' talks at the University, which were sometimes pitched at too high a level and used language and terms that the students didn't understand, e.g. the word molecule. They were also less engaged by elements where instructions were less clear or activities did not have a clear purpose or defined beginning middle and end, such as the loose ending of 'Blast a Biofilm'. In interview or feedback provided via teachers, students also commented on aspects that they found less engaging or less enjoyable.

The brain thing where we did all the parts of the brain would have been better if they'd shown what all the parts of the brain are doing – like which are about emotions, which are about moving. Stuff like that.

I'd like to find out about how the brain sends messages as well as receiving.

I think we should have done more investigations at the university, like we did at school.

Student highlights

In terms of activities, students across all schools were most likely to highlight the bacteria swabbing and handwashing investigation when asked what they enjoyed most, with several linking the latter to the term 'bias'.

I really loved the experiments! I loved the hand washing bias and the bacteria swabbing! ☺MY FAV!

Doing our investigations was best because it helped us learn how to present information scientifically and it helped us to work together in a group whilst learning new Science skills.

[The best thing was] swabbing around the school, as it was really fun.

Other than bacteria swabbing, students described a range of highlights, which indicate that the Project contained elements that appealed on an individual level.

I enjoyed learning about the different parts of the brain.

We enjoyed creating our posters to feedback about our work at the end of the term.

I liked it when [University lead] told us all about becoming a scientist and about all the jobs that scientists do.

Of particular note is the fact that some students at the school where additional content was delivered about antimicrobial honey, mentioned this aspect as something the particularly enjoyed. This feedback highlights the importance of providing memorable experiences for school students.

The best thing was when we learned about the honey we actually tasted it.

Learning about the Manuka honey and getting to taste it

Student suggestions

The students' main suggestions to improve the Project centred on including more investigations or hands-on experiments, and widening the scientific topics that were covered in those investigations.

I think you could have a few more experiments as I love them! And you learn better when you enjoy it! And I enjoy experiments!

Some more investigations would have been good so that we could have learnt even more.

Some more investigations about the brain and how it works would be interesting. We just made a brain at the University but didn't do anything about what the different parts are for.

Investigating about sight and how you see would have been interesting.

3.3. University experiences

The University lead's enthusiasm and enjoyment were palpable in the sessions we observed, as was the rapport he developed with the students. He also reported that researchers and students who were involved in delivering session 3 at the University enjoyed their experiences, particularly the interactions with a younger audience than they would usually encounter.

4. Findings: outcomes

This section documents student outcomes from session 1 and the Project overall, as well as teachers' reflections on outcomes for them and their schools. It also includes outcomes for the University.

4.1. Student outcomes

4.1.1. Impacts on students' knowledge

The vast majority (92.9%) of students answered 'yes' when asked if they learned something new at session 1. By far the most commonly reported examples of learning were related to bacteria, particularly the amount of bacteria on the human body and that there are '*good and bad bacteria'.*

I have learnt that we have 39 trillion bacteria on our body.

That there is 1kg of bacteria on our body.

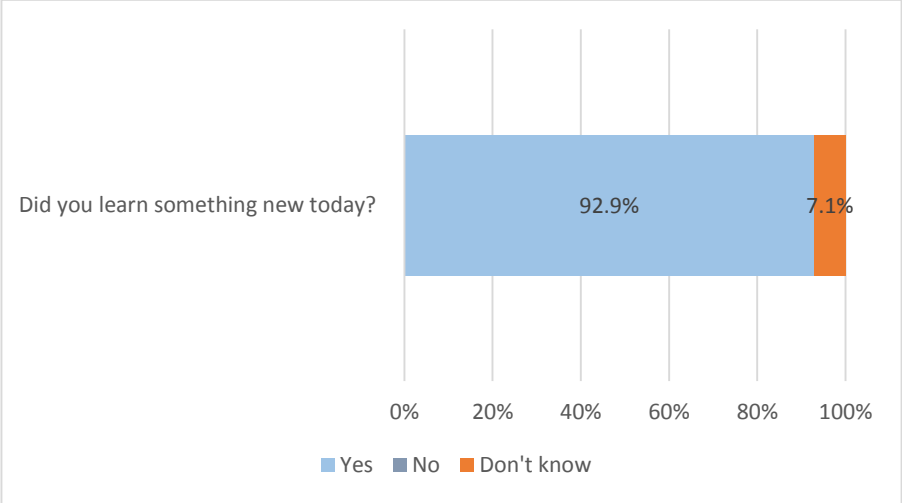
Bacteria is bad and good. There are 39 trillion bacteria in our body.

Students also reported learning about nerves, although these cases were far fewer in number than learning examples related to bacteria.

Your fingertips have more nerves.

I learned where all of our nerves are.

% of students who learned something new from Session 1 (n=348)



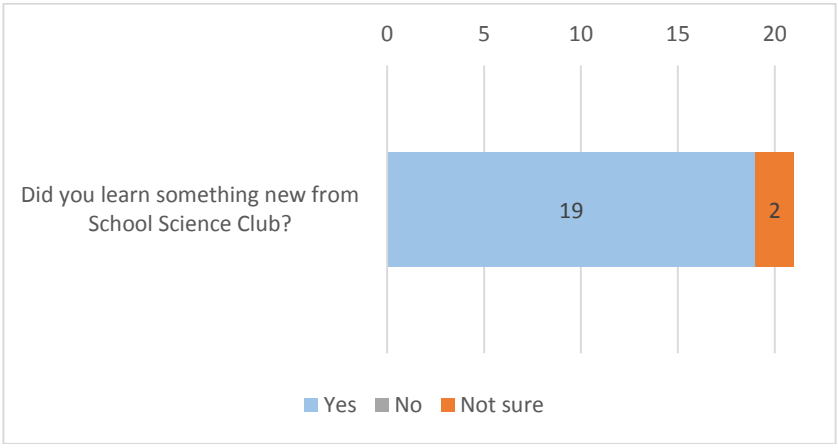
Post-project, the percentage of students who reported via questionnaire that they learned something new was similar to session 1 at 90.5%, with the remainder being unsure, as shown overleaf. Descriptions of learning captured in post-project feedback and during session 3 interviews again highlighted knowledge about bacteria. We had to prompt students for examples of learning that were not related to bacteria. At the end of the Project students reported examples of learning which included swabbing techniques in addition to facts about bacteria.

I learned how to swab. I also learned where most of the bacteria is in the school.

I learned to us agar plates for the first time and that you have 9 trillion bacteria on your body.

That bacteria can multiply if they are in a certain area if they have oxygen. I leaned this by swabbing an area.

No. of students who reported learning something new post-project (n=21)



Teachers reported positive outcomes around their students' attainment in relation to knowledge and understanding of science, which is consistent with students' own feedback.

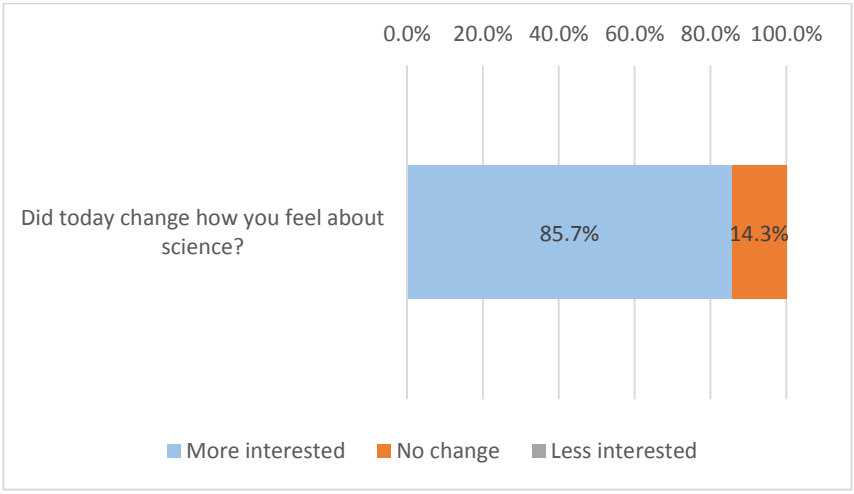
The evidence in their books has been of a good, secure standard and has allowed for exemplification of level 4 and level 5 standards. At moderation, schools agreed the books that were brought along as level 4 and level 5 evidence and were happy with the quality of pieces provided.

The children have developed a much better understanding of scientific content and skills this term through engaging and hands on but simple investigations. The themes selected have helped to increase and maintain pupil engagement throughout the term. I feel that the children have a much more confident understanding of commonly difficult areas such as bias, making changes to investigations and the use of scientific language.

4.1.2. Impacts on students' attitudes towards science

As shown below, most (85.7%) students reported that session 1 increased their interest in science. Several of the respondents who selected 'no change' indicated that they already liked science or were interested in science before this session.

% of students whose interest in science was affected by Session 1 (n=348)



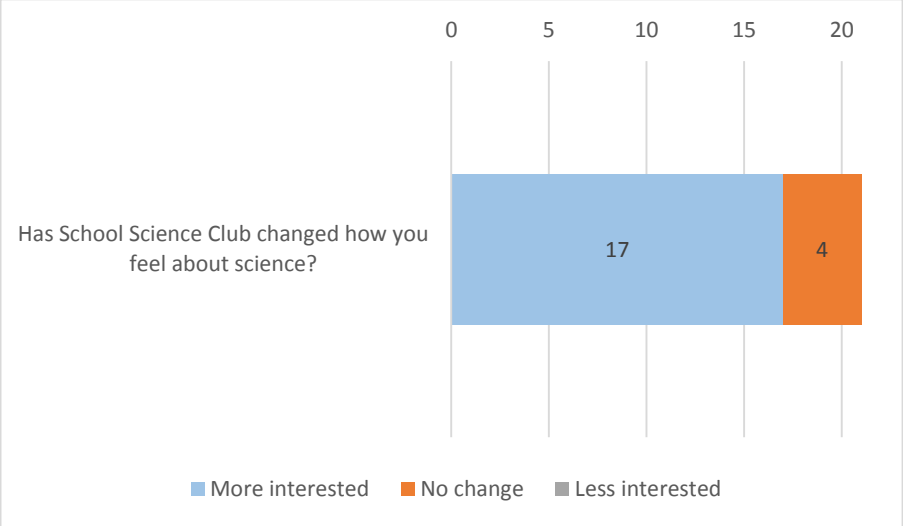
Post-project, 80.9% of student respondents reported that their interest in science had been increased by the whole project. They were asked in survey and interview to explain why the Project had any effect on their interest. Most students attributed increased interest to the practical nature of activities undertaken and the variety of science that was covered.

It made it feel more interesting because we did loads of activities which was fun, rather than just writing and making predictions. This made learning things fun.

It makes me feel this way because science is not just about chemical reactions.

I feel more interested because doing experiments at School science club made me like science even more.

Number of students whose interest in science was affected by the Project (n=21)



Further insight on attitudinal impacts was provided by students being asked in session 1 and end of project questionnaires and interview what they thought about the scientists they met. In all cases, students only mentioned the University lead who had visited their school and all comments about this individual were positive. They focused on a humorous approach and being 'smart', which when prompted students said meant clever.

Really funny, makes things interesting, gives a good explanation on the different activities we did today.

Funny. Cool and interesting.

Fun to watch and very smart.

He was AWESOME!

Teachers also highlighted their students' positive reaction to the University lead as a role model. In addition, they welcomed the inclusion of female scientists from a range of backgrounds and cultures in session 3, with the caveat that some of their presentations needed to be pitched at a different level to make them more engaging for the target age group.

[The University lead] was amazing with the children and they loved him and his visits and having an inspiring figure and scientist help aid in delivery of science is definitely a huge plus for raising engagement and enthusiasm within science.

They always loved [University lead] and really looked forward to his visits. Seeing the other scientists at the University was good as well as it showed that a scientist isn't just an

old man in a lab coat with crazy, white hair (though [the talks] would have benefitted from coming down a level)!

[The University lead] was excellent in engaging with the children and making the world of science appealing. I was particularly pleased at the visit to the University to see that female speakers from a range of cultural backgrounds had been asked to speak as this is an area which we were focusing on as part of our additional pastoral work surrounding the project. Although, maybe this could be pitched slightly differently in future.

Post-project feedback captured via the focus group and interviews indicated that students' intentions to become a scientist were not particularly affected by the Project. There were several examples of students enjoying the project, but it not affecting their intention to pursue a science career.

I want to be a pilot and I've always wanted to be a pilot. I can't say this [the Project] has changed me.

I like science but I want to be a footballer and it [the Project] hasn't changed me.

My mum's a doctor and I want to be a doctor, so I suppose this is kind of relevant but not the reason why I want to be a doctor.

I'm sorry but I've never liked science and I want to be an artist. I still do.

There were also examples where some students described learning about the variety of jobs in in science.

He told us lots about the different things that scientists do that I didn't know before.

I knew like you could be a vet and stuff, but now I know there's loads of jobs. I want to be a vet.

Teacher feedback indicated that in relation to impacts on students' career intentions it was more important for the Project to demonstrate science as an option for everyone rather than affect individual decisions at this stage in students' education.

It's probably not realistic to expect one project to change pupils' views. It's part of a collective effort and this particular project did well in getting across to pupils that lots of different people become scientists. There are so many factors that affect what children want to be. For our children this project contributed by showing science is done by people who have different backgrounds.

[The University lead] was a great role model and whilst it would be lovely to hear someone say "I want to be [University lead]", it's probably unlikely. Visiting the University was good but maybe something more interactive than talks like the children asking questions of scientists such as how and why they became one would have a stronger impact.

It is undoubtable that the children gain so much from collaborative projects such as this one. In addition, the universities benefit from the children being more aware of the world of opportunities available to them which will undoubtedly have an impact on their decisions and choices as they get older.

Teachers highlighted some particular aspects of the Project that they felt had a positive effect on students' feelings and attitudes about science. They emphasised the innately interesting nature of the science themes and topics that were covered and the use of 'real' scientific equipment and techniques, such as UV lights, agar plates, swabs etc.

4.2. Teacher outcomes

In terms of outcomes for themselves, all teachers reported that the Project introduced investigations and resources that they can use in their own teaching practice and that could have potential impact on their approaches to teaching aspects of the science curriculum in future.

> *I have been able to improve my recognition of opportunities to meet hard to hit skills such as bias, making adaptions, reflecting and improving investigations. Most lessons can be taught again in future years as we were given some resources to keep to use again.*
>
> *The project has allowed us to develop correct use of scientific language and terminology linking to their scientific work and learning.*
>
> *For myself, it has been a fantastic opportunity and I have loved working alongside Cardiff University and with [the University lead]. It … has helped me consider other ways of developing our science curriculum within our own school*

Some teachers highlighted wider school outcomes in the form of contacts made with Cardiff University and with teachers from other cluster schools.

> *Developing links with other professionals and organisations which can be used in future to continue to develop STEM learning across the school.*
>
> *The science scheme created alongside the University will be rolled through into next year's Year 6 curriculum and teachers will likely work together as they have this year, to add in a couple of other, 'wow' investigations to the scheme to add further depth and hit a few more standards and level strands.*
>
> *Thank you to Cardiff University and all the staff involved for working with us and supporting us throughout the project. If there is a way of continuing this relationship in the future, we would be very keen to do so.*

4.3. University outcomes

The University lead described how the Project had enthused him and colleagues who were involved in session 3 to want to engage with primary school students in future. He also cited enhancement of his communication and organisational skills as personal impacts, along with learning about the Key Stage 2 science curriculum.

4.4. Influencing factors

Teacher feedback described factors that were thought to have maximised outcomes from the Project. These were: the importance of activities being practical and related to daily life; access to equipment not usually available to schools; having an inspiring role model; and co-creation of the programme by teachers and the University lead.

> *Making science real life and having a visitor to school really helps to motivate and keep the pupils enthused. The project is more enriched with outside support. Continuing to plan alongside teachers helps to meet the needs of the science curriculum and ensure good coverage of skills.*
>
> *[The University lead's] visits definitely encouraged impact as it helped to better engage children in their work. For example, the children invested heavily in their posters as they wanted to be judged the best by the scientists! Access to facilities that we don't possess, such as labs to cultivate bacteria in safe conditions etc. also added a new dimension to our project that we would have struggled to do otherwise.*

Developing an effective rapport with the children is essential. Our children really thought a lot of [the University lead] and revelled in the fact that they were working for him to investigate things. This is a key part of the project as the person who is acting as the 'hook'. In addition, [the University lead] was aware that we had particular elements that we had to deliver as part of our teaching and learning which he supported us with and brought his scientific knowledge that complimented and met our needs.

Teachers regarded the project as a success, but felt that some factors limited the impact of specific investigations and the role model presentations at the University.

The callipers investigation, whilst enjoyable when conducting the practical, was probably the most difficult to draw accurate scientific conclusions from as non-specialists and with such a huge array of results.

Opportunities for more line graphs would have boosted the level 5 elements of the project.

It was obvious that some of the scientists at the University did not know about the level of the children. Some of the vocabulary was far too complex. I think fewer, but more engaging presentations would have been better. Also some of the activities they did at the University lacked the impact of the investigations we'd done in school.

5. Learning: project processes

Cardiff University School of Pharmacy, who commissioned this evaluation, intend to use the findings to inform their future schools engagement work. To aid them in this we have summarised a number of key learning points associated with the Project processes.

Planning and development

- Adopting a co-development approach ensures cohesive programmes of activities that fit with curriculum priorities and are appropriate for target age groups.
- Involving teachers in co-development provides insights on latest educational methods and curriculum developments.
- Documenting and sharing specific aims for each stakeholder group would have ensured all stakeholders were fully aware of one another's ambitions and would aid monitoring of progress and evaluation of outcomes.
- Planning evaluation activities as an embedded part of any programme would have maximised teacher buy-in and commitment to the evaluation process.

Delivery

- Rehearsing individual activities and investigations (could be via phone discussion) with teachers would help optimise both their suitability for audiences and their impacts. Rehearsal could also enhance provider confidence, should this be an issue.
- Where ever possible, ensuring activities are delivered by charismatic individuals who are prepared to learn about the target audiences and develop a rapport with them has greater impact and provides a more enjoyable experience for audiences.
- Helping teachers promptly with all queries or questions related to a project maintains their enthusiasm and develops their knowledge, this is particularly important with teachers who are not subject specialists.
- Integrating visits to schools with visits to the University can widen the range of learning opportunities for students. The former were particularly successful.
- Ensuring University-based activities are of a quality consistent with activities delivered in-school, both in terms of their scientific content and structure/format, would have enhanced enjoyment and outcomes from this element.
- If similar University visits continue in future, moving to a single school involvement per full half-day would reduce schools feeling too rushed, and provide more time for students to experience the 'real' University and to express their own thoughts and ideas. Although appealing in theory, the interactions between students from different schools were insufficient to justify continuing a multi-school approach.
- Including 'action at home' suggestions and activities for students to undertake with their families if they are motivated and want some direction. These could be linked to specific sessions or be more open-ended in nature and would broaden the reach of any school project.

6. Concluding statement and recommendations

The feedback from students and teachers about the Cardiff University School Science Club was overwhelmingly positive. There is sufficient evidence to conclude that it delivered positive outcomes for the Year 6 students and teachers who have participated.

A particular feature of this Project was the involvement of a cluster of schools who had previously worked together on a programme to enhance their science teaching and learning. This feature enabled the University to develop relationships which have strategic potential around STEM engagement and outreach.

The main success factors were the co-development process; the enthusiastic approach and willingness to listen to teachers of the University-lead; and the 'real world', contemporary nature of the science featured, particularly at the in-school sessions. There is scope to refine aspects of the University-based activities, which should optimise outcomes from future similar programmes and for all school visits to the University.

Based on the evaluation findings we would recommend the University to:

- Seek further funding to support more schools to participate in such programmes in future.
- Explore the feasibility of offering opportunities for schools to undertake a programme of linked interactions with the University. Multiple interactions had the benefits of allowing significant content to be covered and developing pupils' connections, familiarity and positive attitudes to the University.
- Continue to incorporate practical hands-on learning, and afford opportunities for pupils to explore content themselves. These features ensured that pupils from a very wide range of abilities and backgrounds could benefit from the programme.
- Consider adding further content about microbial honey for all schools as students at the school where this content was delivered found the combination of tasting honey alongside learning about it to be memorable and engaging.
- Support key teachers involved in this project to share their experiences beyond the participating cluster.
- In future projects, plan and prepare for opportunities for longitudinal follow up with the participating cohort of pupils to investigate longer-term impacts.
- Consider incorporating parent/carer/family perspectives within future similar work to broaden impacts, particularly around career opportunities and aspirations related to careers or further study in science.
- In future projects review the evaluation approaches used, for example with regards to the use of drawings if there is insufficient time for full annotation, discussion and reflection of their meaning, and avoid relying on teacher-led data collection approaches to maximise amount of data captured and to ensure consistency.
- Continue using online feedback from teachers as in general their responses proved very insightful and they received greater uptake than the offer to interview teachers.