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Achieving Excellence Together



**BIOCHEMICAL
SOCIETY**

Understanding DNA technologies

(A Project-Based Learning short course for 12-13 year olds aimed at exploring DNA technologies.)



A Science Outreach Project
at Oldmachar Academy, Aberdeen

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Introduction

Oldmachar academy embarked on a rotation of Project Based Learning (PBL) short courses, with S2 pupils, in the academic year 2023-2024. Each course which lasted approximately 28 lessons, was mandatory. The Science faculty developed a course (booklet provided) with a driving question:

“How can we, as scientists, help our community understand the use of new, potentially controversial, DNA technologies?”

This was also the aim of this scientific outreach grant. The £825 award enabled us to buy a DNA Detectives Kit (<https://www.ncbe.reading.ac.uk/electrophoresis-kits-and-related-items/>) and replacement resources which we could use with our existing NCBE base units.

Over the first 6 weeks of the course, pupils were involved in a series of activities including;

- teacher-led instruction,
- student-led learning (researching & poster making)
- cooperative group activities e.g. experiments (DNA extraction from fruit and DNA electrophoresis), making models, posters, murder mysteries and a little event-planning.

This culminated in a family learning event during which the pupils, with the aid of an experiment, DNA models and posters, helped enthuse family members to learn more about DNA and DNA technologies.

Photo of the final family learning event



Why we wanted to do this.....

1. Enthuse our pupils to become more scientifically literate and more confident in their knowledge of DNA and new DNA technologies.
2. Enable our pupils to enthuse their families about DNA and DNA technologies.
3. Increase engagement with our families outside the more traditional parents night meetings.
4. Improve pupil skills in line with our school leaver profile.
5. Increase pupil awareness of STEM careers linked to DNA.

How well did this project go?

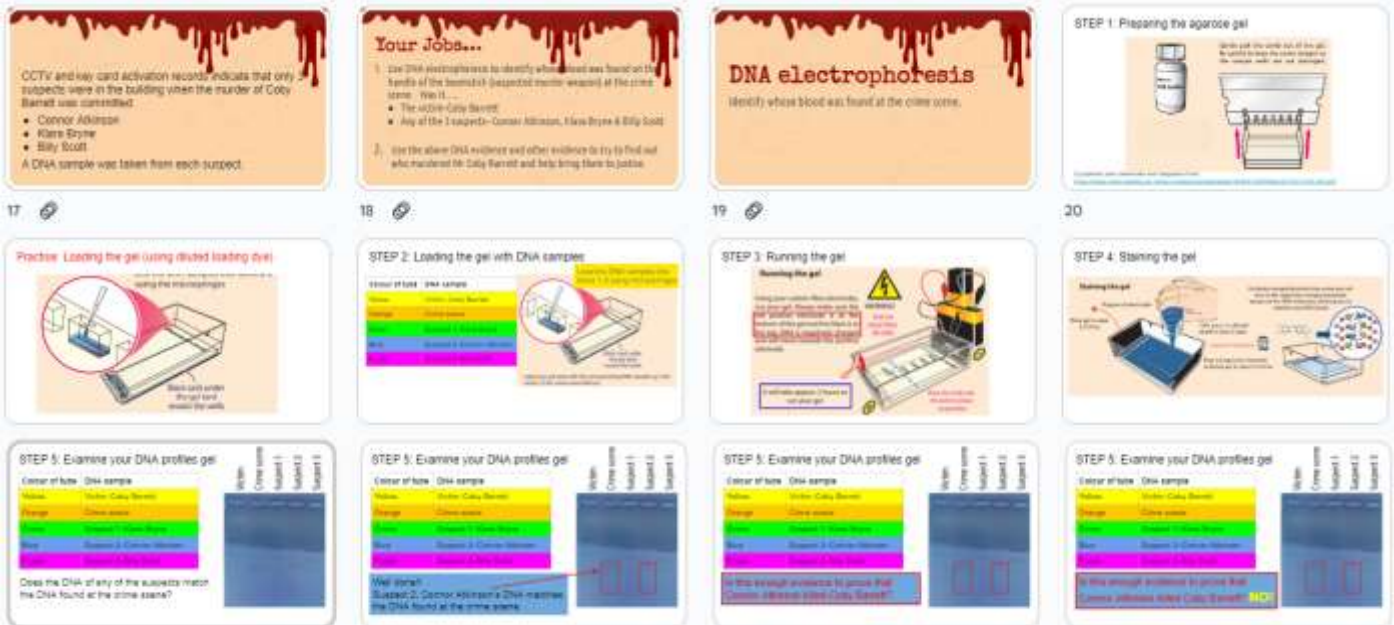
1. Enthuse our pupils to become more scientifically literate and more confident in their knowledge of DNA and new DNA technologies.

By the end of the course pupils were able to provide information on DNA structure, uniqueness of individual DNA, use of DNA in forensics, paternity testing and identifying dead bodies after disasters. The family learning events demonstrated excellent knowledge and application of knowledge in posters, experiments and pupil-devised murder mysteries. When questioned, most pupils expressed good understanding of their work. Pupils were “buzzing” during and after the family learning events and staff were extremely impressed that all the hard work had paid off.

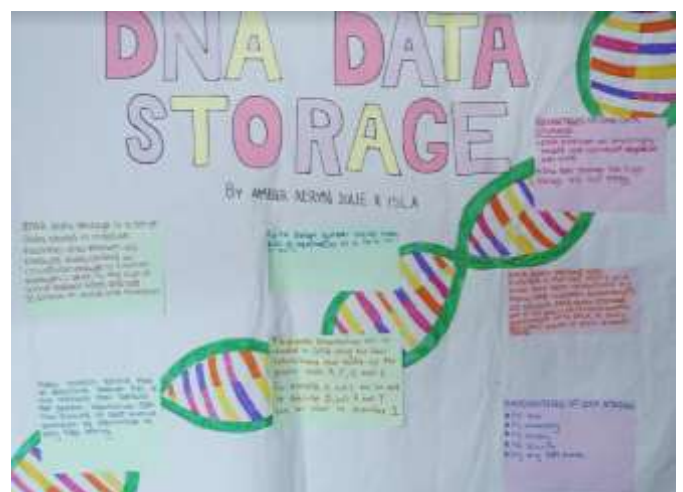
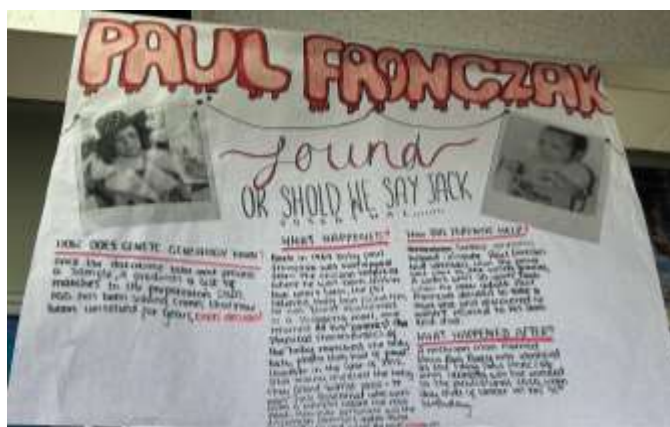
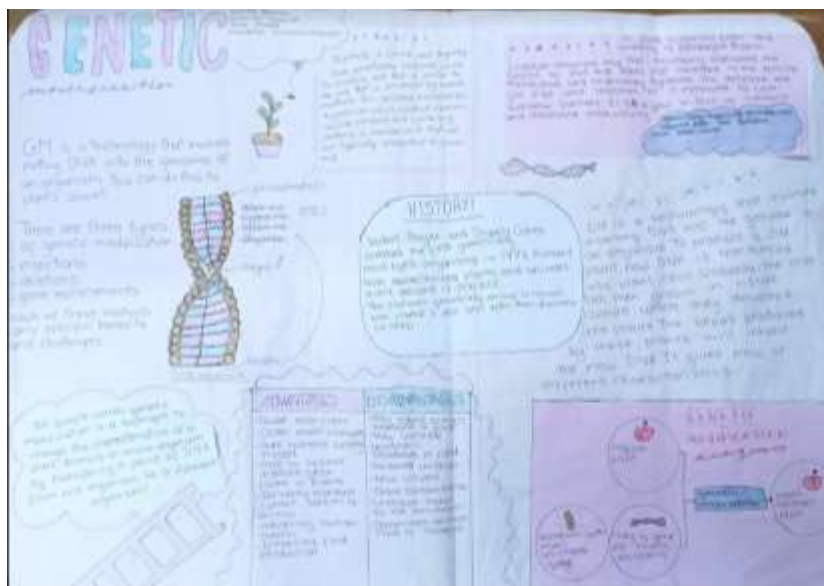
Example of pupil-produced murder-mystery to apply knowledge of DNA electrophoresis in a fun family activity.

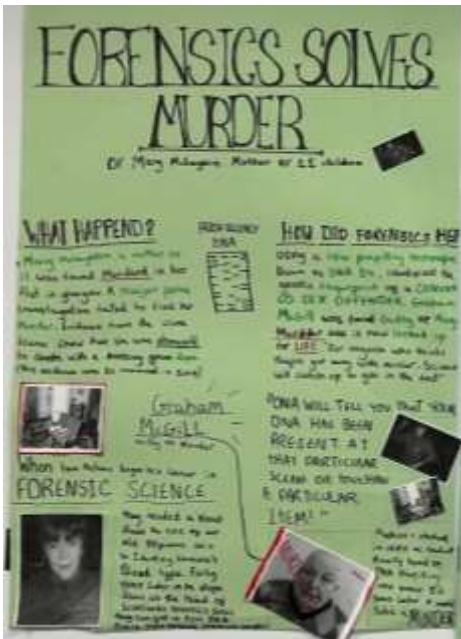
The presentation consists of 16 slides, numbered 1 to 12, with a decorative red blood splatter border at the top of slides 2 through 12. The content is as follows:

- Slide 1:** Welcome to the DNA Family Learning Event. Includes a DNA double helix and gel electrophoresis diagram.
- Slide 2:** DNA electrophoresis kit funded by BIOCHEMICAL SOCIETY Scientific Outreach Grant. Includes the society logo.
- Slide 3:** Today's DNA outreach programme. Lists activities like welcome, DNA electrophoresis, and a quiz.
- Slide 4:** Everyone has slightly different DNA. Explains that DNA samples are 'shopped up' and used for 'DNA 'gel'' electrophoresis to produce a DNA profile (like a fingerprint).
- Slide 5:** Everyone has slightly different DNA. Shows a gel electrophoresis image with lanes labeled 'DNA' and 'Sample'.
- Slide 6:** The Story. A murder mystery plot where a woman is found dead and a man is suspected.
- Slide 7:** The Story Continued... Describes the investigation process and the discovery of a fingerprint.
- Slide 8:** Characters. A title slide for the character profiles.
- Slide 9:** Clara Bryne. Profile of a character who was seen near the crime scene.
- Slide 10:** Leslie Burger. Profile of a character who was seen near the crime scene.
- Slide 11:** Billy Scott. Profile of a character who was seen near the crime scene.
- Slide 12:** Connor Atkinson. Profile of a character who was seen near the crime scene.
- Slide 13:** Evan Matthews. Profile of a character who was seen near the crime scene.
- Slide 14:** Forensic analysis. Explains how computer records were used to determine which individuals had gained entry to the studios.



Examples of posters produced and displayed at the family learning event.





Examples of DNA models produced during the course & displayed at the family learning event.



2. Enable our pupils to enthuse their families about DNA and DNA technologies.
3. Increase engagement with our families outside the more traditional parents night meetings.

For each class's short course, between 25%-50% of each class's families attended our family learning event, to help them learn a little more about DNA and DNA technology uses. Due to the 4pm start we were aware families had work or family commitments which might restrict attendance and some pupils had other activities. Families were highly engaged in an hour of DNA learning activities, due to the pupils producing an event with chunked activities including:

- A little teaching by the pupils
- DNA electrophoresis experiment linked to either the DNA Detective activity or a pupil-produced murder mystery linked to the kit.
- Posters with discussion
- Ethics cards “Scientific Scissors” (<https://www.biochemistry.org/media/amfomtgg/ethics-cards-printer-friendly.pdf>)
- Question and answering session



Family engaged in DNA electrophoresis as part of the pupil-devised murder mystery activity,



Families examining the “we produced these earlier” agarose gels during the murder mystery



Pupils engaging families with how to interpret their DNA agarose gels.

We informally chatted with families during and before exiting the learning events. Most families expressed enjoyment of the events. Most common replies included:

- Loved working/learning from their child.
- Pride over child achievement.
- Enjoyed the experiment and that the pupils got families thinking about what the results meant.
- Enjoyed the murder mystery.
- Learned new information about DNA [each member stated at least 1 thing they had learned].

Selected comments

- *How did these young people get to be so confident? I couldn't have done that at their age.*
- *It's nice to feel part of what the teenagers are learning. We felt part of our kids learning when they were in primary school but not so much in secondary school.*
- *I didn't know any of that before I came in here.*
- *I'm a research biologist and didn't know data could be stored as DNA—WOW!*
- *I wish we could've done something like this when I was at school.*
- *I must admit, I just ignored anything about DNA in the media but I might just try to read and think about it now.*
- *So, Jurassic Park isn't just fantasy?*

Due to lack of time, we didn't survey families about any media/social media posts they had encountered about DNA and DNA technologies but it was encouraging to hear a few individuals suggest they might take time to read DNA stories in future.

In addition, although we planned for the pupils to do the full event-planning, time constraints meant that this was a little more prescribed than originally planned.

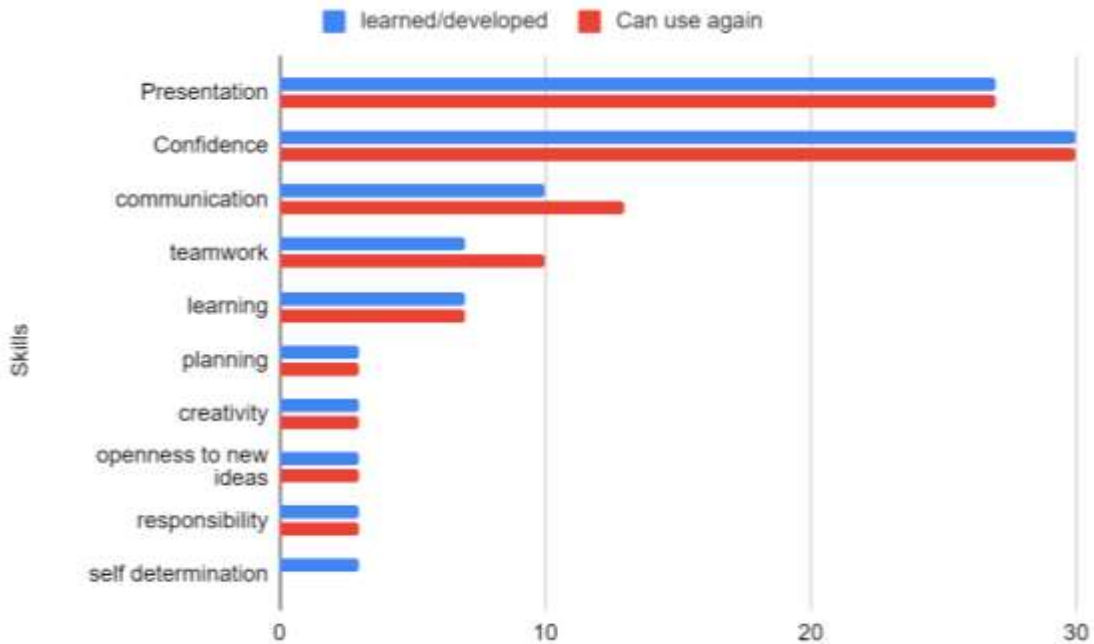
4. Improve pupil skills in line with our school leaver profile.

Due to time constraints, a course evaluation was done with one class. The questions were option-free to prevent bias. Discussions with other classes corroborated these results.

(a) Pupil responses regarding which skills they had learned/improved during the PBL course and which they could use again.

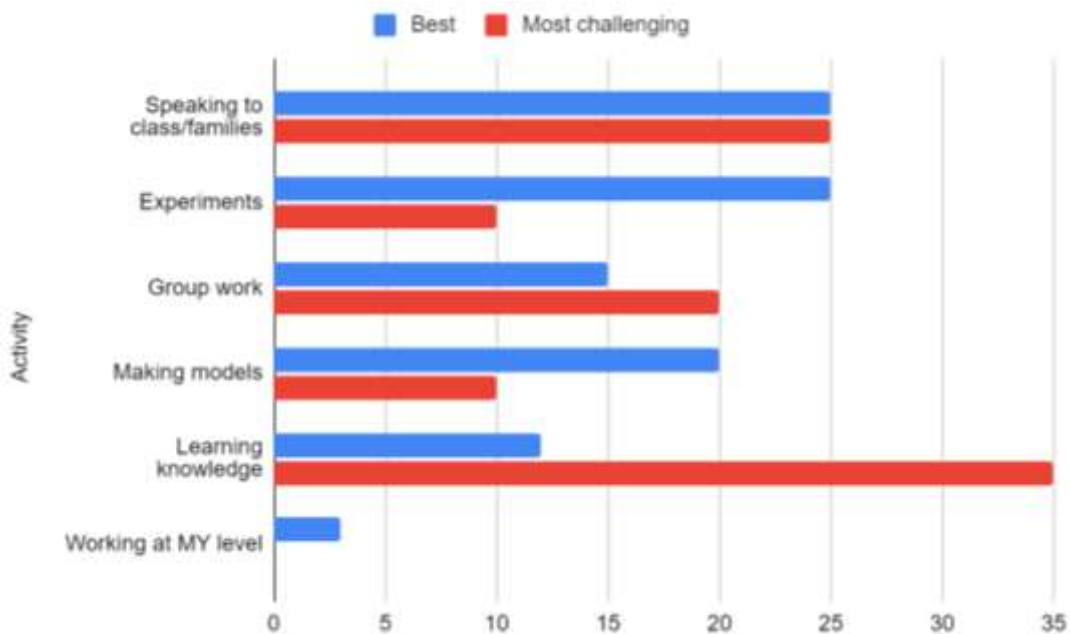
Pupils felt that their confidence, presentation and communication skills had developed the most during the PBL short course. These three skills were regarded as ones that would also be useful in other courses or in future jobs (see graph below).

Oral feedback from the pupils during the first rotation caused us to provide more time and opportunities in future rotations to practise presentations, so that pupils could obtain useful peer feedback for improvement, prior to the family learning event.



(b) Pupil responses regarding which activities they perceived as the “best” and “most challenging”.

25% of pupils rated doing the experiments e.g. DNA extraction and DNA electrophoresis as the best activity. 25% of pupils also expressed that speaking about their learning to the class and/or families was an equally good activity. Several pupils expressed that the family learning event was both their most challenging and best activity.



Pupils reported that learning knowledge was the most challenging activity but their posters, class and family presentations demonstrated a high level of knowledge and understanding. The learning activities were differentiated to promote achievement for all individuals. Aspects of positive group work were good communication, compromise skills and organised division of labour. Some individuals found some group work more challenging as they struggled to compromise, despite having a group work charter and/or group roles. These groups required more teacher support.

5. Increase pupil awareness of STEM careers linked to DNA.

Pupils were more aware of the role of DNA in forensics and linked careers as this was a section of teacher-led learning. Pupils who did further learning in gene editing, gene therapy, genetic modification and DNA as data storage were more aware of linked careers. We discussed DNA-linked careers that they were not as aware of.

Some jobs using DNA.....that you came up with.....

1. Forensic science/analyst
2. Biologist who knows about DNA (cell biologist / DNA analyst)
3. Making GM plants (horticulturist/geneticist)
4. Gene editor/therapist (biomedical scientist / geneticist / biologist / epidemiologist / research scientist)
5. Forensic anthropologist.
6. DNA data storage software engineer

Here are some more.....

7. Genetics counsellor
8. Endangered species / wildlife biologist
9. Archeologist
10. Food technologist
11. Pharmacologist (linking best level of medicine to a person's DNA)



We started the process of trying to get industry collaborators too late in the academic year. We'll pursue this for the next year we run the course.

How did I and the science staff at Oldmachar Academy benefit?

Dr Sheikh (Faculty Head Science) and I enthusiastically shared the PBL course development. Claire Stewart (Physics teacher) stepped in at the last minute to teach half of the PBL classes this year. We enjoyed learning about the new DNA technologies and their applications. To provide a little challenge, I discussed these new developments in N5, Higher and Advanced Higher biology courses.

The DNA electrophoresis experiment resources that this grant supplied, really helped promote pupil engagement within the PBL course which enhanced the teaching experience. Myself and a few of the S2 pupils upskilled a few science colleagues with DNA electrophoresis training. Science colleagues, senior pupil mentors and members of the Senior Learning Team, enjoyed watching the pupils succeed and it provided ideas and impetus for future outreach events. We also enjoyed interacting with families outwith traditional parents evenings to help build relationships.