Science Communication Project

Models of Science Communication

Science communication has been defined as the "process by which the culture and knowledge of science are absorbed into the culture of the wider community." [1] Thus the use of appropriate skills, media, activities and dialogue should arise in awareness, enjoyment, interest, opinions and understanding of science amongst the Government, scientific community and lay public[2].

Research into science communication is ever growing as the appreciation and recognition of its importance on an economic, ulitarian, democratic, cultural and social level are increasingly valued. There are three main phases of science communication. The first phase, scientific literacy, came about in the 1960s[3]. This had four elements to it. Firstly, that the there should be some knowledge of basic text book scientific facts amongst the public. Secondly, that there should be an understanding of scientific methods. Thirdly, Positive outcomes of science and technology should be appreciated, and finally that superstitious beliefs should be rejected[4]. From this phase arose the deficit model of science communication, in which the public were essentially seen to be deprived of scientific knowledge[5]. It was thought that such a model would benefit science education and the ignorant public[3,4]. An impact on the educational agenda in schools was seen. The science curriculum thus went under reformation and saw the combination of theory with a more hands on approach in the classrooms of the 60s and 70s[3]. A report published in the 80s suggested that the public were still lacking an understanding of science[6]. In fact only 34% of the British public in 1988 knew that the Earth went around the sun once a year[6]. Thus it reconsidered as to whether the scientific literacy approach alone was beneficial.

The next phase of science communication came about in the mid 1980s as the model was known as the public understanding of science (PUS)[4,7]. PUS stated that it was the job of the scientists to communicate well and educate the public[15]. In some ways it still incorporated scientific literacy, however the focus shifted toward public attitude to science. The model emphasised the need for proper engagement by scientists to the public to thus improve attitudes. It took the stance of the more knowledge one has, the more positive they well be[4].

Scientific communication has since progressed to science and society phase whereby the deficit of the technical experts, rather than the public, is recognised. The two-way engagement model has resulted in the 1990s. Unlike the deficit model and PUS, which depict communication as a one way flow between the experts and public, this model calls the need for the public to also play an active role. It implies the need for society and science to work together to develop a common, shared understanding[2]. This more recent approach has lead to museums, hospital open days, science weeks and events all contributing to this two-way dialogue approach.

Location of Project

Our science communication project consisted of devising and carrying out a series of science based activities for a school. The target audience was Key Stage 3 science students. The school chosen was Hethersett High School in Norwich. This was an appropriate choice, firstly because is was no more than ten minutes away by car from University of East Anglia, where we would need to transport resources to and from. Secondly, this is a school with a science college status[8]. Therefore this is a school that very much appreciates the importance of science and has a well established science department. Their keenness in the subject is illustrated by the science weeks and science evenings that they hold, and the fact that they have previously invited speakers from the Norwich Research Park. The last five years has seen the Science department have a makeover, with the building of new laboratories, refurbishment of existing laboratories and refurbishment of classrooms. These are used everyday by their students to perform practical investigations and activities, which they emphasise is key to the way in which they teach[8].

At GCSE they offer the 21st Century science curriculum or the option to do triple science, and students are taught range of topics in science during Key Stage 3 [ref. 8]. The national curriculum for Key Stage 3 science involves teaching a number of units *(appendix I)* to students in years 7 to 9 [ref. 9].

Project Development

This project aimed to provide 3X one hour sessions over three days with students aged between 12 and 14. The theme of the sessions was “Changing DNA” and activities were orientated around DNA and mutations. The activities were as follows: DNA recipe, spot the difference, DNA necklace and green fluorescent protein (GFP) transformation.

How we chose the theme and progressed into choosing and designing activities is mentioned in a diary that was kept from the day we chose the project to the last day of activities in the school. The diary recordings are below:

<u>26/09/08</u> Today I selected the science communication project I would like to do. I chose to run a science activity session at Hethersett High School. The session is aimed to incorporate my knowledge gained from the GFP transformation project that I carried out in the 2B24 research module (spring 2008).

<u>28/09/08</u> I have been trying to think of a theme/title for the event. It needs to be something that the GFP activity will link to, but needs to also appeal to the students.

<u>1/10/08</u> Today I heard the song called ‘Changes’ by Will Young on the radio. This gave me an idea for the theme!

<u>3/10/08</u> I suggested the theme ‘changes and mutations’ to the rest of the group (Shaffia, John and Dawn). The theme was approved and will in fact be called ‘Changing DNA’. We brainstormed and researched activities (in addition to the GFP transformation) to fit in with this theme. We also decided that the activities will be aimed at students at a level of about year 8, thus we need to look at how much knowledge these students will have about DNA.

5/10/08 I researched how much is taught about DNA/mutations in Key Stage 3 Science. I used the *Department for Children, Schools and Families* webpage to view the key concepts *(appendix I)*[9]. The curriculum states the fact that students are aware of the cells and tissues hierarchy, that variation exists between living organisms, and that his variation may be inherited or environmental. It also states that students of this level are aware of the terms genetic engineering and selective breeding. Thus they have heard of DNA but know little about it in terms of detail.

I also researched activities the BBSRC use with 11-14 year olds to define DNA and mutations *(appendix II).* I very much liked their idea of introducing DNA as a recipe which can be changed to encode different products.

15/10/08 I contacted a science teacher at Hethersett High to enquire how much knowledge their year 8 students have in the area of DNA that we will be looking at *(appendix III).*

17/10/08 I received a reply from the teacher at Hethersett *(appendix IV).* She said their year 8 students' knowledge is limited, hence the BBSRC 'DNA is a recipe' idea now seems even more appealing and necessary to use with the students.

21/10/08 The group decided on four activities that will be carried out with the students:

- *DNA is a recipe/what is DNA?-* This activity was influenced by the BBSRC activity *(appendix II)* and will include a presentation and students using cards representing bases *(appendix V)* to illustrate base pairing and mutations. The students could wear these cards on headbands perhaps. John will manage this activity.

- *GFP transformation-* This will include the students transforming the GFP gene via the pGLO plasmid into *Escherichia* coli (*E.* coli). The plates will be incubated overnight, and the session shall continue on the following day when students will observe their plates, but also be introduced to GFP variants (as a consequence of mutagenesis). I did originally consider letting them also do a blue fluorescent protein (BFP) transformation, however there is not enough time to create BFP for them and the transformation success is not always high. Therefore the BFP will be shown to them in pictures. I shall manage this activity.

- *Spot the difference*- This will include a type of ‘show and tell’ session. We shall take in artefacts to introduce variation (natural and non-natural) to the children. This will include different coloured corn; *Drosophila* variants (microscopes will be required for this); purple versus red tomatoes; and any other objects we find (perhaps from Dr. Dalmay). Dawn is to manage this activity.

- *DNA necklaces*- This will be done with students to get them to engage with the concept of DNA being real and not just something out of a textbook. It also gives them something to take home. Shaffia will manage this activity.

The session shall finish with some sort of a competition or quiz.

<u>24/10/08</u> Kay told us that Hethersett have confirmed that they are happy for us to carry out the event at their school. We were told that we will have a one hour session on each of three consecutive days with a group of about 30 children. It is possible we shall do a repeat with another 30 children at a later date.

The group of students will consist of different learners, thus we must make sure that our presentations and activities appeal to as many different learning types as possible.
As a group we decided that all children shall do the activities simultaneously, but each individual is responsible for designing and managing their own activity on the. However other group members will also be there to assist students, as will Kay.

<u>28/11/08</u> Activity order was decided:
Day one: An introduction and DNA recipe activity (~20 mins); DNA necklaces (~30-40 mins).
Day two: Show and tell (~20-30 mins); GFP transformation (~30-40 mins).
Day three: Examine successful transformations and presentation showing living pictures (~30 mins); Quiz/prize session (~20 mins).

We started working on the base pairing cards for the recipe activity. We printed bases/letters (A/T/G/C) on coloured card. Each piece of card will be cut in a shape to illustrate the base pairing concept. There will be one card per student and this will have string attached so that it can be worn. We decided against headbands as this would be more costly and time consuming to make. Plus wearing the card around them would allow them to remind themselves of what base they are and thus what they need to pair with.

5/12/08 We had a meeting about what possible questions the students need to asked at the end of the three days so that we can be evaluated. The next step is to work on an actual evaluation now.

9/1/09 Kay emailed an evaluation that will be given to the children after the event. I made a few changes to it with Shaffia and sent it back to Kay *(appendix VI)*.

16/1/09 I received an email from Kay confirming dates and times of visit to the school.
- Tuesday 3rd Feb, 1pm start (leave BIO at 12.00am in order to give time to set up)
- Wednesday 4th Feb 10.20am
- Thursday 5th Feb 2.00pm

26/1/09 Today we wrote a risk assessment form *(appendix VII)*. Shaffia emailed it to Kay.

27/1/09 Kay recommended to leave the quiz out as there is already enough to do on the last day.

I created my GFP presentation *(appendix VIII)*. This is in two parts. The first is an introduction and protocol for the GFP transformation. The second part is for day 3 after students have viewed their transformations. I used Kay's A level GFP transformation protocol that she uses with Sixth forms (*appendix IX)* to base my protocol on.

28/1/09 The group met with Kay to prepare trays full of equipment to take to Hethersett with us. I also prepared the transformation mix which will be required for the GFP transformation activity.

<u>2/2/09</u> Kay was going to take some of the equipment over to the school today, however the school closed due to snow and so she will take all tomorrow. John got the lab coats ready to take with us.

<u>3/2/09</u> Today was day one, we found out that we are actually taking the year 9 top science set. John and Shaffia did their activities. Both ran very well and they seemed to take on all the information and enjoyed it. They were quick however and so we had some time left over in which John did a quiz with them and Kay talked to them about importance of DNA, DNA fingerprinting, the human genome chips, and their opinions.

Tomorrow I shall do the GFP transformation (Dawn will do her spot the difference activity on day 3 now). The transformation activity ought to fill the hour up. However I feel that them looking at their transformations and the presentation on Thursday (day 3) will not fill an entire hour session, even with the evaluations to complete. Therefore I shall add a little more to part 2 of the presentation (*appendix VIII)*.This will include more pictures and examples of living pictures, questions, and examples of how GFP and GFP variants are useful in medical research.

<u>4/2/09</u>
Students performed the GFP transformation. In between incubation times, I tried to emphasise how we were using bacterial cells to produce a desired product (GFP), and thus the notion of bacteria not always being “bad.” I asked questions about what examples of good/useful bacteria they know. I also noticed some of the students were wearing their DNA necklaces from the day before!

As we could not get hold of the corn from Prof. Johnston or any props from Dr. Dalmay, I collected some postcards *(appendix X)* showing variation amongst peas and beans and a pea plant from the John Innes Centre to add to Dawn’s spot the difference activity. There are enough postcards for each student to take one home each.

<u>5/2/09</u>
Students looked at their transformations. There were some unsuccessful ones, but also some very successful ones. Dawn presented her ‘spot the difference presentation’ and showed them the *Drosophila* under the microscope, as well as the pea plant and variant

peas in boxes. She asked questions about other genetic transformations and their application to everyday life which has benefits and negatives. She gave out the postcards, free pencils and evaluation forms. Students were given the opportunity to ask any questions. A few asked about what they could study at university if they enjoyed particular elements of science.

The four activities were designed to take account of as many learning theories and learner types as possible. The learning theories include behaviourist, humanistic and cognitive learning[10,11]. The behaviourist theory involves learning in response to a stimulus and thus includes being conditioned, whether it is classically or operantly. Classical conditioning involves behaviour being paired to a stimulus, whereas operant refers to the modification of voluntary behaviour through the use of consequences[10]. Thus this type of learning builds upon practice through repetition and relies on emphasising positive or negative reinforcement[11]. However humanistic learning assumes that the individual learner is empowered and has the desire to learn, and that the teacher is only their facilitator[10]. Therefore the student must explore and observe. Whilst the facilitator can provide motivation and be a role model, it is ultimately up to the student to self evaluate their progress and take responsibility for their own learning[11]. The learner can watch the behaviour of others and see what results from that behaviour in order to adjust their own[11].

The cognitive theory is the one that takes account of different learner types. It considers how different individuals understand material, process thoughts and the development of insight[10]. The theory implies that that learning involves linking knowledge already obtained with new information being learned, but it is the learner that is in control of this[11]. A student should therefore have some desire to learn, but the teacher must be aware of the individual learner’s development and provide a way of learning suited to them[11].

The cognitive theory goes onto say that experiential learning is necessary, and so by taking account into the different learning types, a group of learners must experience the information being told or demonstrated in more than one way[10]. This is so that the same thing can be taught in many different ways to the same group, thus increasing the chance that the teacher has catered for all learning types and allowed them to assimilate the vital information[10,11].

People do not often have one learning style, but a combination, with one dominating more than another. Activists are those who learn by doing. Thus these learners tend to be enthusiastic and tackle ideas by brain storming[10]. Although they tend to lose patience quickly, they respond well to competitive challenges[12]. Reflectors tend to ponder over experiences before reaching any conclusions, and so prefer time to prepare in advance[10,12]. Theorists include those that are perfectionists. They tend to analyse and link how one thing fits in with another before forming logical theories[10,12]. Finally there are the pragmatists who are always thinking up new ideas and trying them out in practice. They dislike discussing and pondering over these ideas, but instead actively seek to carry out their ideas and so tend to be confident[10,12].

The DNA recipe activity was designed to act as an introduction to the entire event. It introduced the concept of DNA and acted to build upon past knowledge. The idea of a recipe and needing different components to build or programme something was a starting point for further concepts that would be brought up. The base pair cards *(appendix V)*, which required students to stand up and pair with the right base, suited the activists. Whilst the reflectors would have benefited from the presentation *(appendix XI)* in which the same information was illustrated using multiple diagrams and using facts that put DNA into context with everyday life. The theorists of the group would have benefited from the visual aids, examples and the base pairing activity, as they would have been linking the information gained together. The pragmatists and theorists both suited the quiz, giving them the chance to think about the information presented within the hour and also allowed them to extend their thoughts beyond what they have just been told.

The next activity was the DNA necklaces *(appendix XII)*. This most certainly would have suited the activists as they would experience seeing DNA and thus were likely to remember what they learnt. This activity also gave reflectors the chance to think about the information they were presented with in the prior activity when seeing their own DNA. Theorists would have been linking this activity to the previous, and probably included the students who were asking how they would be able to see the double stranded DNA and the base pairs of their own DNA in their necklace. The pragmatists were likely to also have been in this group of students who asked similar questions as well as asking whether this procedure could be done using DNA from any living organism (fig. 1). This was a sign of them seeking new ideas.

Figure 1. Students interacting with us whilst creating DNA necklaces. Those students asking questions were those that were extending their ideas beyond what they have seen in this task.

The GFP transformation could be applied to all four learner types. Being a practical activity which allowed the students to see the end result themselves, the activists were sure to learn the concepts of changing DNA sequences and genetic transformations from this. Theorists would be integrating all the information together. The ones whom performed the activity with confidence and were always one step ahead and were likely to be the pragmatists.

The spot the difference activity, especially the presentation *(appendix XIII)*, would suit the theorists and pragmatists. This activity used all the information learnt over all the sessions and thus gave theorists the chance to piece the whole changing DNA story together. It gave pragmatists the chance to take this information and think one step ahead, this was evident when students were asking questions and suggesting ideas as to how mutations and transformations could be applied elsewhere. Activists would have benefited most from the hands on part of this session, which again incorporated all information learnt over the previous sessions. This included seeing the pea variants and using microscopes to view *Drosophila* variants. Therefore, whilst each individual activity did not apply to all four learner types at the same time, each learner type was accommodated for at some point during the event. Changes made to each activity (as noted in the diary) were all part of the developmental process in creating activities that would be realistic and successful.

Evaluation

To evaluate the students' opinions of the individual activities and experience as a whole, and to find out whether it had changed their attitude towards science, they were given an evaluation form *(appendix VI)* to fill at the end of all three sessions. The evaluation would also be a good indication as to whether we had catered for all the learner types.

The students reported nothing but positive feedback when asked what they thought of all the activities as a whole (fig. 2). They seemed to most enjoy those activities that incorporated more hands on experience, for example the GFP transformation and DNA necklace, whereas the quiz and DNA recipe were enjoyed the least (fig. 3). This would indicate that that the majority of the students were partially activists. This was supported by the fact that when asked what the three most amazing things they learnt were, 38% reported it to be GFP and GFP transformation (fig. 4). Interestingly this was what 19% of students wished to have learnt more about, saying that they would like to have done, or at least learnt more about living artwork and using GFP variants (fig. 5). Contrastingly, more reported being fascinated by the complexity of DNA, as presented mainly in the DNA recipe activity, than actually seeing DNA (fig.4).

The fact that the majority reported science as being fun and to have enjoyed learning about it seems to support the humanistic learning theory, as this finding implies that these students had the desire to learn in the first place (figs. 6 and 7).

Despite their enthusiasm and enjoyment, when asked whether the experience had made them think differently about science, 37% of students said no, 7% were unsure and only 56% said yes. Additionally, when asked whether they would like to become a scientist the students' responses were not distinctly split (fig.8). The majority said they do not know (fig. 8).This group of students may represent the reflectors of the class. Despite this, about 33% of students said they would like to become a scientist (fig. 8), this is a fairly large proportion of students, and so indicates that this experience had a positive influence on a number of students.

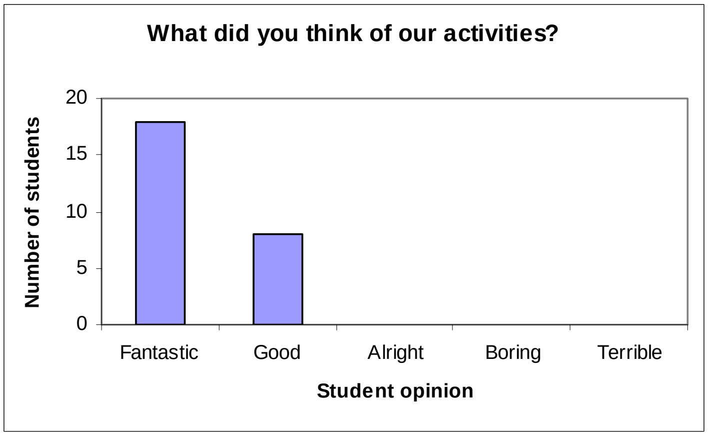


Figure 2. Student responses to the activities as a whole. The response was positive with 18 students saying the activities were fantastic and 8 saying they were good. No students had an opinion lower than this.

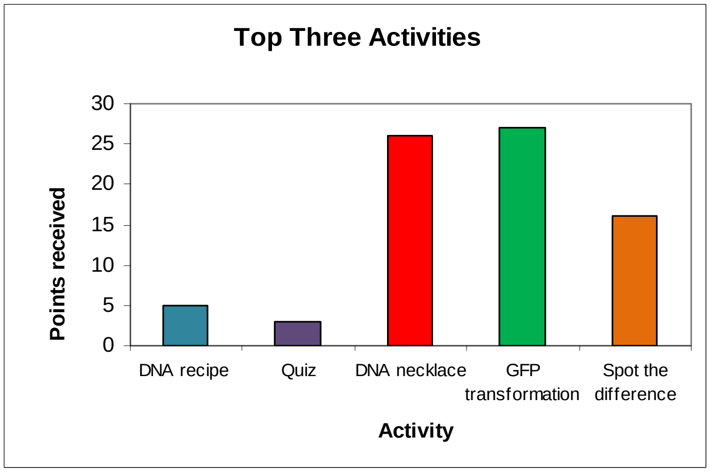


Figure 3. Student responses when asked what their top 3 activities were. Each activity chosen received one point. The points each activity received were then totalled. The practical activities received most points. The GFP transformation received 27 points, DNA necklace received 26 points, whilst spot the difference received 16 points. The DNA recipe and quiz received less points. They received 5 and 3 points respectfully.

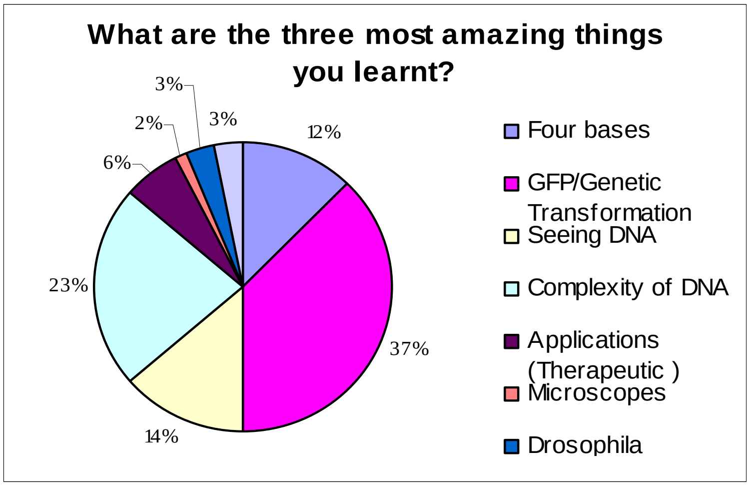


Figure 4. Student responses when asked what the 3 most amazing things learnt were. GFP/Genetic transformation was a popular choice, with 37% if students selecting this, followed by the complexity of DNA, which 23% of students selected. Only 2% of students selected microscopes as one of their choices.

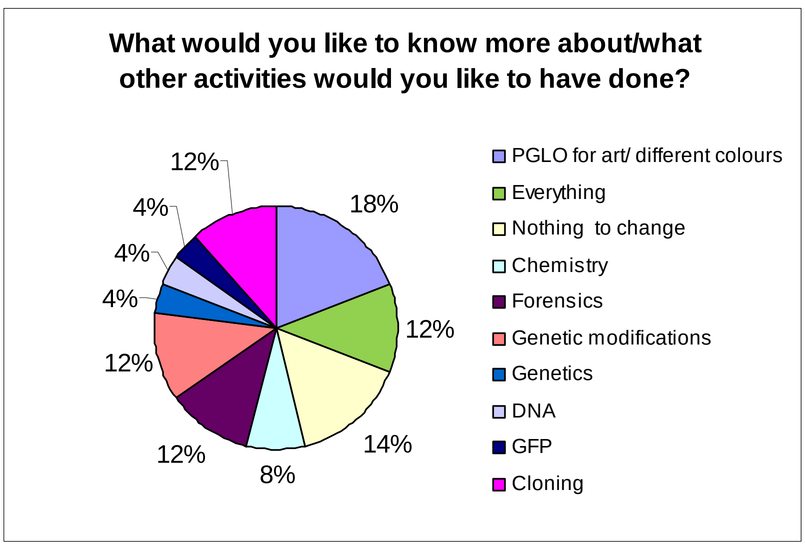


Figure 5. Student responses when asked what they would have liked to have learnt more about. The most popular comments were regarding using pGLO for artwork and creating other fluorescent coloured proteins (18%). This was followed by pupils wishing to learn about genetic modifications (12%), forensics (12%), and those that stated they would like to learn about everything (12%). Some claimed nothing should be changed (14%).

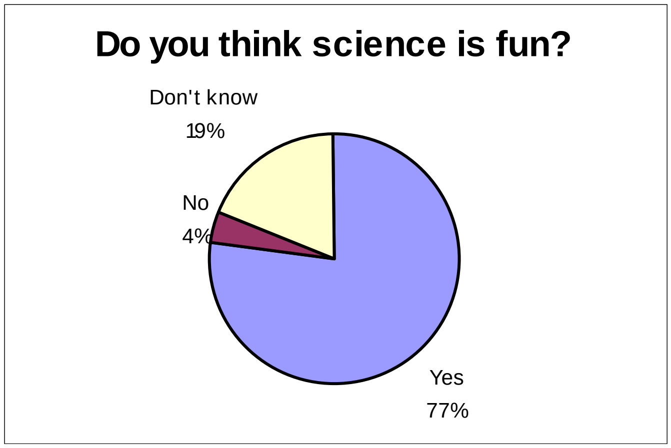


Figure 6. Student responses when asked if they thought science is fun. The vast majority said science is fun (77%), with more being unsure (19%) than saying no (4%).

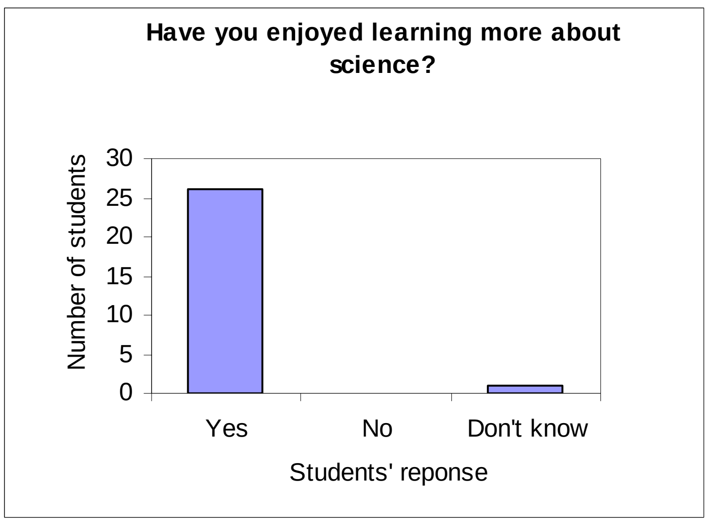


Figure 7. Student responses when asked if they enjoyed learning more about science during this experience. None said no, one student was unsure and 26 students said they had.

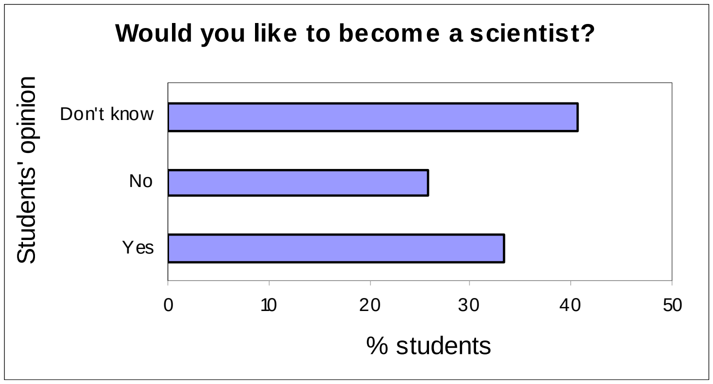


Figure 8. Student responses when asked if they would like to become a scientist. The majority (40.7%) were unsure and 33.3% said they would like to. 25.9% said they would not like to become a scientist.

We can conclude that the majority of students saw this as a positive, enjoyable experience. They enjoyed the hands on approach and the complexity of ideas. Thus we seemed to have provided not only for the activists of the class but also the other learner types, although this in part relied on the students having the enthusiasm for science in the first place. The project influenced at least some of the students, changing the way they think about science and what they think about science as a career. Future projects of this type may incorporate more hands on experiences when it comes to genetic transformations with GFP. However this would require longer sessions to create living artwork, and more time and cost to prepare for such activities.

Appendix

Science at key stage 3	
Units	
Unit 7A. Cells	
Unit 7B. Reproduction	
Unit 7C. Environment and feeding relationships	
Unit 7D. Variation and classification	
Unit 7E. Acids and alkalis	
Unit 7F. Simple chemical reactions	
Unit 7G. Particle model of solids, liquids and gases	
Unit 7H. Solutions	
Unit 7I. Energy resources	
Unit 7J. Electrical circuits	
Unit 7K. Forces and their effects	
Unit 7L. The solar system and beyond	
Unit 8A. Food and digestion	
Unit 8B. Respiration	
Unit 8C. Microbes and disease	
Unit 8D. Ecological relationships	
Unit 8E. Atoms and elements	
Unit 8F. Compounds and mixtures	
Unit 8G. Rocks and weathering	
Unit 8H. The rock cycle	
Unit 8I. Heating and cooling	
Unit 8J. Magnets and electromagnets	
Unit 8K. Light	
Unit 8L. Sound and hearing	
Unit 9A. Inheritance and selection	
Unit 9B. Fit and healthy	
Unit 9C. Plants and photosynthesis	
Unit 9D. Plants for food	
Unit 9E. Reactions of metals and metal compounds	
Unit 9F. Patterns of reactivity	
Unit 9G. Environmental chemistry	
Unit 9H. Using chemistry	
Unit 9I. Energy and electricity	
Unit 9J. Gravity and space	
Unit 9K. Speeding up	
Unit 9L. Pressure and moments	
Unit 9M. Investigating scientific questions	

Appendix I.[Ref. 8] The key concepts in the National Curriculum for Key Stage 3 Science. The relevant units and concepts to our "Changing DNA" theme are highlighted. There is no specific mention of DNA.

3204251

Discovering DNA 'The Recipe for Life'

Created by Dr Sue Assinder of the University of Wales, Bangor

Prifysgol Cymru • University of Wales
BANGOR

Produced by the BBSRC Schools' Liaison Service

bbsrc
biotechnology and biological sciences research council

2. The "Recipe for Life"

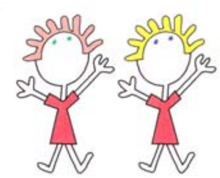
10 minutes

You will need:

- Three volunteer children (all of the same sex).

Outline of the activity:

- Volunteers are used to illustrate differences between individuals.
- The idea is introduced that we contain a "Recipe for Life" - a special chemical called DNA.



Intended message:

- People are different because of their special DNA "recipe".

Step 1
Repeat the two main points from activity 1:

- You need a recipe to make a cake;
- Different cakes need different recipes.

Now point out that we can also see differences between people, using three children from the group to illustrate your point.

Sue's advice: I found this easiest to do with three volunteers of the same sex - each with some obvious physical difference such as hair colour. (Although in the heat of the moment I always seemed to manage to pick children who were uncannily alike!)

Step 2
Ask the children to point out the differences they can see between the volunteers. Obvious things are hair colour and eye colour, but there are other fun things like tongue rolling which can only be done by around 50% of the population. Also ask the children to point out similarities like "all the volunteers are girls"; "they are all humans".

Sue's advice: I usually needed to steer them away from focusing on what the volunteers were wearing.

Step 3
Repeat the story so far:

- Chocolate swiss rolls, jam swiss rolls, cherry buns etc are all cakes. The 'volunteers' are all human and all girls (or all boys).
- The cakes are different - (some are chocolate, some contain jam, some contain cherries) and the girls (or boys) are different (some have blonde hair, some have dark hair).
- Different types of cake are made by following different recipes. →

3204251

2. The "Recipe for Life" *(continued)*

Arrange the children so that they are sitting in a circle to help ensure that they all have a 'fair' say and then ask the question:
Do you think people are different from each other because their bodies have been built using different recipes?
Do you think we each have a recipe inside us which says how we will grow and what we will look like?
You might like to use a floor book to record the group discussion which follows.

Sue's advice: I got a varied response to this question. Here are the tactics I used to deal with the children's answers.

A: No we haven't got a recipe inside of us.

About half the groups I worked with said there wasn't a recipe. I this case I led them round to the idea that there was with the following:

- A recipe does not have to be in the form of a book.
- There is a recipe inside of us but it is a special **chemical** recipe.
- The name of the chemical is **DNA.**
- We can call the DNA recipe the **"Recipe for Life"** *(I wrote this in big letters on the board).*

A: Yes we must have a recipe inside of us.

Some groups thought there must be a recipe inside each human but they couldn't decide how this could be. In this case I would agree with them, say well done and then use the same explanation as for those who answered "no".

A: Yes and its called DNA .

Some groups had a bright spark who said "yes and it's called DNA". In this case I would agree with the child, say well done and lead the whole class to the idea that DNA is a special recipe again by using the same explanation as for those who answered "no".

Step 4
Ask the question - **"Whereabouts in the body is the DNA recipe?"**
Expect a mixed response. These are the answers Sue got in order of frequency:

A: "everywhere".
A: "in the heart, brain" etc.
A: "inside cells".

Take four or five suggestions and then point out that they are **all** correct:
DNA is in every part of the body because it is inside every **cell** in the body.

Extension
There is potential here for a more extensive data collection if time allows - with the children completing a data sheet detailing their own characteristics (hair colour, eye colour etc) and the characteristics of the other members of their group. This data could be used to plot histograms either on paper or using computer programmes such as - the 'Graph-it' which runs on the A4000 and 'Ourfacts' which runs on the BBC Basic.

4. DNA - a chemical "recipe"

15 minutes

You will need:

- A DNA 'scroll-type' banner.
- **Two** large DNA models - use worksheets 6 a - 6 f as a template for the small chemicals (the bases).
  Note: You should prepare the models before starting activity 4.
  Make sure that the sequence of the base pairs in each of the models is *different*.
- Coat stands or wall hooks from which to suspend your DNA models (optional).
- Worksheet 7 (a - c) (optional).
- Worksheets 8 (a - b) The Recipe for Life: Volume 1, recipe book.

Outline of the activity:

- A simple model is used to explain DNA structure.
- The idea of a genetic code is introduced using the "Recipe for Life" book.

Intended message:

- DNA is a large chemical made of four small chemicals (A, T, G, C).
- The order of the small chemicals makes the "Recipe for Life".

Step 1
Explain what DNA stands for.

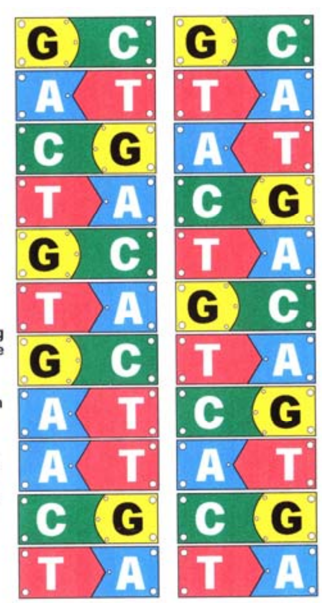
*Sue's advice: I did this by preparing a large banner saying **D**eoxyribo**N**ucleic **A**cid - with the letters DNA highlighted in a bright colour. The children unfurled this banner and we all read out the words a few times as a group.*

Step 2
Introduce the structure of DNA using a large paper or card DNA model.

It is best to <u>make up two models before the workshop</u> by photocopying worksheets 6 (a and f) and using these sheets as your templates. Make sure that the sequence of the base pairs is different in each model. The colours of the four bases should correspond to the colours used for the children's T-shirts or sashes. (The diagram on the right gives an example of two sequences that could be followed). Assemble the models following the instructions on Worksheet 7a.

Suspend the first model from a coat stand or a wall hook. Point out to the children that DNA is a large chemical made of four small chemicals joined together according to special "rules". Get the children to work out the DNA "rules" (ie **the pairing** rule of **'A with T'** and **'G with C'**) and introduce the names of the bases.

Sue's advice: It is more important that the children remember the 'A with T' and 'G with C' rule than the names of the bases. →



4. DNA - a chemical "recipe" *(continued)*

Step 3
Bring out the second large DNA model and get the children to spot that the 'A with T' and 'G with C' rules are the same but the **order** of the small chemicals is **different.**

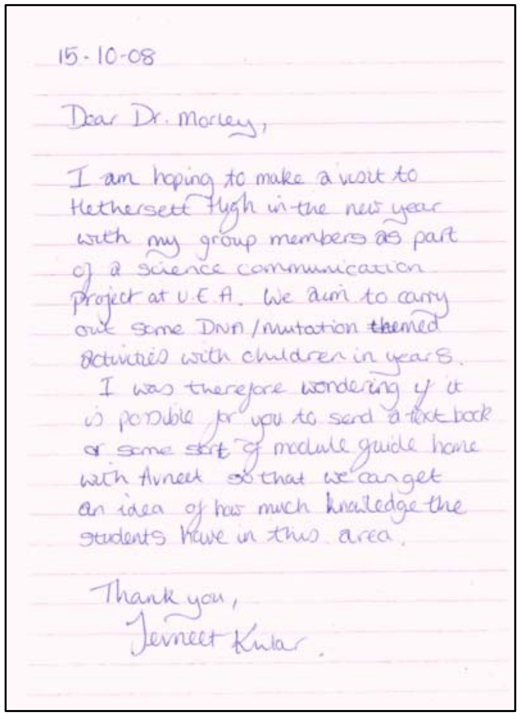
Use this as a link to explain that DNA works like a chemical recipe because the order of the small chemicals acts as a special **code**.

The DNA "recipe" contains instructions to tell the cells in our body what to do.

We all look different because we all have slightly different arrangements of the small chemicals inside us so each of our "recipes" is slightly different. Use the DNA recipe booklet (worksheets 8a and 8b) to reinforce this idea. Point out that the recipe for a human being is actually very long and would fill many encyclopedias.

Extension
If time allows, the pairing message (that the four small chemicals only fit together in certain ways) can be reinforced by asking the children to make their own small DNA models using worksheet 7 (a - c) shown below, either individually or in small groups.

Appendix 2. Activities the BBSRC use with 11-14 year olds to introduce DNA. The activities liken DNA to a recipe for life and introduce the concept of bases. Their activities were very influential in designing our introduction to DNA presentation and the base pairing activity.



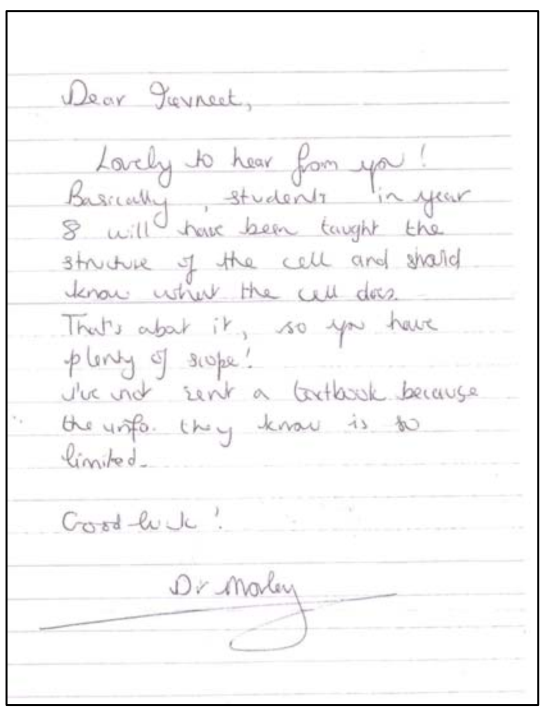
15-10-08

Dear Dr. Morley,

I am hoping to make a visit to Hethersett High in the new year with my group members as part of a science communication project at U.E.A. We aim to carry out some DNA/mutation themed activities with children in year 8. I was therefore wondering if it is possible for you to send a text book or some sort of module guide home with Avneet so that we can get an idea of how much knowledge the students have in this area.

Thank you,
Jevneet Kular.

Appendix III. Letter to a science teacher at Hethersett High School. This letter asked to provide information regarding in how much year 8 students are taught about DNA and mutations.



Dear Jevneet,

Lovely to hear from you! Basically, students in year 8 will have been taught the structure of the cell and should know what the cell does. That's about it, so you have plenty of scope! I've not sent a textbook because the info. they know is so limited.

Good luck!

Dr Morley

Appendix IV. Letter from science teacher at Hethersett High School. This letter stated that their information about DNA is little, although they have some knowledge of the cell.

Appendix V. DNA base pairing cards. Each base was of the same colour and shape and complimented the shape of its base pair. The cards could be used with the students by each one wearing a card around their neck and standing in pairs to form a ‘DNA strand.’

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