

Tree School – A new Innovation for Science and Education

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Abstract — The current decline in the popularity of science at school has resulted in many current activities to encourage and enthuse children in these subjects. One such initiative has been born from a partnership between the Natural History Museum, London, and the Cothill Educational Trust, which aims to engage children in current biodiversity science. This project, named Tree School, combines traditional methods used in botanical taxonomy with new research activities using DNA barcoding to investigate local biodiversity, and the applications of these techniques on a larger scale. The challenges faced and potential opportunities realised have been investigated with a series of pilot workshops, in preparation for the two-year operational phase in 2011-12.

Index Terms — DNA barcoding, identification, trees.



1 INTRODUCTION

The current decline in popularity of the science subjects for school age children has been recognised both in the education sector and also by scientists. With fewer children choosing to continue to study science, there may be a shortage of scientifically literate and trained professionals in the future. A recent Research Councils report highlights this predicament, encouraging the development of innovative initiatives between scientific researchers and schools [1].

Scientists at The Natural History Museum (NHM) in London were keen to address this problem, and began to develop ideas into how modern scientific techniques could be effectively communicated to school children. Public engagement and learning already play a huge role within the Museum; extending these principals through the scientific researchers was an obvious development.

Simultaneously, the Cothill Education Trust was considering ways to excite and encourage the children at their schools in science. A partnership was formed between the NHM and the Cothill Trust, and a new initiative developed with the aim of enabling current scientific practices to be understood and undertaken by

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children. The Tree School project forms a continuing collaboration between the two parties, to encourage a greater interest in science in children.

2 THE TREE SCHOOL

The scientific aim of Tree School was to design and pilot ways of involving children and other non-experts in biodiversity science, specifically international DNA barcoding campaigns. Pupils from the Cothill Educational Trust schools, as well as others from schools across the country, collaborate with NHM researchers to collect scientifically relevant data in this emerging scientific field. This is achieved by attending a five-day workshop at the Old Malthouse School, a fully-equipped educational centre in Dorset, which combines traditional classroom, practical and outdoor teaching techniques. The Old Malthouse accommodates the pupils, teachers and scientists comfortably, allowing a relaxed atmosphere for both study and leisure time.

The workshop incorporates the more traditional methods used in taxonomy and identification with modern laboratory-based work. This enables a deeper understanding of the subject, and also demonstrates how different research overlaps and compliments the other. The trees situated on the Old Malthouse grounds are being used, with the children investigating different techniques to identify the trees to species level.

2.1 TAXONOMY

Field work is carried out at the beginning of the week, where the tried and tested methods still used by botanists in the field today are demonstrated. Each pupil chooses a tree, and captures the relevant data, such as a GPS point, relevant observations and the correct species name. Identifications are made using a variety of binomial keys and pictures, namely:

KeyToNature: Key to trees at the Old Malthouse [2],

The Field Studies Council: 'Tree Name Trail' key to common trees [3],

The Woodland Trust: Leaf identification swatch book [4],

The Collins Tree Guide [5].

A specimen from the tree is also taken and pressed, which is later made into a herbarium sheet incorporating all of the gathered information.

2.2 DNA BARCODING

Leaf samples are also taken from the trees for use in DNA barcoding. This is a compelling new tool, promising dramatic improvements in the rate and accuracy of biodiversity inventories, and the potential to identify samples to a species level. Within the fully-equipped laboratory, the children carry out DNA extraction and PCR amplification and evaluation for their own specimens. These extracts are then taken to the NHM sequencing laboratory, and the DNA sequences produced. The results are added to TreeBOLD [6], the international barcode of life data system, where they will be available to the scientific community.

3 PILOT WORKSHOPS

In 2011, a series of pilot workshops were undertaken to develop these ideas, concentrating on the suitability of the techniques and the resources used. Opinion has been sought from the teachers, children and scientific researchers attending these workshops, with the findings and lessons learnt used to finalise preparations of a series of workshops to take place during 2011-2012. It is anticipated that pupils from both private and state schools will attend these workshops.

A series of questionnaires were carried out both before and after attending Tree School for the children and the teachers. Thirty five children aged between eleven and twelve were questioned, from two different schools and currently in year 7 of the UK system. A series of background questions were asked upon their arrival, including their favourite subject, whether they enjoyed science at school, whether they would like to work in science when they are older, and their perception of a scientist. Three teachers present for the entirety of the course participated in the survey, comparing their perceptions of Tree School with their findings having attended.

3.1 TEACHERS

The common concern prior to Tree School was that the work would be too advanced for the age group attending. Conversely, each participant stated that any opportunity for students to broaden their horizons can only be a positive experience. The teachers also expressed a frustration that there is little opportunity for them to explore new aspects of science, or develop children's areas of interest, due to syllabus constraints. Most work taught during term-time is exam-driven, which of course is a necessity.

At the end of the week, the teachers were pleasantly surprised at the amount the children had understood, and their level of engagement in both classroom lessons and practical sessions.

3.2 PUPILS

Upon arrival at Tree School, the most popular subject proved to be French, with around one third of the children naming it as their favourite subject. The next most popular subjects were History, Geography and Art, followed by Science with four votes. English, Maths and Latin were also mentioned. The majority of the children stated that they enjoy science at school, although very few have considered continuing with science in the future. Most of the group were unsure about what they wanted to do as a career.

An interesting observation is the high number of children who chose French as their favourite subject. The Cothill Trust has one school in France, the Château de Sauveterre, where the children spend one term learning French intensively to a much greater extent than can be covered in normal lesson time. This has obviously had a positive effect on their enjoyment of the subject. It can therefore be assumed that with extra insight and learning into a subject, children

can easily be enthused and encouraged to pursue a subject in the future. With 72% of the children already enjoying science at school, but the same number unsure as to what they would like to do as a career, it is possible that more children could choose to study science at a higher level if given the opportunity to engage in real science at a younger age.

3.3 SCIENTISTS

The workshops also proved an enlightening experience for the research scientists from the NHM. It was felt that the information was communicated effectively, supported by informal reports back from the teachers, students and even the students' parents. The level of engagement with the children grew over the week, leading to some thought provoking discussions. It provided a new perspective on the subject, as children ask very different questions to those usually posed by peers and other academics, and resulted in a two-way enthusiasm between the scientists and the students.

It was also interesting to see how the children reacted to real-life experimental problems faced by scientists. Schools usually teach canned experiments with known outcomes, so pupils are usually able to achieve the correct result, or know where they may have made a mistake. Often, a species may not appear in a guide book, which encourages the child to think about how they may be able to identify their tree. Also, the processes used to extract and amplify the DNA can often fail, for no obvious reason, which can often happen.

4 THE WORKLOAD

It is obviously imperative to ensure that the aims of the Tree School are fully met for each group of children attending the workshops. It is important that they end the week with a proven increased knowledge of identification and scientific methodologies, and also hopefully an increased enthusiasm for botanical science.

Much of this can be gauged from the question and answer sessions during classroom and outdoor activities. In addition to queries for clarification, inquisitive questioning increased and many sensible further and leading questions were asked as the week progressed. This was particularly exciting to see, as many of the children became engaged in the project and were inspired to find out additional information.

Feedback from the children was important in ascertaining the work load, and level of understanding of the classroom aspects. All attending pupils were questioned on the level of the work undertaken – was it too easy, about right, or too difficult. Over 90% of the children claimed the work was about right, stating that although much of it sounded complicated, the methods were easy to carry out with well-explained instructions and help. Three participants thought the work was too easy, and none that it was too hard. Whilst this is a positive result, it is important to consider preparing some additional information for those pupils wishing to investigate the subject further.

Direct testing was also carried out at the end of the week in the form of a

tree identification quiz. A selection of trees was labelled, and the children were given the task of identifying them using the resources and techniques given to them previously. The results were encouraging, with many achieving full marks. Again, the children were questioned about this task, and the different keys available to them. The *KeyToNature* key, developed especially for the Tree School project, was a clear favourite with 23 of the 35 children choosing this as the most user-friendly resource.

5 OPPORTUNITIES AND CHALLENGES

There is a huge opportunity to develop further projects using the same template at the Old Malthouse. The school is a short distance from the Jurassic coast, affording opportunities to study geological formations and other geographic principals. Additional biological courses could also be offered, for example studies into the invertebrate communities of the site, associated with different habitats or plant species. Many of these ideas could be developed in conjunction with other departments within the NHM or could be provided by expertise available directly to the Cothill Trust.

Whilst the opportunity to develop the project at the Old Malthouse is an exciting and achievable prospect, the possibilities of extending the format on a wider scale, even internationally, is not straightforward. Whilst the concept is easily expanded, the varying requirements of different educational structures must be established fully before undertaking the work. This will involve working closely with the key educators to determine prior knowledge, as curriculum may vary greatly in different countries.

6 THE BIGGER SCIENTIFIC PICTURE

Whilst the Tree School project aims to provide scientific skills to children, and engage them in cutting-edge science, the project also is invaluable to current scientific research. Currently, an international consortium of scientists are working to build libraries of short, specimen-linked DNA sequences against which unknown specimens might be identified to the species level. This will only succeed as an identification tool for unknown specimens if a comprehensive library of DNA barcodes is first developed. All DNA sequences generated by the children will be entered into this database.

It is also thought that heavy sampling can improve the overall efficacy of a DNA barcode database, and will help to test the expectation of low intraspecific variation as compared to interspecific variation. If sampled intensively as part of this project, the British tree flora could serve as a test-bed for the effects of intensive specimen sampling on DNA barcode performance.

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