

COMMUNITY DIRECTIONS

Teaching Sustainability with Haptic and Ludic Methods

Peter Harper

Department of Natural Sciences, Department of Chemistry, University of Bath, Claverton Down, Bath, BA2 7AY, UK

Keywords: *Biodiversity; Haptic; Ludic; Sustainability*

Abstract

Sustainability themes are taught in classrooms using PowerPoint and Excel tools. This is essential, as it is fundamentally a quantitative topic: you must do the numbers.

However, students are only human and often find that too much data is too much. Other modalities are called for, and at the University of Bath we have experimented with hands-on (haptic) and gamified (ludic) approaches, usually out of the classroom. This engages other parts of the students' brains and bodies, puts things in perspective and helps them learn better.

Projects can be written up for assessment and usually contain a large quantitative component.

Introduction

Among the projects that have been tested within this framework are:

- Creating a shelter with natural materials collected from semi-natural woodland on the campus
- Exploring biodiversity in a variety of taxa using collecting tools and hand-lenses
- Tracing the flows of water through the campus from entry to exit points
- Creating a simulacrum of a UN COP session, with up to 80 countries represented
- Using a gamified calculator system to plan a national decarbonisation strategy
- Measuring biomass and rates of sequestration in a seminatural woodland
- Running a pantomime-style crown court trial in which a cow, representing the global livestock industry, is in the dock
- Experimenting with full-scale photovoltaic systems to find optimum outputs
- Using a giant floor map of Europe to explore existing and possible energy interconnectors
- Exploration of the University's energy system, including CHP, renewables and district heating.

These activities fit well into the rest of the course material and readily lend themselves to either formative or summative assessment.

Detail of Selected Exercises

Biodiversity

Typically, students split into groups focusing on specific types of organisms, usually plants, which lend themselves better to observation by beginners over a short space of time. We commonly use the following groups:

- Trees
- 'Forbs', i.e. non-grass angiosperms
- Fungi, lichens and algae
- Mosses and liverworts

All this takes place on the university campus (University of Bath). Some groups require the assistance of hand-lenses, which are provided (**Figure 1**).



Figure 1 A Student Demonstrating Correct Use of the x10 Hand-Lens

Groups count the number of distinct species they find of each type, and also time themselves doing this exercise. On this basis they are able to generate statistical and graphical results and test typical ecological generalisations such as Simpson's Index and area diversity.

There is sometimes a competitive element: 'Which group can identify the greatest number of species'? This is something the students can relate to, and it goes them along.

Low-Carbon Shelter

This exercise is conducted in a semi-natural woodland within the university campus.

The assessed task is a Lifecycle Analysis of the finished shelter, relative to a comparable, unserviced commercial building of the same floor area. The shelter includes natural, recycled and fully industrial materials. A further assessed task can be the preparation of various foods, again with an associated LCA. The illustration is from one of the student reports in 2024 (**Figure 2**).

Water flows on the campus

This entails tracing the flows of both potable and rainwater through the campus to various destinations. Because water is strongly conserved, it lends itself to representation by means of a Sankey Diagram (**Figure 3**). The students can also create 'tube' style maps of the main nodes and flows. They need to do a substantial amount of research and 'ground truthing' to follow the flows and obtain the quantities.

In many cases, quantities cannot be measured but must be calculated or inferred. These are all excellent tasks for assessment.

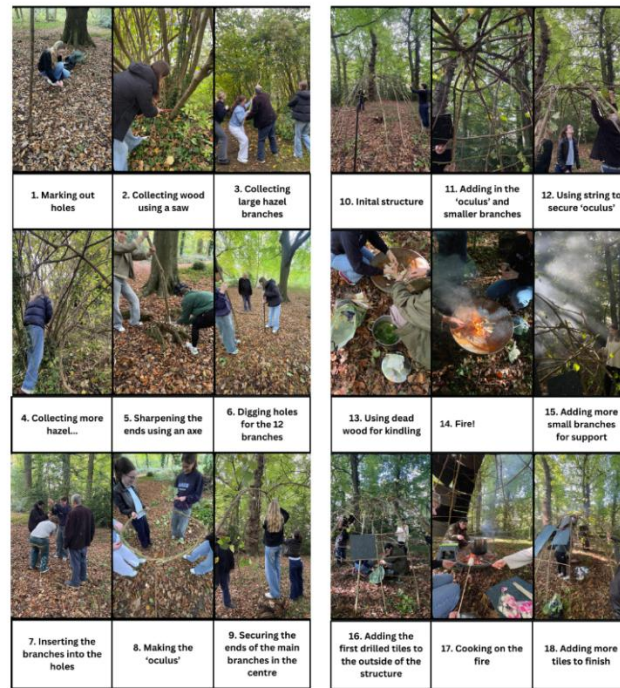


Figure 2 Photos taken a by a student in 2024

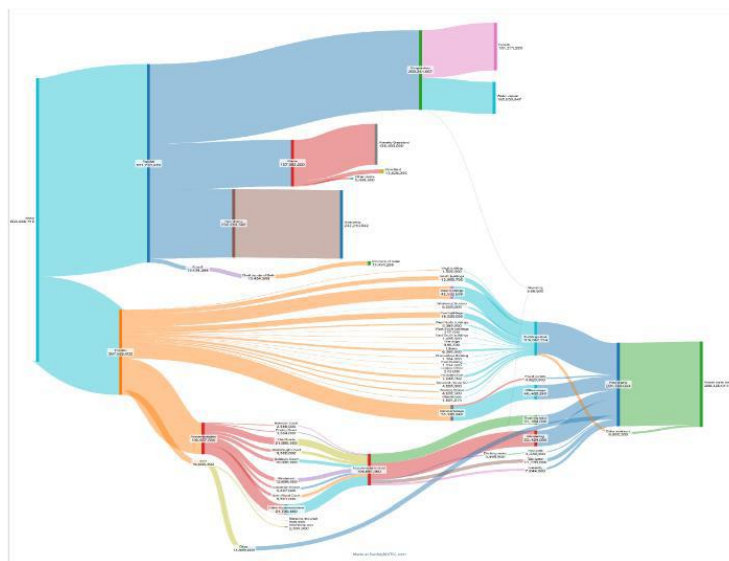


Figure 3 A Sankey Diagram showing flows of water through the University of Bath campus, .from one of the student reports

The students also get to notice certain features of the system, such as inspection covers. It strikes me as important that they understand that the theoretical flows are embodied in actual physical hardware and must work in the real world. All this is mostly physics, but it turns into chemistry and biology at the wastewater end of the process.

Exploring interconnectivity with a large floor-map

This exercise uses a large floor-map of Europe to model energy transitions, supply, and connectivity. Students are provided with a large supply of tokens representing various energy sources, and cabling to represent interconnectors as cables or pipelines. Students ‘adopt’ a single country or group of countries (Figure 4).



Figure 4 Students using the giant floor map to model potential transitions and interconnections

There are various ways it can be run. Typically, the class takes the official European target of net-zero by 2050, assesses the low-emission resources, and the need for imports and exports. Commonly, it is found that North Africa plays a significant role, and there is an increase in nuclear energy.

Usually, students can arrive at a plausible net-zero plan. Their reports concern the transition process: how to get there, and the interplay between the raw technology and likely political constraints. Students report their results to a tally-person operating a computer spreadsheet, and this generates a parallel display of accumulated energy inputs on screen, building towards the total expected demand in 2025.

Biomass studies on the campus

Students often wonder how much renewable energy could be supplied from the campus itself, and in other exercises they study the photovoltaic installations, and the potential of ambient heat. In this project they try to estimate the potential for a supply of biomass energy, making surveys of existing woodland and samples of cut trees from the woodland. The reports calculate information about the standing crop and rates of growth, and what the energy value might be given various kinds of conversion systems. Students might also be asked to compare the biodiversity value of living trees with their value as biomass energy (**Figure 5**).



Figure 5 Cut section of an oak log showing annual rings. This is one method of estimating the age of trees in the wood

'Gamified' Household Carbon Calculator

This exercise uses instant survey techniques, with students inputting data via their smart-phones, which they all have. The task is to work out the best balance of approaches to achieving the UK government target of net-zero emissions. Students 'vote' for various measures until the goal is reached. A typical result is that their initial assumptions, that lifestyle changes must be the cornerstone of decarbonisation, are not borne out.

This is a group activity for the class, but individual students can explore the calculator further, make different choices and generate different results, whereupon the implications can be discussed.

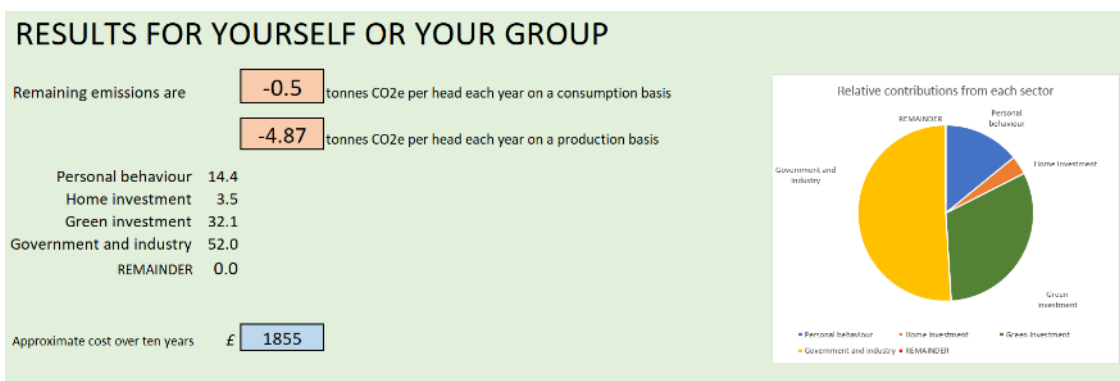


Figure 6 Sample page from the bespoke calculator. The pie-chart is interactive and responds to changes of choice

Pantomime Courtroom Drama

The exercise is aimed at exploring the place of livestock in agriculture, and potential impacts on climate change and biodiversity. There is a basic script, which all participants have. Students are invited to take particular parts and are provided with suitable costumes. Lecturers can also participate, and indeed many like to join in. Notably, the defendant is a pantomime cow, representing the global livestock industry, accused of 'crimes against the biosphere' (one German postgrad was the back end of the cow and has dined off it ever since). Otherwise, all the elements and characters of classic TV courtroom drama are observed, with an extra detail, that the audience are given prompts for heckling the court, for and against the defendant. It can get noisy.



Figure 7 The "Judge", Suitably Attired

A key feature is that the outcome is not known in advance. The audience itself is the jury. Typically, the pantomime is played out, then there is a class discussion for (say) 30 minutes, in lieu of a jury deliberation, a secret ballot is taken to determine the verdict, which is read out with due solemnity by the foreperson. If the defendant is found guilty, she is then sentenced, otherwise set free, usually with general rejoicing.

The report-back task is an assessment of the impact of livestock in various environmental dimensions,

implications for food, and suggestions for sustainable ways forward.



Figure 8 "Daisy the Cow" with cowherd, who speaks for her. She is ready marked with butcher's cuts