Green learning for HE
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Abstract
The overall aim of this project was to deliver inspirational environmental workshops to students from under-represented groups in regional HEIs. The objectives were to engage a wider range of undergraduates in STEM learning, to raise the profile of STEM on campuses and to provide professional development training to the STEM faculty and students attending or volunteering on the workshop. The workshops emphasised the need for a sustainable low carbon economy. Students examined how engineers have historically made a major contribution to modern industrial society. Undergraduate students and HE staff were encouraged to consider leading a reduced carbon lifestyle whilst also appreciating the need for creative, well-engineered ways of addressing climate change. The outcome of the project for the participants was a raised awareness of the way in which engineers are working to combat climate change and the experience of an enjoyable, fun and interactive workshop.

Keywords: sustainability, widening participation, outreach

Background
Bradley and Crowther (2004) argue that there is a need to raise awareness of sustainability issues throughout higher education and point to the Bradford model for teaching eco–design, giving examples and case studies of good practice (which involved giving the student a hands-on experience, with activities such as the disassembly task and the wheelie bin challenge).

It is the team’s experience that the subjects of climate change and global warming are issues that are relevant to all undergraduate students, but are only studied by a few in any practical way. In addition, students from non-technical subjects can be confused and unsure about the issues relating to climate change. This project sought to demystify some of the issues and make the information accessible to all. The initial rationale was to deliver the workshops to under-represented groups of students at HEIs; however, this proved not to be possible as the participants were selected by the HEI and tended to be from engineering departments.

The attitude of primary school pupils to learning about the environment and ecological issues is discussed in a study by Jenkins and Pell (2006) which indicates that both boys and girls agree that environmental issues are extremely important. However, there seems to be little incentive to study and learn about them, with responses from both sexes listing various ecological and environmental issues among the ten least popular science topics. This would suggest that there is a need to develop pedagogic practices which are innovative and exciting in order to engage pupils in the study of eco-diversity.

The London Engineering Project was established and funded by The Royal Academy of Engineering between 2005 and 2009. Working with universities and schools throughout London, the project explored a number of ways in which under-represented groups could be reached through carefully crafted interactions with STEM ambassadors who, as role models, used innovative and fun activities to engage school pupils from diverse backgrounds.
**Rationale**

The School of Engineering Design & Technology (EDT) at the University of Bradford has a track record of working in the area of widening participation. This work has involved running summer schools, workshops and various activities with the aim of raising aspirations and inspiring students who would not normally consider studying STEM subjects. The school has been active in seeking to address the gender imbalance within engineering by the work of Females Actively Involved in Rewarding Engineering Roles (FAIRER) and has worked extensively with the UK Resource Centre for Women in Science, Engineering and Technology to develop strategies for promoting females within the engineering profession. From this background, the School of EDT wanted to explore the impact that could be achieved by running hands-on eco-workshops at HEIs throughout the UK.

The project was developed from a similar workshop that has been delivered extensively throughout the UK and EU. The team’s experience of working in multi-discipline environments has enabled the project to be delivered in a way that is suitable for undergraduate students of any discipline. The approach to learning is a hands-on workshop interspersed with short talks and DVD clips, ideally delivered to around 30 student participants. The workshop is particularly suitable for students from non-scientific backgrounds who will have the opportunity to experience a scientific, yet fun and approachable interactive project. The intended outcomes and benefits are as follows:

For student participants:
- A clear insight into climate change and possible solutions
- An understanding of the work that scientists and engineers are currently undertaking to combat climate change.

For participating academic staff:
- Professional development training in the area of low carbon engineering
- Raising the profile of STEM on campus.

**Purpose and goals**

The key goal was for the University of Bradford team to share its expertise in running eco-workshops. The team had previously been approached by other HEIs to run such workshops and the National HE STEM Programme funding enabled this to take place.

The purpose was to deliver fun, hands-on workshops that were informative and helped to break down barriers to engagement with STEM using an environmental theme. The key outputs from the project were:
- Positive student feedback
- Requests for repeat workshops to be delivered
- Requests for the workshop to be delivered overseas
- TV and press coverage
- HEI staff trained in how to run the eco-workshops
- Training materials supplied to HEI staff
- “Train the trainer” concept (trainee school teachers shown how to deliver workshops).

**Concept**

The concept for the workshops was based on a series of workshops, run by the School of EDT at the University of Bradford, that were originally designed for school pupils in years 10 to 12. These workshops proved to be extremely popular and were further developed for use in HEIs.

**Assumptions and context**

The assumption was that the programme would be delivered over one day. Equipment and materials were provided by the project team and included the following:
Heating appliances
Glassware (beakers)
Chemicals (methanol and KOH)
Used cooking oil
Potatoes (bio-plastic)
Pans/spoons
Safety gloves/goggles
Pipettes
Colour dye and fragrances.

The approach

The workshop programme is shown in Annex A. The production of bio-diesel and soap rely on a chemical reaction called \textit{trans-esterification}. Normally, straight vegetable oil is too viscous to be used in a modern diesel engine, but trans-esterification transforms the oil to make it thinner. The chemical reaction is: \textit{Triglycerides + methanol = methyl esters + glycerol}. Either potassium hydroxide (KOH) or sodium hydroxide (NaOH) is used as a catalyst. You need to perform a titration in order to find out how much catalyst is required. Add a few drops of indicator to 10ml of isopropyl alcohol in a beaker, now add 0.5ml of KOH to the solution. Continue adding the KOH, 0.5ml at a time, until the red colour persists after stirring. The isopropyl alcohol is now pH neutral. Add 1ml of the waste oil to the solution and stir. The red colour will disappear as the oil has made the solution acidic. Continue adding KOH, 0.5ml at a time, until the red colour persists. Record how much KOH you put into the solution. The volume (ml) of KOH it takes to neutralise 1ml of oil equates to the number of grams of KOH it takes to neutralise 1 litre. Mix 50ml of methanol with 2 grams of KOH and stir. Add this “methoxide” to 250 ml of oil, heat to around 40°C and stir for 10 minutes. Leave the mixture to settle overnight and then separate the biodiesel from the glycerol.

Briefing notes, PowerPoint slides and a list of equipment required can be obtained from the School of EDT at the University of Bradford.

Guide to running the eco-workshop

1. Introduction and welcome, overview of the day (ppt 1)
2. Introduction to the team and commence programme, using \textit{Introduction to the Future of Fuel} to explain peak oil
3. Following instructions contained in presentation, make batches of bio-diesel from used cooking oil (optional teaching on titration if time permits)
4. Break (approximately 10 minutes)
5. Use \textit{Clean up Your Act} (ppt 3) to explain the story of soap
6. Make soap, following instructions in the ppt
7. Break for lunch (30 minutes – 1 hour)
8. Introduction to bio-plastic, using \textit{Turn Potatoes into Plastic} (ppt 4) to explain how to make bio-plastic
9. Extract starch from potatoes to make bio-plastic (as per ppt 4)
10. End workshop with discussion or optional eco-quiz.

Assessment

In total, six workshops were delivered to HEIs throughout the UK. All of the workshops proved to be highly successful in different ways. The team recognised that they were on a journey of experience and each workshop presented them with the opportunity to receive verbal feedback from the participants regarding what was successful and what could have been improved upon. Approximately 190 students and staff participated in the project. The gender ratio of female to male was much higher than one would normally expect (around 45% of participants were female). The
majority of participants had a keen interest in STEM and sustainability issues prior to attending the workshop.

The key learning outcome for the team was to note that flexibility in approach and delivery is essential. Specifically, the team were prepared to work with groups who were simply happy to receive the teaching and take part in the hands-on activities. On the other hand, the style adopted at some of the HEIs favoured discussion and debate. Anyone wishing to run this project in the future should be prepared to accommodate both styles.

**Evaluation**

A copy of the evaluation questionnaire given to participants at the end of the workshops is given in Annex B. The results of the questionnaire analysis indicate that participants found the workshops enjoyable, useful, interesting and well-organised.

In total, six workshops were delivered and 190 students participated in the project. The feedback from the questionnaires indicates that all students either agreed or strongly agreed that the activity was worthwhile and that as a result of participating in it they were more aware of environmental issues and would try to live a greener lifestyle. No-one indicated that they did not enjoy the workshop or that it was not interesting. Comments from the participating students include:

- ‘I will take more consideration over my throw-away view and consider recycling.’
- ‘I now understand that as an individual I can help with making our world green. I will try my hardest to GO GREEN.’
- ‘I was aware of the issues raised, but the importance of these issues were [sic] highlighted for me.’
- ‘I am certainly interested in using bio-diesel in my own car for both cost issues and green credentials.’
- ‘I made bio-fuel and bio-plastic and it was very informative.’

One of the unforeseen benefits of running the workshop with trainee schoolteachers was that there is potential for them to use the training in schools when they qualify. A further benefit was the possibility of linking up with academics from other HEIs with the goal of future collaboration.

**Discussion, summary**

Overall, the project was a great success and the students enjoyed both the theoretical part and the hands-on activities. The team’s experience is that students like the combination of teaching and practical work. HEI staff benefited from the learning experience and had the opportunity to develop skills in running hands-on eco-projects.

**What is the legacy that has been left?**

Staff at HEIs have been trained and have experienced the interactive teaching approach that is very much a part of the eco-workshop. In total, seven HEI staff were trained and provided with PowerPoint presentations and training material and the offer of help to run the projects themselves. Students undertaking teacher training expressed interest in delivering the workshop in schools when they qualify.

**What would we do differently?**

It would have been helpful if we could have had a clearer understanding of the type of students we would be engaging with prior to the workshops so that we could tailor the material accordingly. It proved very difficult to target the widening participating and under-represented groups. A more creative approach to engaging with this target group is required.

From our experience it is very difficult to ensure that you engage with your target group if you are not working on campus and are unable to promote the workshop yourself. We would suggest that
students be selected through student unions or by the many interest groups that are to be found on campus.

**Was the approach successful?**

Our approach of being flexible and able to accommodate students from different disciplines, including non-scientific subjects, worked extremely well; however, our aim to target students from under-represented groups was not successful. Students at the HEIs were self-selecting and tended to come from engineering and science backgrounds. It is difficult to find a way around this issue due to the lack of control we had in recruiting students to attend the workshops. Students were recruited to participate in the workshops by HEI staff and by volunteer workers for Engineers Without Borders (EWB) who were based at the hosting HEI.

**Has the process enhanced professional practice in your area?**

Following their success at HEI level, the workshops have now become part of the level 4 undergraduate training for engineering students at the University of Bradford. Staff have expressed an interest in running the workshops within their respective HEIs.

**Further development**

**Developing the work**

The Bradford team is continuously upgrading the workshop to include new teaching material and is currently working on new projects that include the following:

- Heat pump design
- Build your own solar panel
- Design your own sustainable house
- Design your own composting toilet
- Building a combined heat and power stove.

**Sustaining the project**

As described above, the project will continue to run at the University of Bradford. The team is also available to run workshops at other HEIs on request.

**References**


**Further reading/bibliography**

