

Problem-Based Learning: A Case Study of Sustainability Education

A toolkit for university educators



Sophie Bessant, Patrick Bailey, Zoe Robinson, C. Bland Tomkinson,
Rosemary Tomkinson, R. Mark Ormerod and Rob Boast



Foreword

Surely one of the best ways of starting to understand the complexity of sustainability is to actually tackle a genuine problem, and to tease out the various factors and issues that are associated with potential 'answers'? Of course, one of the first lessons to be learnt is that only rarely is there a single 'right' answer, and 'solutions' almost always come with strings attached. These complex scenarios with no 'right' answer are often called 'wicked problems', and the process of learning about the issues through studying the scenario and trying to answer key questions about it is called 'problem-based learning' (PBL). This toolkit is designed to provide some helpful advice, scenarios and observations about using PBL to teach students about sustainability, with a particular emphasis on how to scale up PBL without it becoming prohibitively expensive. It has been compiled by colleagues from Keele, Manchester and Staffordshire Universities, who have been jointly running a three year HEA-funded project to explore how to increase the numbers of students studying a module in sustainability, at

levels ranging from 1st year at University through to postgraduates. Ensuring that all of our graduates have an awareness of issues concerning the environment and sustainability is a crucial remit for our universities. The time available to us to make these solutions work is not limitless. If we can't equip this generation of young people with the skills, then we may well pay a very heavy price. But if we can, the benefits will be enormous.



Jonathon Porritt MBE
Founder of *Forum for the Future*
Chancellor of Keele University

Background and Introduction to the Project and Toolkit

This toolkit is one outcome of a three-year project entitled: *'Hybrid problem-based learning: a scalable approach to sustainability education?'*, funded by the Higher Education Academy's National Teaching Fellowship Scheme and is a collaboration between Keele University, the University of Manchester and Staffordshire University. The project aimed to explore effective ways of adapting traditional problem-based learning approaches for the delivery of transformative sustainability education to large student numbers.

Sustainability is a major and expanding issue for higher education and many institutions are attempting, in different ways, to embed the principles and practice of sustainability within their operations. It is highly desirable that as many graduates and postgraduates as possible should be 'sustainability literate' when they leave higher education, having had the opportunity whilst at university to explore sustainability issues within their own lives, their chosen disciplines and their future professions. One way of enabling this is having greater numbers of students undertaking sustainability-focussed modules and projects.

Problem-Based Learning (PBL) approaches are highly effective at enabling deep and transformative student learning and have been considered an ideal approach for tackling the complex, multidisciplinary, 'wicked' problems of sustainability, and for providing genuine opportunities for students to tackle real-life sustainability issues within their immediate environment. Traditional PBL approaches can be, however, very resource and time intensive, and often require one facilitator (a member of staff) for every group of 8 - 12 students. Embedding and extending sustainability literacy within curricula through PBL thus presents considerable practical challenges, particularly at a time of competing pressures on staff time and resource.

Through this project we have adapted traditional PBL methods to enable a mode of PBL that is suitable for the delivery of sustainability

education, that is less resource intensive and that has the potential to be scaled-up to large cohorts of students. The three universities involved developed different sustainability-focused modules aimed at different academic levels. Students were involved in the development of our pedagogical approaches during the project via detailed evaluation and feedback, which informed the planning of the modules year-on-year. The different approaches taken at the three universities allowed us to assess the influence of: student year of study; multidisciplinary and multicultural teams; group size; level and method of group facilitation; and also (crucially) the feasibility of scaling up the hybrid PBL approach to much larger numbers of students.

This toolkit provides illustrative examples of the key aspects of three years of work in the three universities and is aimed at educators wishing to learn more about any one of the following areas:

- traditional and hybrid problem-based learning;
- delivering less resource intensive PBL;
- the use of online learning technologies/social media in group-based teaching and learning;
- education for sustainable development; and,
- managing student group working dynamics.

An accompanying list of relevant information sources, under specific topic headings, can be found at the end of the toolkit, along with the appendices which contain useful pedagogical examples.



Contents

1. Why use Problem-Based Learning for Sustainability Education?	1
2. Comparing Approaches to Problem-Based Learning	2
2.1 How does traditional PBL work?	
2.2 The role of PBL facilitators	
2.3 What is hybrid PBL?	
2.4 How can PBL be adapted to be less resource intensive?	
2.5 How can PBL be adapted for sustainability education?	
3. The Educational Benefits of Problem-Based Learning	6
3.1 End-of-module questionnaire and focus group findings	
3.2 Student testimonials	
4. Designing Hybrid PBL Teaching Modules for Sustainability Education	9
4.1 Considerations for hybrid PBL module design	
4.2 Summary of modules, key module statistics and example PBL scenarios	
5. The Challenges of Problem-Based Learning	10
6. Enabling Effective Student Group Working in Problem-Based Learning Environments	11
6.1 Deciding on group size	
6.2 Who chooses the groups?	
6.3 Instructions, induction and ground rules	
6.4 Assigning roles and responsibilities	
6.5 Dealing with disciplinary and cultural differences within student groups	
6.6 Peer assessment in PBL	
7. The Role of Information Technology and Social Media in Hybrid Problem-Based Learning	14
7.1 Virtual delivery of module content: PowerPoints, podcasts & screencasts	
7.2 Virtual PBL groups: online student communication and collaboration	
7.3 Virtual PBL facilitation	
7.4 End-of-module questionnaire, focus group findings and student testimonials	
7.5 Technology for assessment	
Conclusions	19
Appendices	21
Useful Information Sources	32

1. Why use Problem-Based Learning for Sustainability Education?



“Education is not widely regarded as a problem, although the lack of it is... The truth is that without significant precautions, education can equip people merely to be more effective vandals of the earth. If one listens carefully, it may even be possible to hear the Creation groan every year in late May when another batch of smart, degree-holding, but ecologically illiterate, Homo sapiens who are eager to succeed are launched into the biosphere.”
(David Orr, 1994, pg. 5)

Education for Sustainable Development (ESD) is concerned with developing and fostering educational practices (both formal and informal) which support more sustainable futures for all. ESD has been described as:

“...a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the earth’s natural resources. ESD applies transdisciplinary educational methods and approaches to develop an ethic for lifelong learning; fosters respect for human needs that are compatible with sustainable use of natural resources and the needs of the planet; and nurtures a sense of global solidarity.” (UNDESD, 2005, pg. 1)

The aim of transformative sustainability education is to generate shifts in the perspectives, values and attitudes of learners, and to create action-orientated, sustainability-literate ‘change agents’ who are empowered to live and work in ways which make a positive impact on the world around them. At the higher and further education level sustainability education takes many forms, from attempting to embed sustainability holistically across entire institutional curricula, to discipline-specific embedding of sustainability, to individual sustainability-focused degrees and modules. There are also many informal learning environments including societies and volunteering groups within the university setting which bring students together and can enhance student sustainability activity and activism.

Many educators believe that the ideal pedagogies for the development of sustainability literacy are those which enable students to develop practical problem-solving skills in real-life sustainability contexts – pedagogies which are student-centred, active, experiential, collaborative, contextual, skills-focused and problem-based. The collaborative and experiential learning processes involved in PBL, and the real-world scenarios explored, are ideal for building such sustainability competencies and skills. Students are able to search for problem solutions and develop new skills through a holistic systems approach to sustainable development.

2. Comparing Approaches to Problem-Based Learning

2.1 How does traditional PBL work?

Problem-based learning (PBL) is a collaborative and participatory student centred approach to teaching and learning, based on group work and problem exploration. PBL may be described as a socially constructed pedagogy as all participants are collectively involved in a shared process of constructing knowledge. PBL originates from medical education and specifically from McMaster University in Ontario, Canada, where it was pioneered in the 1960s. When we talk about ‘traditional’ problem-based learning, most people think of the medical education model. The traditional PBL approach is outlined in Table 2a.

<i>Traditional Problem-Based Learning: the Medical Education Model (Table 2a)</i>	
<i>Module set-up</i>	Cohort size can range from a few dozen to several hundred students, divided into teams of 8 – 12. Each team is assigned its own trained team-work facilitator. Throughout a module PBL groups are introduced to a series of hypothetical ‘problems’ or ‘scenarios’ based around different ‘real-life’ topic areas. The problems introduce the topics using narrative but without giving detailed information. Problems are focused on students learning content knowledge and forming diagnostic skills. Scenarios usually last one or two weeks with varying amounts of class sessions per week usually in 1 or 2 hour blocks.
<i>Initial class sessions</i>	PBL groups meet with their facilitator either in a large classroom with other groups present or in private study rooms. PBL groups work with the facilitator and each other to explore the problems. Students are encouraged to exchange ideas, feelings and knowledge and to reflect on their own experiences. The process is chaired by one member of the group and notes are taken by a scribe. After being given the problem, groups work through the following process: <ul style="list-style-type: none"> • Highlight and clarify unfamiliar terms and concepts • Define the nature of the problems and issues for exploration • Analyse and brainstorm the problems, possible solutions, explanations & actions • Formulate specific learning objectives and questions for further research; students themselves decide what the most important aspects of a topic to research are – this is a key feature of PBL.
<i>In-between sessions</i>	Students engage in self-directed learning based on the agreed learning objectives. Groups may also meet outside of class to work together.
<i>At following sessions</i>	Students share the results of private study, cite resources and discuss findings and ideas by going through the agreed learning objectives. The group sharing process should cover the necessary breadth of background knowledge for a particular topic.
<i>Assessment</i>	Medical education PBL has traditionally been assessed by Objective Structured Clinical Examinations (OSCEs) and Modified Essay Questions (MEQs). This means that it is important that all students in a cohort learn all of the information which they may be examined on.

2.2 The role of PBL facilitators

In PBL, module tutors become the ‘facilitators’ and monitors of group learning rather than simply ‘delivering’ module content. Students are guided towards learning outcomes through scaffolded and structured projects with prompts from facilitators. Facilitators also aid students in the formulation of learning objectives. PBL facilitators are often members of academic teaching staff, but may also be academic researchers, postgraduate students, or various other trained individuals, but are not necessarily discipline experts.

The job of the facilitator is to:

- Facilitate the group process and the PBL learning environment
- Monitor, evaluate and guide student discussions
- Have background information about the topic in question and ‘drip-feed’ this information as the need is identified by the group (without giving definitive answers)
- Steer students towards certain ideas if key data is being missed out
- Intervene if students are not working or if discussions become too tangential
- Help students to formulate relevant learning objectives for further research (if help is required)
- Ensure that classes run according to agreed timetables and monitor the attendance of students

Facilitators should complete some form of PBL induction/training programme before commencing work with students. Module leaders may hold evaluation sessions with facilitators during and after PBL modules to assess the on-going effectiveness of the PBL process.



2.3 What is hybrid PBL?

We use the term ‘hybrid PBL’ to describe pedagogies based on the principles of traditional PBL that have been adapted in some way. Adaptations can take many forms but usually involve either blended learning approaches (combining face-to-face and online technologies in teaching), or alternating, within a module, between lectures and PBL. During this project we adapted PBL in several ways, aiming to develop a mode of PBL delivery that is: 1) suitable for and serves the aims of sustainability education, and is 2) more flexible than traditional PBL, less intensive in staff time and resources, and thus more feasible for use with larger student cohorts and fewer members of staff.

2.4 How can PBL be adapted to be less resource intensive?

Our approach has been to use a variety of online learning technologies, social media tools and different class-based teaching and learning methods. Table 2b describes the main adaptations to PBL used during this project. Different approaches were trialled by the three universities.

Although we were able during this project to successfully utilize a less resource intensive mode of PBL (i.e. fewer members of staff facilitating larger numbers of student groups) we were not able to test these pedagogies with cohorts of more than 45 students due to the numbers recruited on to the modules. The next phase of our research will involve utilizing our resource-low hybrid PBL approach with cohorts of around 100 students.

**Hybrid Problem-Based Learning:
Methods for more Resource Efficient Delivery (Table 2b)**

Similarities to traditional PBL	<ul style="list-style-type: none"> • Student-centred and student-driven group learning • Students define learning questions and learning objectives • Students share ideas, experiences and knowledge to address problems
Differences to traditional PBL and details of the 'hybrid' adaptations trialled during this project	Fewer face-to-face timetabled module hours – for example, having 1 hour weekly sessions rather than the typical 2 hours or more per week.
	Fewer facilitators per module – for example, having one facilitator manage multiple PBL groups. At one university we had one facilitator for seven PBL groups.
	Less face-to-face facilitator input with individual groups – two of the universities delivered face-to-face group facilitation during class sessions in short time slots with each group; for example, 5 -10mins per group per week rather than one facilitator spending several hours per week with one group.
	Range of group sizes – there were from 4 to 9 students per group.
	A mixture of approaches in class – class sessions involved a mix of learning approaches, including: traditional PBL problem exploration and project work; individual group and whole class discussions and debates; mini-lectures lasting <i>ca.</i> 20 minutes within an hour session; outside speakers/presentations; videos; student presentations; and support with assessment formats.
	Online learning materials – one university delivered content-based learning materials online before class via podcasts and PowerPoint slides to ensure a certain breadth of background content was covered by students.
	Group working guidance and support materials – were provided in class via group working exercises and online via videos to support student group working.
	Virtual student communication – students were asked to set up a virtual PBL group working environment in which to carry out their PBL work, to communicate, plan and share research, ideas and information. Students used varying online learning technologies and social networking sites for their virtual PBL and online communication, e.g. the university Virtual Learning Environment (VLE), email, Facebook [®] and Skype [®] .
	Virtual student collaboration – students were tasked with producing collaborative pieces of coursework together online using tools such as wikis, discussion boards and file sharing.
Online facilitation – as the majority of group work was conducted outside of the scheduled contact hour(s) facilitated guidance from module tutors was provided to groups online through VLE discussion boards, email and Facebook groups.	

2.5 How can PBL be adapted for sustainability education?

The main aim of using PBL for sustainability education is for students to investigate real life sustainability problems – which are inherently ‘wicked’, open ended and without a simple solution. Through this process, students develop a greater understanding of the multifaceted nature of sustainability issues and develop interdisciplinary sustainability skills, as well as a range of professional competencies. This range of skills includes, but is not limited to: effective communication; ethical awareness; global citizenship; discussion and negotiation; listening and respecting others; team working; self- and group-reflection; inter-cultural understanding; systems thinking; creative thinking and stakeholder engagement. The modules and scenarios used in this project were designed to be practical, relevant and transferable to real-life situations, giving students the chance to think holistically and critically. The three universities took different approaches to module design and delivery, but there were overarching themes/methods across the three:

- **The design of PBL scenarios** – were as far as possible: based on real-life sustainability projects, case studies and scenarios; considered sustainability from different angles, i.e. environmental, social, economic and political; and considered different international and cultural perspectives. The topics were more open-ended than in traditional PBL with less built-in scaffolding. The focus of the scenarios was to work collaboratively to build creative and innovative approaches to tackling sustainability problems, thereby generating new sustainability ‘knowledge’ in the process.
- **The role of the facilitator** – was to stimulate ideas and creativity rather than ‘steer’ students towards specific learning objectives. The facilitators did have to provide (to varying extents) guidance and ideas about the key areas that students should be researching for each scenario and roughly where projects should be heading in terms of their outputs. However they tried not to

constrain group creativity, and students were largely free to follow their own research interests and the aspects of problems they thought were important (within guidelines).

- **PBL assessments** – were designed to be as authentic as possible, i.e. reflecting the real world and flowing naturally from the problem scenarios. We aimed to challenge students through creative and innovative approaches to assessment. At two of the universities the main module assessment involved students working on real-life campus sustainability projects in groups. Many groups contacted and spoke to real stakeholders from within the universities to complete this task, such as environmental managers, estates staff and academics, as well as professionals from other external organisations. One assessment method involved making a video based on the group’s specific sustainability projects which students then presented to senior university managers and environmental staff.

All three universities used reflective diary assessments, which students were asked to complete weekly as the modules progressed. Other assessments across the universities included: poster presentations; leaflet design; designing an educational wiki; report writing; designing a newspaper article; a workbook of sustainability tasks and questions; an intervention action plan; and presentations.

- **PBL groups** – were as far as possible set up to be interdisciplinary and intercultural, akin to real-life working situations, to aid in the exploration of complex sustainability problems.



3. The Educational Benefits of Problem-Based Learning

Traditional and hybrid problem-based learning can be very effective approaches for the exploration and development of sustainability literacy, as well as for developing a wide range of learning and professional skills. PBL can deliver a variety of educational benefits and develop a whole host of transferable graduate skills owing to the collaborative and active nature of the learning involved.

<i>The Educational Benefits of (Hybrid) PBL: and Graduate Skills Developed (Table 3)</i>	
<i>Increased ownership of learning, becoming active learners and learning HOW to learn</i>	Students themselves decide what the most important aspects of a topic are to research, they define their own research objectives and they collaboratively decide how they will divide, plan and manage their research. Through engaging in self-directed learning, students develop a more active approach to seeking information and learn how to find the information they need, i.e. learning how to learn.
<i>A deeper level of learning through group discussion</i>	During group discussions a variety of viewpoints and experiences emerge which expand students' views on particular topics. Arguing around a subject and explaining things to others reinforces the learning of all members and learning to listen to the ideas of others is an essential skill. Individuals with particular disciplinary backgrounds can act as 'consultants' for their areas as well as collaborating in developing new knowledge.
<i>Team working</i>	The design of the course should ensure that students gain experience of many key team working skills, including: <ul style="list-style-type: none"> • contributing ideas, listening and accepting alternative perspectives; • developing and writing logical and sequenced arguments, emphasising the positive aspects of an argument, and handling objections to an argument; • being sensitive to others values and feelings; • communicating in a group, honing interpersonal skills, and relating to peers; • diplomacy and conflict management; • project management, prioritizing tasks, and sharing responsibilities; • leadership, organising and motivating others, and taking initiative.
<i>Transferability of skills and knowledge</i>	Focusing on real-world case studies, practical issues and actual experiences, and having to weigh up and consider many options during problem exploration should enhance the transferability of knowledge and skills acquired.
<i>Confidence and presentation skills</i>	During PBL sessions students discuss issues and put their ideas across to their group. Groups and individuals may also present their ideas to the whole class. The whole PBL process is very interactive and discursive. The course is thus designed to fuel the development of ideas and enhances the confidence of students in expressing their views and presenting to their peers.

<i>Interacting and communicating with professionals</i>	Many groups seek information from relevant professionals to inform their research tasks. Students interview, email and speak on the telephone to people from within the universities and from external organisations. These exercises are invaluable for increasing students' confidence in interacting with professionals and gaining insight into different professions.
<i>Thinking critically, innovatively and creatively</i>	During the PBL classes students are encouraged to think critically and devise original ideas and potential solutions to problems.
<i>Making friends</i>	We saw evidence of PBL groups at all three universities building environments of trust, support and friendship. However this did vary from group to group and some groups were more functional than others.

3.1. End-of-module questionnaire and focus group findings

Results from the end-of-module questionnaires and the focus groups used in academic years 2011/12 and 2012/13 provide positive evidence that students were practicing and developing many of the skills detailed in Table 3 as a result of the modules, as well as a range of sustainability skills.

- An average of 94% of students across the three universities said that their skills for 'working in a team on a group task' had either 'improved' or 'improved greatly'.
- 75% of students said that their skills for 'listening to others opinions and respecting people's differences during group work' and 'communicating your point of view to a wider audience' had 'improved/improved greatly'.
- When asked: 'Do you feel that you have gained any skills as a result of this module that will improve your chances of getting a job or enhance your performance at work, now or in the future?' – 78% of students said yes.
- 80% of students said they enjoyed working in a group; 77% said that their group worked well together.
- At Keele, where the module was focused around practical 'greening' issues, students on the module in 2012/13 said that they participated in the following activities more often as a result of the module: 69% recycling; 59% saving energy at home; 49% employing green practices when shopping, e.g. buying organic, Fairtrade, locally sourced food/products; 38% travelling by public transport/biking/walking rather than driving.
- Interestingly, only 64% of students across the three universities said that their attitude towards sustainability/environmental issues had changed 'a lot' or 'a great deal'. It was felt that a possible reason for this lower percentage was the prior high level of sustainability awareness of the students opting to take these sustainability-focused modules.



3.2 Student testimonials

A range of student responses from the questionnaires and focus groups across the three universities in 2011/12 and 2012/13 are shown below:

“One of my biggest fears is that you go through the education system and you learn information but you never put it into a context of business. I wasn’t interested in sustainability at all before starting this module and suddenly, now I love it. I can see myself going into a company and being able to put all my skills into practice and implementing sustainability within that business.”

“This module is more practical and so, more useful than other modules. Sitting in lectures you forget the information and only a few points stick in your mind. In this course we faced real problems, when you solve a problem you never forget how you solved the problem.”

“Our group contained a good mixture of people with different backgrounds, skills and knowledge. This created a good platform for discussion and allowed us to delegate tasks during the project that people were best able to do. I’ve really enjoyed seeing people from different backgrounds come together to form ideas about improving sustainability and interacting with people from other courses.”

“Working in a group allowed me to improve my social skills, such as getting my ideas across and listening to others. This module has pushed me to become more confident and improved my social skills.”

“It was nice to be treated like an academic even though it’s an undergraduate degree. When we met Mr X the environmental manager to talk about the energy issues it was a really professional meeting and the topics we discussed were nicely in depth; really technical. In some modules it’s still like school. It’s nice to be in a work based environment.”

“I have learned that working as a team: generates a wide range of possible alternative points of views through brainstorming; allocates responsibilities; helps develop a time-line; and most importantly, motivates us.”

“I didn’t believe as an individual I could make a difference but now I know that I can.”

4. Designing Hybrid PBL Teaching Modules for Sustainability Education

4.1 Considerations for hybrid PBL module design

The following set of questions will be helpful to consider if you are thinking about setting up a hybrid problem-based learning module:



- What knowledge, ideas, skills and competencies do you want students to develop through the module?
- How many PBL scenarios will each group complete during the module?
- Will each PBL scenario cover a different thematic/topic area or will each scenario cover a range of interweaved topic areas?
- Will PBL scenarios be weekly, fortnightly, or just one or two per module?
- Will all groups do the same PBL scenarios or will different groups explore different aspects of the module?
- If each group carries out a different scenario, how will you stimulate shared learning between groups?
- Will you use different learning approaches alongside PBL, for example, lectures, online learning materials, class discussions, student presentations?
- What are your learning objectives for the module and how might you assess these?
- Will there be individual as well as group assessments?
- Do you need facilitators? Who? How do you obtain and train them?
- Do you need to design an induction to PBL for students?
- How will you use e-learning as part of your approach? Do you have the necessary technical expertise?

4.2 Summary of modules, key module statistics and example PBL scenarios

Appendix 1 – displays a summary of the modules developed at Keele, Manchester and Staffordshire universities during this project, including key statistics from the modules.

Appendix 2 – contains example PBL scenarios investigated by students during this project covering a range of sustainability ‘problems’.



5. The Challenges of Problem-Based Learning

There are certain issues which can present themselves during problem-based learning as a result of the group working and student-led emphasis. Many of these issues are similar to those found in other forms of small group teaching and many have been experienced in one form or another during this project. For example:

- **Group members failing to turn up.** This alters group dynamics and hinders progression with group work.
- **Lack of preparation** – by some students before a group meeting; again this slows the pace of group work and can lead to frustration.
- **Dominating students** – within a group environment can put others off and be intimidating.
- **Passenger students or ‘free riders’** – may simply ride on the work of others and contribute little to group tasks.
- **Conflicts within groups** – may arise, especially when group assessment is involved and one or more people have not pulled their weight.
- **Facilitators fail to manage group problems** – by allowing domineers, conflicts or free-riders. This can lead to frustration and breakdown of group spirit.
- **A new way of working can lead to groups having difficulty getting started.** Groups need to become comfortable with each other and the new mode of learning.

“I didn’t get along with the group I was in and felt bullied by certain members.”

“Sometimes I faced difficulties working with the students who did not have any background in humanitarian aid or development studies.”

- **Disciplinary and cultural differences** – can cause problems when groups experience communication problems, conflicts between differing learning styles and negative attitudes towards working with people who may have different backgrounds and expectations.
- **PBL training for facilitators and students** – is essential, but of course has resource, time and cost implications.
- **Issues of module content coverage.** This relates to the topics being explored by PBL groups and can be a worry for students and staff, especially if different groups cover different topics.
- **Some students find group work stressful and daunting** – and may not be confident in a group situation.

“Unfortunately some members of the group were less cooperative and this made the experience less enjoyable, mainly due to having to chase them up about work and not attending meetings.”

“My group worked well although we had one group member who didn't show up he was like a ghost group member.”

With forethought and planning, most of these challenges can be avoided or overcome. The next two sections deal with how we planned for and tackled some of these issues during group work.

6. Enabling Effective Student Group Working in Problem-Based Learning Environments

“A team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable.”
(Katzenbach and Smith, 2005, pg. 2)

There are many ways of seeking to ensure functional and productive group working during PBL. This section covers some considerations, ideas and tips for setting up PBL and supporting students through this new way of learning.

6.1 Deciding on group size

The optimum group size for PBL-style learning will depend on several factors and will vary from one institution, one subject and one cohort to the next. In traditional PBL, group size usually ranges from 8 – 12. Some important considerations for deciding on group size during this project included: the level of group facilitation/support to be given to individual groups, and the year group of students.

- **Level of group facilitation.** At Manchester University the PBL approach taken was more traditional, whereby each group had its own assigned facilitator and received weekly facilitation in 2 hour sessions. In this more traditional PBL set-up large group numbers (up to about 8) worked well. At Keele and Staffordshire the groups received less face-to-face facilitation time and more online support. Facilitation during the 1 hour weekly sessions was split between the groups in 5 - 10 minute time slots. It was felt that, with reduced face-to-face contact time, smaller groups would be more manageable in terms

of group dynamics, potential group problems, and would provide less potential for ‘free riders’. The group sizes which worked best and were preferred by students at Keele and Staffordshire were between 4 and 6 members. It is worth pointing out that some students felt that groups of 3 were too small. Indeed, if groups are too small there can be less creative interactivity and greater difficulties if any members are absent.

- **Year Group of Students.** Our project suggests that the year of study of student groups also plays a role in how well groups work together, and this impacted on the most manageable and appropriate size for groups. The postgraduate students on the Manchester module worked very effectively in larger groups. This could be due to several factors, e.g. a potentially greater commitment to their studies than undergraduate cohorts; because they received individual face-to-face group facilitation; or because the cohort was 99% international students who often have a high motivation to succeed.

The foundation and first year students at Keele sometimes struggled with group work, which could be associated with the fact that these foundation and first years do not count towards the final degree grade, hence the lower motivation from some individuals. Also, students early on in their undergraduate career are only just learning how to learn, and are less familiar and experienced with self-directed learning. It was felt that lower level cohorts had more chance of working well together, bonding and establishing a good team ethic in smaller groups which were less complex to manage.

6.2 Who chooses the groups?

There are many ways of splitting up a class of students into groups for PBL. Each method has advantages and disadvantages. Four different ways of allocating groups are discussed below:

Random Groups – can be generated from class lists before a module commences or in class using lettering or numbering systems. This method doesn't allow students any ownership over whom they are allocated to work with and it also does not guarantee that groups are mixed by any particular criteria.

Self-Selected Groups. Allowing students to pick their own group appeals to many students who will be wishing to work with particular course friends. This can be positive when students pick people that they know they're going to work well with. However, this can also result in students from single disciplines, single nationalities or friendship groups sticking together. Some groups then have advantages/disadvantages due to prior subject knowledge, disciplinary skills, study skills, language skills, etc. This method also risks people feeling rejected if they do not form into a group easily.

Diverse Groups – can be pre-decided before a module starts by manipulating students into teams based on different criteria to maximise the diversity of groups, for example: discipline, nationality, educational background, gender, etc.

Self-Selected Diverse Groups. During this project we have strived to ensure that students are working in diverse, interdisciplinary, internationally-mixed, 'real-world' teams like those that graduates will experience in their future work places. To achieve diverse groups but also to empower students to make some of the choice about groups themselves, one solution trialled was to allow students to pick their own teams within specific guidelines. After doing a few ice-breaker activities with the whole class, students were asked to pick their own teams within these specified criteria – for example, each team must: be mixed gender, be mixed nationality, contain students from a variety of disciplines, etc.

6.3 Instructions, induction and ground rules

When students join university they may have never worked in a group-based setting before or completed group work assignments. PBL is a very different way of learning as there is much more emphasis on students taking control of their own learning rather than passive knowledge transmission. Therefore providing a thorough introduction and induction to group working is of utmost importance to aid groups in working together successfully. It may be helpful to provide a PBL and group working handbook as well as the generic module handbook.

[Appendix 3](#) – contains an example group working handbook from this project.

6.4 Assigning roles and responsibilities

Assigning roles and responsibilities to group members can help to ensure that all members take part and contribute towards a successful team culture. It is useful to have a designated chair who keeps the PBL process moving along, a scribe to write down all the key points and a disseminator who is in charge of distributing the agreed learning objectives to the whole group, e.g. via email or Facebook. Additionally, when groups decide on their learning objectives for each PBL task, you can ask them to devise the same number of objectives as there are members of the group, and each member then becomes responsible for researching that particular area. This provides some form of accountability within group members and also to facilitators.



6.5 Dealing with disciplinary and cultural differences within student groups

As has been suggested previously, a diverse group, in terms of disciplinary background and national culture, can enrich the learning process and enhance students' appreciation of different viewpoints and cultures, a key sustainability literacy competency. However, difficulties can arise from different cultural expectations and different learning styles. This means that attention has to be given to group processes, and exercises need to be built in for improving understanding of process-related issues. A study into learning styles amongst the Manchester students involved in this study showed that differences in approach to learning were greater between different disciplines than between different nationalities. One approach to dealing with expectations has been to provide videos online before modules start to inform students about the nature and expectations of the module.

Many issues are still better dealt with face-to-face. For example, a PBL scenario about post-earthquake reconstruction in Kashmir produced some interesting political discussion in a group that contained both Indian and Pakistani students. This could have moved beyond heated discussion but other group members acted as a moderating force and, as a result, all students in the group had a valuable learning experience (albeit unplanned). The temptation can be to make all scenarios sufficiently anodyne so that they will not cause offence, but that is to miss an opportunity for learning. The important point is to monitor what is going on so that an intervention can be made, whether online or face-to-face, to reduce tensions. It is a good idea to have regular 10-minute 'process review' meetings when the groups are face-to-face and can candidly talk about the dynamics of what has been happening.

Language can be a hidden problem in mixed groups; for example, native English speakers may be expected to do an unfair majority of written work and oral presentations, or there can be issues to do with the pace of debates, i.e. non-native speakers may need more time to process group discussions and to formulate responses. In

an asynchronous online mode the problem is lessened as non-native English speakers have more time to consider and form their response. Cultural differences can also influence the extent to which a student is forthright in his or her views and some moderation may be necessary to ensure that all group members are heard.



6.6 Peer assessment in PBL

Many potential problems in PBL relate to the extent to which individual team members contribute equally and fairly to group projects, and how this is reflected in the marking of group assignments. Do all students receive the same mark irrespective of their contribution or should marks be moderated in light of individuals' effort?

Peer assessment is the assessment of student work (or contribution to group effort) by other students, and is one way of managing these issues. Peer assessment was used during this project to allocate group marks to individuals. There are many benefits of using peer assessment, including: helping students learn to evaluate their own learning; encouraging students to engage with assessment criteria; giving students a sense of ownership of the assessment process; and encouraging students to be more involved in group work and to take more responsibility for their learning. Also if students know that they are going to be assessed by their other group members this can also serve as a useful motivator! There is software available for conducting peer assessment, e.g. WebPA[®], or a bespoke methodology can be devised.

[Appendix 4](#) – contains an example peer assessment tool used during this project.

7. The Role of Information Technology and Social Media in Hybrid Problem-Based Learning

We trialled a range of online learning technologies and social media tools in different formats for different educational purposes during this project; this was a key aspect of our ‘hybrid’ approach.

7.1 Virtual delivery of module content: PowerPoints, podcasts & screencasts

In traditional PBL, module content is not ‘delivered’ in the same way as it would be during lectures; students develop their knowledge of an area through exploration of problems. If different groups are working on different topics, it can be difficult to ensure that all students cover the breadth of material across different topic areas. One approach taken was the ‘delivery’ of some core module content through online resources, including PowerPoints, podcasts and screencasts, which students could access and investigate in their own time. Students were asked to listen to a short podcast accompanying a set of PowerPoint slides around a different topic before coming to the weekly PBL classes. It was hoped that the online materials would ensure that all students were learning some core background content and that students from different disciplinary backgrounds would be brought up to a more level playing field before tackling complex problems together in class. It is also possible to reverse this process and provide the content after the class PBL exercises.



2 How to use these teaching slides

- These slides are not intended to form a complete lecture on the session topic, you will need to listen to the audio recording alongside the slides.
- You should also carry out additional research, either web-based or in Hitchcock and Willard (2009): The business guide to sustainability.
- There are a limited number of case studies included. You can develop your own portfolio of case studies as part of the course.
- The slides and the audio recording remain the copyright of

activities at the back of each slide
y out to help you understand

esci.keele.ac.uk



3

Greening Business: addressing the questions – Why? What? How?

Dr Zoe Robinson, Keele University, z...

Session outline

- 1) Why learn about 'greening business'?
- 2) Motivations for businesses to 'green'
- 3) Perceived barriers to 'greening'
- 4) What does 'greening' involve?

Activity for Week 8 – Purchasing and Sustainable Certification Schemes

This weeks podcast and slides are all about purchasing and how businesses can make their purchasing activities more sustainable. For this weeks activity each group has been allocated a sustainable certification scheme. Your task as a group for Thursday's class is:

- Research your scheme in relation to the questions opposite
- Be prepared to feedback (for a couple of minutes as a group) to the rest of the class about the scheme

Examples of issues to consider

- Who is it run by?
- What are its aims?
- What are the benefits of the scheme?
- Are there any downsides to the scheme?
- What are the criteria that are needed to achieve certification?
- How much does the scheme really achieve?
- Are there aspects that are not included in the scheme that you think should be?

Group 1 – EU Ecolabel
Group 2 – RSPCA Freedom Food
Group 3 – Fairtrade
Group 4 – Soil Association Organic Standard
Group 5 – Marine Stewardship Council
Group 6 – Forest Stewardship Council
Group 7 – Red Tractor Assurance

It is worth considering the following issues in relation to online content delivery during PBL:

- **How long should podcasts/screencasts be?** In the context of problem solving and not wanting to spoon-feed all the answers to students, it is probably a good idea to opt for a short introduction/background to a topic (ca. 5 – 10 minutes) leaving you free to delve deeper into issues in class sessions. Shorter materials are also more in line with concentration times.
- **How do you ensure that students are listening/watching podcasts and screencasts as instructed?** Setting tasks, or embedding topical news articles, videos or pictures within online materials, which will then feed into the following PBL class session, can encourage students to engage. Linking assessments or quizzes to weekly online materials may also encourage students to keep up-to-date.

7.2 Virtual PBL groups: online student communication and collaboration

This project explored ways in which we could foster productive group working environments within PBL groups who have less time and space to meet each week. The approach taken was to encourage students to set up online group meeting spaces to conduct a significant proportion of their PBL group work. This included communicating and also completing pieces of coursework together online. The communication and collaboration tools used were both synchronous and asynchronous.

- **Synchronous online PBL** – involves all group members being online and communicating at the same time. Online conversations include video, voice and text messaging using tools such as Skype, web conferencing, or ‘chat’ facilities on the university Virtual Learning Environment (VLE) or in Facebook. The immediate nature of synchronous group communication is useful for quick decision making and clarification on issues.
- **Asynchronous online PBL** – means that participants do not all have to be online at the same time but members will leave messages that the rest of the group can pick up and respond to, for example, through discussion boards, forums and threads in the university VLE or on Facebook. This approach is well suited for gathering information and opinions, and allows participants to contribute at their convenience and to spend some time researching their responses.



7.3 Virtual PBL facilitation

This project also trialled online PBL facilitation, whereby the facilitator is part of the students’ online group discussion space and acts as a resource to answer questions, provide tips and guidance, monitor group dynamics and to check which group members are and aren’t contributing. Online facilitation was trialled through two approaches:

- **Facilitation through the VLE.** Each PBL group in a module had an online learning space set up within the VLE with the discussion board and other tools activated. Students were encouraged to communicate, share research and complete tasks together using these tools. At one university students were given a set minimum amount of words that they had to contribute each week. The facilitator oversaw group interactions and provided info/guidance when necessary.
- **Facilitation through Facebook.** At Keele University in the second and third years of the project, student groups were allowed to use Facebook to communicate and undertake their PBL group work. The module facilitator became a member of each group’s Facebook group (this is possible without students having to become ‘friends’ with the facilitator on Facebook) and again provided guidance, information and answered student questions. The use of Facebook was initially suggested by students who had found the VLE discussion boards ‘clunky’, not user friendly and had opted informally to set up their own Facebook group. Students were essentially given the choice of which online forum media they wanted to use; all groups chose Facebook over the VLE.

7.4 End-of-module questionnaire, focus group findings and student testimonials

Results from the end-of-module questionnaires, and the focus groups used in academic years 2011/12 and 2012/13, indicated that there were advantages and disadvantages of each online approach. Student feedback was taken on board each year in order to refine the online aspects for the next year's delivery.

- An average of 64% of students across the three universities said that they found the online group working aspects of the modules 'effective' or 'very effective' for investigating group problems and carrying out group work.
- 67% of the Keele students rated the podcasts and PowerPoint slides either 4 or 5 out of 5 on a scale from 'not at all helpful/ interesting' to 'very helpful/ interesting'.

• Podcasts and PowerPoint Slides

Response from students was mixed and indicated scope for making the online learning materials more engaging, shorter, more concise and more mandatory/enforced.

"The podcasts and lectures were very knowledgeable and having the podcasts as well as lecture slides made them more interesting and kept your concentration."

"They were quite tedious and boring to listen to, although they had good info."

"The information is clear and useful. I can download the podcast anytime and listen to it wherever I want."

"Listening to the podcasts was very convenient as you could do so in your own time. I found them a useful way of receiving a good overview of a topic that then allowed you to do your own personal research afterwards if you found an aspect interesting."

"I only listened to a few podcasts so I didn't really use them for learning."

"For the most part they were interesting, though it was often hard to get all the way through one without stopping."

• Online student communication, collaboration and facilitation

Although some student groups found using the university VLE tools (e.g. discussion boards and file sharing) helpful for carrying out PBL group work, many more students (at all three institutions) said that using the VLE system was inconvenient as they did not habitually log in to the VLE daily. Students also said that the VLE tools were not particularly user-friendly and were outdated in comparison to other online platforms. File sharing through the VLE was one of the more useful aspects for students when collaboratively completing coursework.

Many students expressed preference for using Facebook or other tools that they would otherwise use daily for social networking, e.g. Skype, rather than using the VLE. When any student in a given PBL group logs into Facebook and makes a contribution to their group discussion space, all members immediately see a notification (on their smart phones or laptops) and are able to check what has been said and respond at their convenience. The module facilitator was able to oversee the interactions of all groups, provide information to groups, remind

students about deadlines, post important links (including links to the VLE and podcasts), and generally keep track of groups to identify which groups needed extra help. During a focus group the Keele students they said they liked being 'watched over' by a module tutor, that it felt like a 'safe environment' to discuss ideas and that the level of facilitation was 'just right'. It is also worth pointing out that there are many other online communication and collaboration tools available on the market which would be suitable for use in PBL, Facebook is just one of these tools.

Crucially, using Facebook enabled smaller numbers of facilitators to be used for larger numbers of groups, by combining shorter class facilitation slots (5 - 10 minutes per group per week) with Facebook facilitation. One facilitator was able to manage up to seven groups using online means and the staff time spent facilitating online was far lower than if each group had had an individual face-to-face facilitator. The average time spent facilitating seven groups online per week was 2 hours in total. If seven groups had individual face-to-face facilitation each week this would equate to a minimum of 7 staff hours (or 14 hours if class sessions were two hours long). Student opinions about using the VLE and Facebook included:

"I really liked the ability to communicate and work with my group via Facebook as it made me much more likely to check the group and I found it easier to share material and research. I liked the way we could also easily communicate with the facilitator via Facebook as this meant we got quick and effective replies to any questions we had."

"Change the mode of communication [from VLE] as it becomes difficult to get hold of people online and to share information. On the VLE the functions are rigid and limited compared to other online platforms."

"All of our group meetings, group works and group documents are planned and shared by Facebook. It is convenient and updated easily every day."

"The VLE proved to be more difficult for communicating, so my group switched to Facebook. Once we used Facebook we all found communicating quick and effective."

"The module facilitator was helpful when we had questions and easily contactable."

"Facebook is a very useful and convenient way of sharing information and organising group meetings."

Although Facebook has been a huge success as a PBL innovation during this project there are certain issues to consider with its use:

- **Students' Social Space.** Facebook is a social space and many users have private profiles which they share only with friends. Asking students to collaborate with each other through Facebook and to also allow a facilitator member of staff to join their group discussion space can bring up privacy issues. As PBL practitioners we must be careful that students do not feel that their private space has been invaded by staff. Fortunately this issue did not seem to be a problem when trialled at Keele, and most students welcomed having a facilitator present online (a junior member of staff). However, some students did mention that if the module leader had been part of their online group they would have felt more restricted. It's worth noting that the facilitator-student relationship tends to be more informal than that with the module leader and this is important when social networking is to be used.

- **Staff Social Space.** There are similar privacy problems for the facilitator. However, by using the correct privacy settings on Facebook, it is possible for staff and students to be part of the same discussion groups without being able to see anybody else's private profile. In all cases at Keele, students much preferred having a facilitator member of staff within their Facebook group than having to use the VLE discussion board which they found much less user-friendly.
- **Reporting Problems.** With any online means of student discussion there needs to be a way of students reporting issues and worries, including confidential issues, to the group facilitator. Students were advised that if they wanted to seek confidential advice they should use official university email correspondence and schedule one-to-one meetings if necessary. Students were strongly discouraged from sending personal inbox messages to staff via Facebook.
- **Distracting Students.** The worry here is that asking students to conduct group work via Facebook might distract them from the task at hand, as they get involved with other things that are happening on the social media site. However, during this project we found that Facebook discussion groups were used by members far more frequently than VLE discussion spaces and individual members made scores of contributions during the

module rather than a few sporadic inputs when using the VLE. In our opinion the merits of using Facebook as a group meeting space for PBL, and a space for PBL facilitation, far outweigh any of the disadvantages.

7.5 Technology for assessment

The use of technology was not confined to content delivery, communication and PBL facilitation. The three universities also undertook a number of approaches to using technology to aid the assessment of students:

- Online submission of coursework was commonplace and, in some cases, Turnitin® was used to check the originality of the submissions. Feedback was often then delivered online.
- Students submitted their reflective diary reports online. Setting weekly/fortnightly deadlines for diary submissions can help motivate students to keep up to date with this task.
- Wikis were used by students as a way to submit assessed work, and were also used by facilitators to provide feedback.
- Students were asked to compile videos and to submit these as a form of assessment online.
- The peer assessment exercises were also carried out online, either via Blackboard® quizzes or via WebPA® software.



Conclusions

The original aim of this study was: “To explore effective ways of adapting traditional problem-based learning pedagogies using a range of hybrid and blended learning approaches, for the delivery of transformative sustainability education, to large student numbers in a less resource intense manner.” A wide range of issues relating to the PBL delivery of education for sustainability were explored through this project and have been discussed in the previous chapters. Specific issues explored were:

- The best methods for running such exercises (and the pitfalls).
- The best types of student support (especially the technology-based opportunities).
- The differences between undergraduate year 1 and 2, and postgraduate students in their approach to PBL.
- How best to assess such modules.
- Are the programmes achieving what we set out in the proposal?
- Are the programmes making a difference to student learning, confidence and skills?
- Do the programmes offer future viability?
- Are large-scale PBL approaches effective for generating transformative sustainability learning?

Important key findings of this study may be divided roughly into three categories: the use of PBL for sustainability education; the use of hybrid PBL; and scalability.

• **The use of PBL for sustainability education**

We embarked on this project with a strong belief that the PBL approach was well suited to sustainability education, and the student feedback has strongly endorsed that view. The three universities used diverse scenarios that engaged the students in very different ways, and we would especially highlight the success of:

- PBL scenarios based in the students’ own institution, that were not only directly relevant to the students, but that also generated ideas that were of genuine value to the universities.
- Problems that were based on situations that students would be likely to encounter in their work after graduation, which helped to reinforce the value of employability skills.
- Situations that were far-removed from most students’ experiences and out of their comfort zone, as they addressed problems such as humanitarian aid for which resources, logistics, politics and social factors needed to be considered.

Overall, in terms of student engagement, the broader educational benefits, and the range of challenging scenarios used, we are convinced that sustainability is ideally suited to PBL-based delivery.

• **The use of hybrid PBL**

A wide range of delivery methods and group working practices were explored during this project, which do not form part of a ‘traditional’ PBL approach. From our observations, there are two main conclusions – the first is that the mixed format was well received by students, and students benefited greatly from the various formats, media and assessment methods. Secondly, there were a small number of problems that arose due to the lack of a single facilitator for each group, and/or from the range of resources and activities that students were asked to engage with (e.g. managing group dynamics, on-line discussions, ensuring everyone carried out essential background work), but we found successful ways of addressing these issues.

- **Scalability**

- The first observation is that all three universities (to varying extents) encountered problems, with enrolling the student numbers (e.g. over 100) that we had hoped for, on to the PBL modules; this was entirely to do with the way that module options are (or are not) available to students, and the tendency for students to choose electives from within their discipline area. Having said that, over 300 undergraduate engineering students at the University of Manchester take a different compulsory sustainability module delivered through PBL. However, being delivered in a more traditional PBL approach (i.e. one facilitator per group) this module is very resource intensive.
- Secondly, it is perfectly possible for one facilitator to manage several (indeed many!) groups, but the hybrid PBL approach is then essential as groups must tackle their 'wicked' problems with less individual face-to-face guidance from the facilitator, instead using a range of online and face-to-face methods and resources. Although this requires more work in setting up the hybrid PBL materials at the start of an exercise, it can be much more efficient in the long run.
- Thirdly, whilst traditional PBL groups are relatively large (8 – 12 members), we found that the ideal group number depended on several factors including the year group of students and the amount of face-to-face facilitation received by groups. Small groups of 4-6 people worked very well during this project and ensured that every group member knew that their contribution was crucial.
- Finally, during a hybrid PBL approach, the only practicable way for the groups to carry out most of their discussions was online, and (however efficient one might think one's University VLE is) the best medium is the one with which the students are most comfortable. For us, in 2013, this was Facebook, and we simply had to find ways to deal with some of the concerns about using social media for educational purposes.

In summary, our experience suggests that PBL is an ideal approach for sustainability and related issues and that exceptional PBL scenarios can be designed which really engage the students at every level of study. The hybrid PBL approach introduces additional features, which we feel significantly enhance the educational experience and employability skills. Moreover, we have shown that the often high cost of traditional PBL (primarily for facilitators) can be replaced by a hybrid PBL approach using a mix of resources; this really does allow the (economical) scale-up of PBL, provided that a number of guidelines are followed, particularly concerning the way that the PBL groups are set up, guided, and supported.

Appendices

Appendix 1: Summary/Aims of the Modules and Key Module Statistics

Summary/Aims of the Modules			
<i>University</i>	<i>Module Title</i>	<i>Year Group of Students</i>	<i>Aim of Module</i>
Keele University	Greening Business: Employability and Sustainability	Foundation and 1 st year undergraduate	To introduce students to the environmental and sustainability responsibilities of business and the motivations of organisations to engage with this agenda. To equip students with the basic skills and awareness to drive sustainability improvements in their future workplaces. Working in small groups students tackle a different area of sustainability related to the Keele campus, e.g. waste management or renewable energy, and formulate a plan and recommendations for improving the sustainability of that area.
The University of Manchester	Project Managing Humanitarian Aid	MSc	To develop professional skills in students and to introduce them to the main concepts of, and barriers to, humanitarian aid projects in a complex world. Through tackling a series of small-group projects, students study the concepts of stakeholder engagement and the interaction of economic, environmental, legal, political, social and technical aspects of setting up humanitarian aid projects, with a view to developing abilities and skills for assuming professional responsibilities in their future careers.
Staffordshire University	Greening the Campus	1 st and 2 nd year undergraduate	To deliver sustainability teaching to students across a range of subjects as a university-wide elective module. In small working teams students work on campus-based projects aimed at informing and changing the sustainability behaviours of first year students. The projects are local biodiversity, energy, waste and food.

Key Module Statistics					
Academic Year	No. of Students on Module	Module Length	Number of PBL Groups	No. of Disciplines and Nationalities on Module	Staff Resource
Keele University					
2010/ 11	42	12 weeks, 1 hour per week	8	D: 17 N: 10	1 module leader, 1 module facilitator
2011/ 12	44	12 weeks, 1 hours per week	7	D: 18 N: 10	1 module leader, 1 module facilitator
2012/ 13	32	12 weeks, 1 hour per week	7	D: 15 N: 9	1 module leader, 1 module facilitator
The University of Manchester					
2010/ 11	24	12 weeks, 2 hours per week	3	D: 4 N: 12	1 module leader, 3 facilitators
2011/ 12	35	12 weeks, 2 hours per week	5	D: 4 N: 12	1 module leader, 5 facilitators
2012/ 13	25	12 weeks, 2 hours per week	5	D: 4 N: 6	1 module leader, 5 facilitators
Staffordshire University					
2010/ 11	-	-	-	-	-
2011/ 12	16	12 weeks, 1 hour per week	4	No data	1 module leader, 1 module facilitator
2012/ 13	10	12 weeks, 1 hour per week	2	No data	1 module leader, 1 module facilitator

Appendix 2: Example PBL Scenarios

Keele Scenario 1 – Instructions for students, case study details and the group task

Keele – Example PBL Scenario – Uniformsdirect

Instructions

- Carefully read the case study below
- Highlight any terminology you don't understand and discuss it with your group to clarify
- Highlight the sustainability issues that you think are important - you might want to use different colours to help categorise the different sorts of issues, including: environmental issues; resource/financial issues; legal issues; social issues; and behavioural issues.
- Think about and discuss with your group: the things the company is doing that are unsustainable; how certain practices/issues could be improved; the benefits to the company of making sustainability improvements.

The Case - You are working for Uniformsdirect, a company which designs and supplies uniforms to a range of different sectors, including the hospitality and entertainment sector. The company is based in the centre of Stoke-on-Trent and has about 70 people directly employed in the main offices and distribution warehouse. The main offices are housed in a 1960s office building which has not had any major renovations since it was built. The majority of employees live in North Staffordshire; some live in Manchester and Birmingham. The clothing is manufactured in a factory on the rural outskirts of the busy city of Jakarta, Indonesia. Many factory workers in these areas are migrants from Indonesia's poorer eastern islands who have travelled to Jakarta for work. The cotton used to produce uniforms is imported into Indonesia from the cotton growing regions of central Asia, mainly from Uzbekistan, and the clothes dyes are imported from India. Once clothes are manufactured they are shipped to Dover in England before being transported via lorry to the central distribution warehouse in Stoke. Recently the company has not been winning tenders from clients that they would have normally expected to win tenders from. The senior management have heard rumours from prospective clients that this is because Uniformsdirect are not seen as considering the sustainability agenda enough to satisfy their own stakeholders. However, not everyone on the senior management board at Uniformsdirect is convinced that it is worth investing in sustainability issues, particularly in current economically difficult times. No-one in the company has any environmental management background but you have been asked as a team to take responsibility for environmental and sustainability issues within the company. Some prospective clients have asked whether your company has an Environmental Management System or a Sustainability Policy in place but no-one really knows what this means. Your team have been asked to provide a five minute oral brief to the senior management of Uniformsdirect on what steps the company should be starting to take to address its environment and sustainability responsibilities.

Task:

- Your task as a group is to present a five minute oral brief to senior management on what steps the company should be starting to take to address its environment and sustainability responsibilities.
- To do this you need to have a greater understanding of the relevant issues and will need to carry out some more research before presenting the brief to the senior management in class on the 7th February. You will have a short amount of time in class next week to prepare how your group will present its ideas but most of your group work should be done before the session. You do not need to produce any PowerPoint slides or typed documents. This task is not assessed.
- By the end of this week's session you must have decided as a group four things that you need to do more research about before presenting the brief next week; these will be your 'Agreed Learning Objectives'. Be as specific as possible, and write these on your group's 'Agreed Learning Objectives' form (attached). It might be a good idea to assign one learning objective/research area to each person.
- The brief must be a short summary of the issues that you decide (as a group) are most important to get across to the senior management to help them to decide how (and whether) to start to address sustainability considerations within the company.

Keele Scenario 2 – Instructions for students, details of group project 4 and facilitator notes

Keele – Main Group PBL Projects

Keele University has committed to embedding a ‘deep green’ sustainability ethos throughout its operations with the aim of becoming an internationally-recognized sustainability leader within the Higher Education sector. There are several areas which the University wants to investigate in order to further improve its sustainability performance. Your group will be investigating one of the following 9 sustainability projects:

- 1) A Sustainable Vehicle Fleet
- 2) Environmental Baseline Review of Keele Leisure Centre
- 3) Environmental Baseline Review of Keele Library
- 4) Waste Management and Recycling at Keele
- 5) Enhancing Sustainability within the Student Experience
- 6) Green Transport Strategy
- 7) Energy Reduction in Academic Buildings
- 8) A Renewable Energy Strategy for Keele
- 9) Green Purchasing Policies – Cleaning Products

Instructions – Read through your chosen project. Following the 6 steps below will help you to successfully complete your group projects:

1. Highlight and clarify unfamiliar terms and concepts - make sure you know what everything means and make sure you are clear about what your group task is asking of you.
2. Analyse and brainstorm the task, what are the problems and issues that need exploring, what ideas and solutions can you come up with.
3. Formulate group learning objectives for further research. Learning objectives are a list of things that your group needs to find out and research to be able to complete the task. You may want to split your research into 4/5 areas so each team member takes responsibility for one part of the research.
4. In-between class sessions you should research the topic/area/issue that was assigned to you, through the internet, books, articles, etc. and be ready to share this research with your group the next time you meet.
5. Remember to keep in regular contact with your group and discuss ideas and progress via your Facebook or Blackboard discussion groups. You should also meet up as a group in person in-between class sessions.
6. Module staff will be monitoring online group interaction. Please feel free to ask the module facilitator any questions related to your project via email, Blackboard or Facebook. The facilitator is there to provide guidance and support through the group projects.

For all of the group projects it is very important to consider the following two things:

Current Practice: What is Keele currently doing and how can you find out about this? Are there relevant members of staff that you could contact and talk to? Is there information on the internet about what Keele is doing?

Other Universities: What are other universities doing? Can you use examples from other institutions (or other organisations/businesses) to back-up your recommendations?

Keele – Group Project 4 - Waste Management and Recycling at Keele

You are working within the Environmental Management team at Keele University. To help to continue to improve waste management practices and recycling facilities on campus, the University would like your team to conduct an audit of the different facilities and practices occurring around the campus and to understand the financial, environmental and energy implications of recycling.

You have been asked to produce a five minute video for the University's Senior Management outlining the findings of your waste management and recycling audit and an action plan for improving waste management practices on campus. The recommendations will need to be quantified in terms of waste figures. Your recommendations should also consider the financial, environmental and energy costs of current practices and of your proposed more sustainable practices. Recommendations must be based on your detailed research of waste management on the campus. **The recommendations must be realistic in addition to being well justified.**

You will need to make sure that you have considered any relevant environmental/sustainability issues, in addition to resource, financial, social, behavioural, ethical and legal issues.

A few questions to get you thinking:

- What are all the different types of materials that can be recycled on campus and where are the locations of all the recycling facilities?
- How well advertised are recycling facilities and how convenient is it for staff and students to recycle? How could communication be improved?
- Are there examples of recycling facilities being misused? What might be the implications of this?

Facilitators Notes

The waste management and recycling audit should consider:

- All the different types of materials that can be recycled on campus and the location of all of these recycling facilities.
- Which materials can be recycled in many easily accessible locations? Which materials have to be taken to a certain place to recycle?
- What materials cannot currently be recycled?
- Evidence of difficulties in managing recycling schemes on campus, i.e. overflowing bins, dirty bins, wrong wastes in recycling bins.
- What information would help people recycle correctly? I.e. knowing the impact of putting the wrong/dirty stuff in recycling bins?
- Advertising and ease of recycling for staff and students. How could this be improved?
- Where do materials disposed in recycling bins on campus end up?
- Recycling associated with bars, restaurants and halls of residence on campus.
- The energy and raw material savings associated with recycling different materials.
- Could you include monitoring of waste management practices into the action plan?
- Could you research student attitudes to waste and recycling?
- Could the University/Council do anything to help student's off-campus with their management of waste?
- Should there be such an emphasis on recycling? Does this prevent students/staff thinking about the higher actions of the waste hierarchy?
- What are the alternatives to recycling - reducing waste, reusing products, not buying certain things in the first place?
- Could you propose some realistic new waste management and recycling targets for the university? What are the targets/achievements of other institutions?

Manchester Scenarios – Instructions for students, case study details and the group tasks

Manchester – Example PBL Scenario 1 – Food Aid

You are a team of consultants, working with international aid agencies and charities, which advises on policy and programmes for disaster relief and humanitarian aid. You have been asked by a consortium of East African governments to provide information that could help them individually to decide whether or not to accept food aid.

Background – During the summer of 2010 there was widespread drought in East Africa, affecting half-a-dozen countries. This has led to food shortages, notably of maize. The US government has promised considerable quantities of maize for distribution throughout east Africa – either through government agencies or, where appropriate, international aid agencies based locally. The Minister of Health in one of the countries involved has expressed concerns about the advisability of accepting US maize, much of which is likely to be from genetically modified seed. Some of the countries are considering their own trials of GM maize but at the moment it cannot be grown or imported without a government licence in any of the countries and the licences are not readily issued. The World Food Programme is keen to see the people fed and maize is their staple diet. The European Union has banned GM maize but has very little surplus that it can offer to East Africa.

Task – Because of the range of governments and agencies involved, you have been asked to complete your report in the form of a *wiki*. The sources of any information should be clearly given in the relevant places and, where available, links given to the source material. The governments will wish to see a comprehensive argument of all the differing perspectives but encourages you to propose an acceptable way forward. Because of the difficult food situation at present, you have two weeks in which to build your wiki. You may wish to appoint one team member as ‘webmaster’, to take charge of the organisation of the wiki and to help other team members to enter data.

Manchester – Example PBL Scenario 2 – Transitional Accommodation Strategy

You are a team of ‘facilitators’ working with international aid agency *Building for Humanity* which encourages collaboration between architects, builders, designers and the humanitarian world.

Background – On 25th October 2010, eleven-year-old Amina was sitting in school. “When I noticed my pencil rattling on the desk I quickly ran outside,” recalls Amina. Some of her classmates were less fortunate and unable to save themselves. On the islands where the girl lives, schools suddenly ceased to exist or were seriously damaged. The earthquake triggered a tsunami that swamped coastal villages on the Mentawai Islands and swept away many of the buildings that the earthquake had left standing. With logistics provided by the military much was done to save lives by the simple provision of tents and tarpaulins, but longer-term assistance is required to help the population rebuild their communities and infrastructure, whilst providing medium-term solid shelter.

Task – Immediately following this incident, as a multi-disciplinary team, your aim is to assess the situation on the ground and, with the help of the following groups to develop a strategy to provide suitable transitional accommodation (housing, schools, clinics, etc.). It is vitally important that all issues of sustainability are taken into account, and a realistic balance is achieved between emerging technologies and the constructional methodologies traditional in the area. Take account of potential transport difficulties, severe shortages of skilled labour and building expertise, as well as the availability of potentially suitable building materials. It is worthy of note, at this point, that many of the surviving buildings were of locally traditional construction. The groups you will be working with are: local community groups; local police and security forces; army and other military personnel; aid agencies and charities – both at organisational level and in the field; non-governmental organisations (UN, UNHCR, ICRC, etc.); designers; manufacturers; health organisations; and food charities.

You are to analyse possible alternative approaches and propose an environmentally sound and sustainable **strategy** for the construction of buildings, listed above. Achieve a realistic and workable balance between international aid and local skills and manpower. Make a reasoned proposal for a technological strategy which, if employed, would facilitate the creation of sustainable and safe buildings, and act as the building blocks of a longer-term rebuilding of communities. Present your analysis and proposals both as an A4 report of up to 1000 words and a set of PowerPoint Presentation slides that could be delivered in approximately 20 minutes. Please note: This is not a physical design exercise. You must design an appropriate and workable strategy based on best current knowledge. Any such strategy must be workable, sustainable, affordable in both the short and longer terms, and should propose an appropriate **project plan** for all potential participants (local and international).

Appendix 3: Example Group Working Handbook

[ESC-10043 - Greening Business: Employability and Sustainability ESC-00004 - Greening Business: An Introduction

Group Working Handbook



This booklet contains a number of supplementary materials designed to support the group working processes involved in this module, including exercises which you will work through with your group. Sections are listed below:

- 1) Introduction to group working – page 1
- 2) Skills developed through group working – page 2
- 3) Team decision making – page 2
- 4) Setting ground rules for teamwork (Exercise A) – page 3
- 5) Team roles (Exercise B) - page 4
- 6) Dealing with group conflict (Exercise C) - page 6
- 7) What are Graduate Attributes and how does working in a group contribute towards them? (Exercise D) – page 6/7

0 | Page

1) Introduction to group working

During the class sessions of this module you will be working in groups of 4 or 5 exploring different scenarios and tasks which relate to sustainability and greening businesses. Together with your group you will be devising recommendations and action plans for these scenarios. You will also be involved in class discussions, debates and presentations. You will be encouraged to exchange ideas, feelings and experiences with your group.

Module content will not be delivered in a traditional lecture style. It will be delivered online via podcasts and PowerPoint slides which you will be expected to access on a weekly basis. These will form the basis of discussions in class and will provide background information to help you in your assessments.

The module leader and facilitator will monitor group learning and will be on hand to provide guidance and support. When you are given a sustainability task to work through in class you should roughly follow this process as a group:

- 1 **Highlight and clarify unfamiliar terms and concepts - make sure you know what everything means and make sure you are clear about what your group task is asking of you.**
- 2 **Analyse and brainstorm the task, what are the problems and issues that need exploring, what ideas and solutions can you come up with.**
- 3 **Formulate group learning objectives for further research. Learning objectives are a list of things that your group needs to find out and research to be able to complete the task. To start off with it's probably easiest if you split your research into 4/5 areas and each team member takes responsibility for one element. As group work progresses you will probably want to reassign new jobs to different people.**
- 4 **In-between class sessions you should research your agreed learning objectives, i.e. research the topic/area/issue that was assigned to you, through the internet, books, articles, etc.**
- 5 **At the next class session you should each take it in turns to share what you have found out and discuss the findings and ideas.**
- 6 **Use all the information your group has found out to complete the group assessments and tasks.**

1 | Page

2) Skills developed through group working

“A team is a group of people with complementary skills who are committed to a common purpose and hold themselves mutually accountable for its achievement” (Katzenbach and Smith, 1993)

Much of the work on this module involves working in a team and performing together as a team. Being ‘mutually accountable’ means that all group members are jointly responsible for the achievement of the team and must all pull their weight. Some of the skills you are likely to develop and gain confidence in through group working include:

- Problem solving skills
- Listening and negotiating skills
- Communicating in a group
- Communicating to a large group of people, i.e. presentations and answering questions
- Dealing with conflicts
- Sharing responsibilities within a team
- Managing a project and prioritising tasks
- Leadership skills
- Working in an interdisciplinary team
- Working in an international team
- Creative and entrepreneurial thinking

3) Team decision making

Team decision-making is a complex process which is underpinned by group discussions, questioning and pulling together evidence to support decisions. During your group work projects you may wish to consult the following criteria when making decisions as a group or choosing between different options and ideas.

- Weigh up the advantages and disadvantages of each option
- Think about previous similar decisions and the results which occurred
- Consider what resources will be needed and what is feasible
- Consider what is being required of your group – are you answering the question that has been asked and fulfilling the task that has been set?
- Consider what criteria you will be judged/graded upon
- Can you all agree?
- Have you all listened to all opinions and weighed these up?

2 | page

4) Setting ground rules for teamwork

Exercise A – Ground rules

Consider your experiences of working in a team and what ground rules you think should be put in place in order to promote appropriate behaviour and attitudes towards group roles and responsibilities. Each group should agree upon at least 5 ground rules for their team:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

Ground rules for teamwork generally fall into three main categories:

- **Team culture** - this category deals with promoting an environment within the group which is beneficial to team working, e.g. everybody is given the chance to speak, or everyone's opinions are taken on board.
- **Team member responsibilities** - this category deals with an individual's behaviour within the team, e.g. team members must strive to always be on time and turn up to all meetings, or team members should let the group know in advance if they will be unable to make a meeting.
- **Team organisation** - this category deals with generic management activities which should underpin the work of any successful team, e.g. the group must keep regular minutes of meetings and type up all agreed actions and responsibilities, or everybody must check their emails/Facebook at least daily

3 | page

5) Team roles










There are many different roles which people perform within a team. The Belbin® team roles exercise is used to identify people's behavioural strengths and weaknesses whilst working in groups and in the workplace. There are 9 team roles, each has good and bad points and a balance of roles is important in any team. In smaller groups one person may carry out several of the roles.

Exercise B - Team roles

Look through the descriptions of Belbin® team roles on the next page, and briefly answer the following questions with your group:

- Which is most and least like you (you may identify with more than one team role)?
- In your group are there any roles that are missing or roles that are over-abundant?
- How do you think the team roles present in your group will be likely to affect the way you work as a team?

Belbin® Team Roles

Team Role	Contribution	Allowable Weaknesses
 Plant	Creative, imaginative, free-thinking. Generates ideas and solves difficult problems.	Ignores incidentals. Too preoccupied to communicate effectively.
 Resource Investigator	Outgoing, enthusiastic communicative. Explores opportunities and develops contacts.	Over-optimistic. Loses interest once initial enthusiasm has passed.
 Co-ordinator	Mature, confident, identifies talent. Clarifies goals. Delegates effectively.	Can be seen as manipulative. Offloads own share of the work.
 Shaper	Challenging, dynamic, thrives on pressure. Has the drive and courage to overcome obstacles.	Prone to provocation. Offends people's feelings.
 Monitor Evaluator	Sober, strategic and discerning. Sees all options and judges accurately.	Lacks drive and ability to inspire others. Can be overly critical.
 Teamworker	Co-operative, perceptive and diplomatic. Listens and averts friction.	Indecisive in crunch situations. Avoids confrontation.
 Implementer	Practical, reliable, efficient. Turns ideas into actions and organises work that needs to be done.	Somewhat inflexible. Slow to respond to new possibilities.
 Completer Finisher	Painstaking, conscientious, anxious. Searches out errors. Polishes and perfects.	Inclined to worry unduly. Reluctant to delegate.
 Specialist	Single-minded, self-starting, dedicated. Provides knowledge and skills in rare supply.	Contributes only on a narrow front. Dwells on technicalities.

6) Dealing with group conflict

If you have a productive team with an effective team culture, team members should be able to:

"Trust one another. Engage in unfiltered conflict around ideas. Commit to decisions and plans of action. Hold one another accountable for delivering against those plans. Focus on the achievement of collective results" (Lencioni, 2002)

Lencioni (2002) describes five dysfunctions of team working:

- Absence of trust between group members
- Fear of conflict and individuals thus being wary to engage in open discussion
- Lack of commitment and members who are reluctant to commit fully to the task at hand
- Avoiding accountability and responsibility for group work
- Disregard for team results and individuals putting their own needs first

When we think about conflict the most visible types of conflict, such as arguments, spring to mind first. Conflict in teams however comes in many forms, some examples are given below:

- A dominant team-member causing disharmony by imposing their will on others.
- A team culture which denies individuals the opportunity to voice differing opinions.
- Fragmentation of the team into sub-groups, each with their own agenda.
- A team-member who does not pull their weight, or is inflexible.

Exercise C – Issues which may lead to conflicts

In your group, each member of the team should be given about two minutes to talk about any issues they feel could lead to conflict within the team. This could be something that they have experienced, have observed, or are concerned may occur. All team members should agree on how the problem could be avoided or overcome.

6) What are Graduate Attributes and how does working in a group contribute towards them?

Graduate attributes are the qualities and skills that students develop during their time at university. These attributes are more than just what you learn within your specific subject area. They are qualities that increase individual confidence; prepare graduates for the world of work; build problem-solving skills; and help graduates to appreciate the importance of contributing positively towards society, communities and the environment. The Keele Graduate Attributes are shown on the next page.



Exercise D - Graduate Attributes

a) Make a list of 3 graduate attributes and qualities that you hope to gain/improve upon during this module and explain why.

1.

2.

3.

b) How will these attributes help you in your future life?

It is very important that you are able to articulate your skills and tell people about them. This is vital for your own self-confidence, for when you are applying for jobs and when you're meeting new people. Don't be afraid to sell yourself and your attributes!

Appendix 4: Example Peer Assessment Tool

Peer Assessment Tool

Use this form to provide feedback on the performance of the members of your team. Your comments should be honest and relate to the contributions of individual group members. Absence due to illness or other valid reasons should not be taken into account in your assessment of level of contribution. Rate each member of your team (and yourself) according to the criteria below on a scale of 1-5. Make sure you use the grading correctly.

5 = Excellent 4 = Good 3 = Average 2 = Poor 1 = Very poor 0 = Did not contribute

Your Name:	Yourself	Team member name:	Team member name:	Team member name:	Team member name:	Team member name:	Team member name:
Criteria							
1. Attending group meetings regularly and on time							
2. Contributing actively to group discussions in class, outside of class and online							
3. Gathering, reviewing and sharing appropriate ideas and information							
4. Analysing information, deciding what is relevant, coming up with ideas to be used in the group project							
5. Contributing to the structure and design of the coursework/video							
6. Contributing to the writing of coursework (filming and editing the video)							
7. Helping to keep the group focussed on the task							
8. Contributing to a harmonious team culture							
9. Helping to identify and resolve any potential group conflicts							

Useful Information Sources

Education for sustainable development

- Corcoran, P. B. and Wals, A. E. J. (2004). *Higher Education and the Challenge of Sustainability: Problematics, Promise and Practice*. Kluwer Academic Publishers: USA.
- Drayson, R., Bone, E. and Agombar, A. (2012). Student attitudes towards and skills for sustainable development. *Higher Education Academy*. [Online]. Available at: <http://www.heacademy.ac.uk>
- Filho, W. L. (2000). Dealing with the misconceptions on the concept of sustainability. *International Journal of Sustainability in Higher Education*. 1: 1 (9-19).
- Gough, S. and Scott, W. (2008). *Higher Education and Sustainable Development: Paradox and Possibility - Key Issues in Higher Education*. Routledge: London.
- HEA (2006). Education for sustainable development. *Higher Education Academy*. [Online]. Available at: <http://www.heacademy.ac.uk>
- HEFCE (2005). Sustainable development in higher education. *Higher Education Funding Council for England*. [Online]. Available at: www.hefce.ac.uk
- HEFCE (2008). Sustainable development in higher education: consultation on 2008 update to strategic statement and action plan. *Higher Education Funding Council for England*. [Online]. Available at: www.hefce.ac.uk
- Hegarty, K., Thomas, I., Kriewaldt, C., Holdsworth, C. and Bekessesy, S. (2011). Insights into the value of a 'stand-alone' course for sustainability education. *Environmental Education Research*. 17: 4 (451 – 469).
- Luna et al. (2012). Universities and the green economy: graduates for the future. *Higher Education Academy*. [Online]. Available at: <http://www.heacademy.ac.uk>
- Orr, D. W. (1994). *Earth in Mind: On Education, Environment and the Human Prospect*. Island Press: Washington DC.
- Ryan, A. (2012). Education for sustainable development and holistic curriculum change: a review and guide. *Higher Education Academy*. [Online]. Available at: <http://www.heacademy.ac.uk>
- Sterling, S. (2012). The Future Fit Framework: an introductory guide to teaching and learning for sustainability in HE. *Higher Education Academy*. [Online]. Available at: <http://www.heacademy.ac.uk>
- Sterling, S., Maxey, L. and Luna, H. (2013) (Eds.). *The Sustainable University: Progress and Prospects*. Routledge: England.
- Stibbe, A. (2009). *The Handbook of Sustainability Literacy*. Green Books: UK.
- Tomkinson, R., Tomkinson, B., Engel, C. and Lawson, A. (2008). Education for Sustainable Development in Engineering: Report of a Delphi Consultation. *Loughborough, Engineering Subject Centre*. [Online]. Available at: <http://www.engsc.ac.uk/downloads/scholarart/delphi-consultation.pdf>
- UNDESD (2005). Education for Sustainable Development Brief. *United Nations Decade of Education for Sustainable Development, UNDESD*. [Online]. Available at: <http://www.unesco.org>
- van Weenan, H. (2000). Towards a vision of a sustainable university. *International Journal of Sustainability in Higher Education*. 1:1 (20-34).
- Wals, A. (2009). Learning for a Sustainable World: Review of Contexts and Structures for Education for Sustainable Development. *UNESCO*. [Online]. Available at: <http://unesdoc.unesco.org>
- Wals, A. and Jickling, B. (2002). Sustainability in higher education: from doublethink and newspeak to critical thinking and meaningful learning. *International Journal of Sustainability in Higher Education*. 3: 3 (221-232).
- Wiek, A., Withycombe, L. and Redman, C. L. (2011). Key competencies in sustainability: a reference framework for academic program development. *Sustainability Science*. 6: 2 (203 – 218).

Sustainability education and campus-based learning

- Ballantyne, R. and Packer, J. (2009). Introducing a fifth pedagogy: experience-based strategies for facilitating learning in natural environments. *Environmental Education Research*. 15: 2 (243 – 262).
- Hopkinson, P., Hughes, P. and Layer, G. (2008). Sustainable graduates: linking formal, informal and campus curricula to embed education for sustainable development in the student learning experience. *Environmental Education Research*. 14: 4 (435 – 454).
- Karol, E. (2006). Using campus concerns about sustainability as an educational opportunity: a case study of architectural design. *Journal of Cleaner Production*. 14 (780 – 786).
- Lipscombe, B. P. (2008). Exploring the role of the extra-curricular sphere in higher education for sustainable development in the United Kingdom. *Environmental Education Research*. 14: 4 (455 – 468).
- Savanick, S., Strong, R. and Manning, C. (2008). Explicitly linking pedagogy and facilities to campus sustainability: lessons from Carleton College and the University of Minnesota. *Environmental Education Research*. 14: 6 (667 – 679).

Problem-based learning, active learning and group learning

- Ahlfeldt, S., Mehta, S. and Sellnow, T. (2005). Measurement and analysis of student engagement in university classes where varying levels of PBL methods of instruction are in use. *Higher Education Research & Development*. 24: 1 (5-20).
- Allen, D. Duch, B. J. and Groh, S. E. (1996). The power of problem-based learning in teaching introductory science courses. In Wilkerson, L. and Gijsselaers, W. (Eds.). *Bringing problem-based learning into higher education*. Jossey-Bass: San Francisco.
- Allen, D.E., Duch, B.J., Groh, S.E., Watson, G.B. and White, H.B. (2003). Scaling up Research-based Education for Undergraduates: Problem-Based Learning. In Kauffman, L.R. and Stocks, J.E. (Eds.). *Reinvigorating the Undergraduate Experience*. Washington, Council on Undergraduate Research. [Online]. Available at: http://www.cur.org/publications/aire_raire/delaware.asp
- Boud, D. and Feletti, G. (1998). *The Challenge of Problem-Based Learning*. Kogan Page, London.
- Brew, A. (2012). Teaching and research: new relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research & Development*. 31: 1 (101-114).
- Ellis, G. and Weekes, T. (2008). Making sustainability ‘real’: using group-enquiry to promote education for sustainable development. *Environmental Education Research*. 14:4 (482-500).
- Engel, et al. (2007). Whole System Approach to Problem-Based Learning in Dental, Medical and Veterinary Sciences – A Guide to Important Variables. *Manchester: Centre for Excellence in Enquiry-based learning*. [Online]. Available at: <http://www.osier.ac.uk/298/>
- Gijsselaers, W. (1996). Connecting Problem-Based Practices with Educational Theory. In: Wilkerson, L. and Gijsselaers, W. (Eds.). *Bringing problem-based learning into higher education*. Jossey-Bass: San Francisco.
- Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*. 16: 3 (235 – 266).
- Hmelo-Silver, C. E., Duncan, R.G. and Chinn, C.A. (2006). Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*. 42: 2 (99-107).
- Hoare, A., Cornell, S., Bertram, C., Gallagher, K., Heslop, S., Lieven, N., MacLeod, C., Morgan, J., Pickering, A., Wells, S. and Willmore, C. (2008). Teaching against the grain: multi-disciplinary teamwork effectively delivers a successful undergraduate unit in sustainable development. *Environmental Education Research*. 14: 4 (464 – 481).
- Johnson, D.W., Johnson, R.T. and Smith, K. (2007). The State of Cooperative Learning in Postsecondary and Professional Settings. *Educational Psychology Review*. 19 (15 – 29).
- Katzenbach, J. R. and Smith, D.K. (2005). The Discipline of Teams. *Harvard Business Review - Best of HRB 1993*. [Online]. Available at: http://meridiancoaches.com/resources/Discipline_of_Teams.pdf

- Kek, M. and Huijser, H. (2011). The power of problem-based learning in developing critical thinking skills: preparing students for tomorrow's digital futures in today's classrooms. *Higher Education Research & Development*. 30: 3 (329-341).
- Kirschner, P.A., Sweller, J. and Clark, R.E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist*. (41:2) 75 – 86.
- Loyens, S. M. M., Magda, J. and Rikers, R. (2009). Self-Directed Learning in Problem-Based Learning and its Relationships with Self-Regulated Learning. *Educational Psychology Review*. 20 (411 – 427).
- MacVaugh, J. (2007). *Problem-Based Learning: the ability to conduct independent inquiry into real-life issues*. University of Gloucestershire Business School and the Centre for Active Learning Publication: UK.
- Pepper, C. (2010). 'There's a lot of learning going on but NOT much teaching!' student perceptions of Problem-Based Learning in science. *Higher Education Research & Development*. 29: 6 (693-707).
- Reeves, T.C. and Laffey, J. M. (1999). Design, Assessment, and Evaluation of a Problem-based Learning Environment in Undergraduate Engineering. *Higher Education Research & Development*. 18: 2 (219-232).
- Schmidt, H. G. (1993). Foundations of Problem-based learning: some explanatory notes. *Medical Education*. 27 (422 – 432).
- Tomkinson, B. (2008). *Educating Engineers for Sustainable Development: Report of a Royal Academy of Engineering sponsored pilot study*. The University of Manchester. [Online]. Available at: <http://osier.ac.uk/164/>
- von Blottnitz, H. (2006). Promoting active learning in sustainable development: experiences from a 4th year chemical engineering course. *Journal of Cleaner Production*. 14 (916 – 923).
- Woods, D. R. (2006). Preparing for PBL. *MacMaster University Text*. 3rd Ed. [Online]. Available at: <http://www.chemeng.mcmaster.ca/pbl/pblbook.pdf>
- Woods, D. (2008). *Problem-based learning, especially in the context of large classes*. [Online]. Available at: <http://chemeng.mcmaster.ca/pbl/pbl.htm>

Technology-based approaches for PBL

- Brodie, L. M. (2009). eProblem-based learning: Problem-based learning using virtual teams. *European Journal of Engineering Education*. 34: 6 (497).
- Hill, J. L. and Nelson, A. (2011). New technology, new pedagogy? Employing video podcasts in learning and teaching about exotic ecosystems. *Environmental Education Research*. 17: 3 (393 – 408).
- Lo, H. (2009). Utilizing computer-mediated communication tools for problem-based learning. *Educational Technology & Society*. 12: 1 (205-213).
- Orrill, C.H. (2002). Supporting Online PBL: Design Considerations for Supporting Distributed Problem Solving. *Distance Education*. 23: 1 (41-57).
- Park, S. H. And Ertmer, P. A. (2008). Examining barriers in technology-enhanced problem-based learning: Using a performance support systems approach. *British Journal of Educational Technology*. 39: 4 (631-643).
- Robelia, B. A., Greenhow, C. and Burton, L. (2011). Environmental learning in online social networks: adopting environmentally responsible behaviors. *Environmental Education Research*. 17: 4 (553 – 575).
- Schoenfeld-Tacher, R. Bright, J. M., McConnell, S.L., Marley, W.S. and Kogan, L.R. (2005). Web-based technology: Its effects on small group "problem-based learning" interactions in a professional veterinary medical program. *Journal of Veterinary Medical Education*. 32: 1 (86-92).
- Stewart, T. M., MacIntyre, W. R., Galea, V. J. and Steel, C. H. (2007). Enhancing problem-based learning designs with a single E-learning scaffolding tool: Two case studies using challenge FRAP. *Interactive Learning Environments*. 15: 1 (77-91).
- Tomkinson, B. and Hutt, I. (2012). Online PBL: a route to sustainability education? *Campus-Wide Information Systems*. 29: 4 (291 – 303).

- Waters, L. and Johnston, J. (2004). Web-delivered, problem-based learning in organisational behaviour: a new form of CAOS. *Higher Education Research & Development*. 23: 4 (413-431).
- Woltering, V. (2009). Blended learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: Results of a mixed-method evaluation. *Advances in Health Sciences Education*. 14: 5 (725).

Interdisciplinarity and dealing with diversity

- Belbin[®] (2012). *Belbin Team Roles*. www.belbin.com
- Dobson, H. and Tomkinson, B. (2013). Practical Education for Sustainable Development through interdisciplinary problem-based learning. In: Atfield, R. and Kemp, P. *Enhancing education for sustainable development in Business and Management, Hospitality, Leisure, Marketing and Tourism*. Higher Education Academy: York.
- Lago, C. and Barty, A. (2003). *Working with international students: a cross-cultural training manual*. UKCOSA London.
- Reynolds, F. (2003). Initial experiences of interprofessional problem-based learning. *Journal of Interprofessional Care*. 17: 1 (35-44).
- Selby, D. (2006). The catalyst that is sustainability: bringing permeability to disciplinary boundaries. *Planet*. 16 (57 – 59).
- Steiner, G. and Posch, A. (2006). Higher education for sustainability by means of transdisciplinary case studies: an innovative approach for solving complex, real-world problems. *Journal of Cleaner Production*. 14 (877 – 890).
- Strauss, P. and U, A. (2007). Group assessments: dilemmas facing lecturers in multicultural tertiary classrooms. *Higher Education Research and Development*. 26:2 (147-161).
- Sudweeks, F. and Ess, C. (Eds.) (2001). *Cultural Attitudes Towards Technology and Communication*. Murdoch University School of Information Technology.
- Tomkinson, B. (2005). Trans-Cultural Issues in Teaching and Learning. In: Ouellett, M. *Teaching Inclusively*. New Forums Press.
- Tomkinson, B. Engel, C. Tomkinson, R. and Dobson, H. (2007). Introducing an interdisciplinary professional course on Sustainable Development into Engineering programmes. In Aung, W. et al. (Eds.). *Innovations 2007*, International Network for Engineering Education and Research.
- Vann, J., Pacheco, P. and Motloch, J. (2006). Cross-cultural education for sustainability: development of an introduction to sustainability course. *Journal of Cleaner Production*. 14 (900 – 905).
- Wisker, G. (Ed.) (2000). *Good Practice Working with International Students*. SEDA Paper 110, Staff and Educational Development Association.
- Woods, C., McMorrow, J., Braidman, I., Lorenzo-Zamorano, S. and Bowsher, C. (2006). Embedding Interdisciplinarity: The Evolution of an Undergraduate EBL Module. In: Case studies: CEEBL-Supported Projects. Centre for Excellence in Enquiry-Based Learning (CEEBL). University of Manchester [Online] Available at: <http://www.campus.manchester.ac.uk/ceebl/projects>.

Acknowledgements:

This guide was developed and authored in 2013 by the project team for this HEA NTFS funded project: Sophie Bessant, Professor Pat Bailey, Dr Zoe Robinson, and Professor Mark Ormerod – Keele University; C. Bland Tomkinson and Rosemary Tomkinson – *The University of Manchester*; and Dr Rob Boast – *Staffordshire University*.

For more information about the project and toolkit, please visit the project website: www.keele.ac.uk/hybridpbl, or alternatively, contact Sophie Bessant, Sustainability Project Officer, s.e.f.bessant@keele.ac.uk, 01782 – 734115.

Alternative Formats:

This publication can be downloaded from project website or from the HEA website (<http://www.heacademy.ac.uk/>). For readers without access to the internet, we can provide a CD formatted version. We can also offer a large print or Microsoft Word® formatted version for visually impaired persons. For alternative format versions please contact Sophie Bessant, s.e.f.bessant@keele.ac.uk.

Copyright:

The copyright for this publication is held by the authors of this toolkit. The material may be copied or reproduced provided that the source is acknowledged and the material, wholly or in part, is not used for commercial gain. Use of the material for commercial gain requires the prior written permission of the authors.

Images:

All of the images used in this publication are royalty-free images purchased from: www.fotolia.com® and www.shutterstock.com®.

