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Innovative learning at the University of Edinburgh

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The activities available to civil engineering students during the University of Edinburgh's innovative learning week in 2012 were examined. The academic staff proposed a wide range of possible activities and student participation was optional. Popular activities were those with a 'hands-on' element: making or doing something. The practical activities offered included designing and building trebuchets, relaying railway permanent way on a heritage railway, practical workshops on engineering in international development and learning to juggle. These activities suggested that heuristic learning by trial and error was likely to enhance the visualisation skills that contribute to good engineering design. Further, the linking of achievement to purposeful practice rather than innate talent could inform teaching methods in the future. They also showed that in some cases safety culture messages were still not fully assimilated by students.

1. Innovative learning week – an opportunity for engineering education

In 2012, the University of Edinburgh introduced innovative learning week (ILW) into its academic year. This week provides a time free from normal timetabled classes, during which students can engage in a variety of innovative learning activities. The university provided minimal guidance about what should be offered during ILW, beyond stating it should offer an opportunity for experimentation and innovation in forms of learning without the constraints of the normal curriculum, and that it should not be assessed for academic credit. The implementation of ILW was left to be carried out at department level by individual staff members who were enthusiastic enough to devise and lead activities. This paper discusses the experience of ILW within the School of Engineering at Edinburgh in 2012. The School of Engineering at Edinburgh is large and diverse, covering the disciplines of chemical, civil, electrical and mechanical engineering. It employs approximately 80 full-time academic staff, and provides teaching for over 1000 undergraduates as well as taught MSc students. The activities that form the focus of this paper were mostly based in the civil engineering discipline, but were open to students from other disciplines.

The introduction of ILW within the context of engineering was opportune because it is recognised that there is a need to find ways to engage staff and students in new and innovative methods for teaching and learning that spark students' (and staff's) passion for engineering and education, while helping students (and staff) develop core engineering skills. ILW has provided an opportunity to experiment with such teaching methods and to assess their effectiveness from both staff and student perspectives.

By examining the experience of ILW within civil engineering at Edinburgh, this paper contributes to the ongoing debate about how engineering education can be made 'exciting, creative, adventurous, rigorous, demanding, and empowering' (Vest, 2006), and about how to engage and prepare students for the exhilarating challenges they will face during their careers as professional civil engineers.

The aims of this research are to

- identify what academics do when requested to develop innovative learning activities

- explore how students react to various ideas of innovative learning
- identify some of the positive and negative outcomes of ILW for both students and staff.

2. Literature and context

Engineers require a broad educational base and a remarkably wide range of abilities. In addition to possessing strong analytical skills, according to the National Academy of Engineering (NAE, 2004) the engineer of 2020 will be expected to demonstrate practical ingenuity and creativity; they must be good communicators who understand the principles of business, management and possess leadership skills; they are expected to work professionally to the highest ethical standards and be lifelong learners while exhibiting dynamism, agility, resilience and flexibility.

The importance of learning objectives that go beyond teaching a body of knowledge has long been recognised by educators. Bloom's taxonomy, for example, is a widely used framework to assess the ability of curricula to address student capabilities across a wide range of learning objectives (Bloom, 1956). Bloom's taxonomy identifies three critical learning categories; learning outcomes may be knowledge based (cognitive), may promote emotional development (affective), or may require the physical ability to perform a task (psychomotor). A quick comparison of the attributes required of engineers with Bloom's categorisations reveals all three domains are vital to engineering education. Gaining high ethical standards, dynamism and agility, among others, seem to be learning outcomes that fall into the domain of affective objectives, whereas practical ingenuity seems to combine psychomotor with cognitive learning outcomes.

Despite these likely demands on future engineers, teaching methods in engineering education have changed little over the past 20 years (RAE, 2007). There have been only 'modest improvements from traditional lecture and note taking' (Brown and Poor, 2010). This is problematic as the traditional lecture format is one that intuitively would seem to support predominantly cognitive learning outcomes. In the context of physics education, Deslauriers *et al.* assert: 'It is almost certainly the case that lectures have been inefficient for centuries' (Deslauriers *et al.*, 2011). There is an ongoing debate on how to rejuvenate engineering education to enhance the learning of future engineers, with some calling for 'dramatic and fundamental transformation of the education process' (Kalonji in NAE (2004)). Teaching reform is required to produce better skilled, more motivated graduates who are highly employable and able to manage the complex, multi-dimensional challenges they will face.

The science and engineering education literature contains examples of practice that moves beyond the rhetoric of the traditional lecture. The wealth of literature on problem-based learning is an obvious example of efforts to move to higher-order cognitive learning outcomes (by encouraging students to apply, analyse and create rather than just remember and regurgitate). In addition, there are case studies of projects that aimed to develop those practical skills of engineering students that would contribute to student mastery of affective and psychomotor learning outcomes. Two examples are Forsythe (2009) who exhorts the virtues of physical model making so that students experience the dynamics of construction processes, and Hermon *et al.* (2010) who argue the importance of group design–build–test projects for the engineering curriculum. There is evidence of the learning benefits that can be brought by alternative teaching methods; Deslauriers *et al.* (2011) found that physics students' learning could be more than doubled by employing a 'deliberate practice' method that encouraged students to engage actively during lectures and repeatedly practice solving problems using physicist-like reasoning.

However, these examples are outliers and the challenge remains to find ways to scale-up the delivery of this type of activity such that it becomes the norm rather than the exception. This paper explores one approach to addressing this challenge.

3. Methods

A number of methods have been used to collect the data necessary to inform this discussion.

3.1 Analysis of quantitative data from ILW

Records kept by the Engineering Teaching Organisation at the university of the number of ILW activities put forward by academics and the number of students who signed up to the activities offered were analysed.

3.2 Student questionnaires

Students who participated in the activities run by the authors were asked to complete a two-part questionnaire. The first part was completed prior to undertaking an activity and was designed to ascertain students' motivations and what they hoped to gain. The second part was completed after the activity and asked students to identify both expected and unexpected benefits, and any issues encountered.

Questionnaires were anonymous to allow students to give honest opinions and a linking question (What is the name of the first street on which you lived?) was used to link corresponding before and after questionnaires without giving away the identity of the student.

A content analysis was then undertaken on student responses. A coding scheme was applied to the data to select responses in

Activity name	Description	Bookings/capacity	Did the activity run?	Predominant learning outcome characteristics using Bloom's taxonomy
Sustainability poster competition	A poster competition, to produce poster(s) aimed at the general public explaining the why and how and wider benefit of the tri-generation centre in George Square. Aimed at all first year and second year chemical engineering students, but others welcome.	0/72	No	Cognitive
Civil Engineering Smartphone Guided Tour	**Interesting infrastructure identified around Edinburgh. Tour with questions devised and made available by means of smartphones.**	**96/Unlimited**	**Yes**	**Cognitive and affective**
Engineers Without Borders (EWB) and Royal Academy of Engineering (RAEng) workshops	Workshops designed to introduce students to engineering in international development run by EWB and coordinated by local student and professional EWB members.	75/75	Yes	Cognitive, affective and psychomotor (depending on the workshop)
Trebuchet target practice	**To build trebuchets/catapults to hurl a fixed mass a given distance using selected supplies/budget per team (teams of 3–6).**	**43/50**	**Yes**	**Cognitive and psychomotor**
Railway engineering on the Bo'ness and Kinneil Railway	**Carrying out a variety of civil engineering-related tasks on the Bo'ness and Kinneil Railway (a heritage railway 20 miles from Edinburgh). Strictly practical and hands-on.**	**36/48**	**Yes**	**Psychomotor**
Change the World in a Week: key skills development activities	**A course to help engineers develop key skills by developing an engineering idea that will change the world. Includes idea generation, decision making, concept design and presentation as well as engineering ethics.**	**0/30**	**No**	**Cognitive and affective**
Value of Water scientific communication	**Workshop and public engagement activity. How do people value water? Different aspects of this question will be explored in the workshop along with training in different means of scientific communication. The students will then work in groups to develop an exhibition, activity, website, film, game etc., to communicate one idea related to the value of water.**	**0/30**	**No**	**Cognitive and affective**

Table 1. Details of activities proposed by academic staff: five activities proposed by civil engineering academics are shown in bold type (continued on next page)

Activity name	Description	Bookings/capacity	Did the activity run?	Predominant learning outcome characteristics using Bloom's taxonomy
Energy, Climate Change and Fossil Fuel Depletion Conference	Theme; Energy, Climate Change and Fossil Fuel Depletion. Day 1: Informative/inspirational talks to kick off. Day 2: Students work individually to research topics. Day 3: Facilitated debates and groups formed. Day 4: Groups produce a presentation to reflect the group view. Day 5: Conference where each group presents and the house decides a policy.	0/65	No	Cognitive and affective
Student debates	A series of debates on contemporary topics. Day 2: Meet for group and topic allocation. Day 3: Continue research and preparation. Day 4: Debates held with voting on outcome.	0/60	No	Cognitive and affective
Research Institute (RI) open half-days	Open half-days to be organised by RIs. To be coordinated and delivered by postgraduate students and research staff. Intention is to provide an overview of the broad area covered by the RI (i.e. should not just include local work).	60/95	Yes	Cognitive
Mobile phone mapping exercise	Talks on mobile phone networks. Students will then disperse across Edinburgh to collect signal strength data using smart phones. Group reassembles at end to view/discuss signal strength map of Edinburgh.	13/30	Yes	Cognitive
Visit to UK Astronomy Technology Centre (UKATC)	Students to visit and tour UKATC at Blackford Hill adjacent to campus, to see workshops and current and past projects.	10/10	Yes	Cognitive
Excel Expo	Introduction to Excel.	17/45	Yes	Cognitive
G-Clamp workshop practice	Hands-on workshop practice, to make a simple hand tool.	11/24	Yes	Cognitive and psychomotor
'Bounce: The Myth of Talent and the Power of Practice'	Students will learn to juggle, considering their success against the concepts of innate talent and practice of skills. Based on Syed (2011)	20/72	Yes	Affective
Sustainable Energy Systems seminars	A series of seminars from private sector, international researchers and policymakers on sustainable energy systems.	258/596	Yes	Cognitive

Table 1. Continued

Activity name	Number of participants	Beginning of activity survey responses	End of activity survey responses
Trebuchet building and target practice	43	38	29
Railway engineering on the Bo'ness and Kinneil Railway	36	7	6
EWB & RAEng workshops	75	26	12
Bounce: the Myth of Talent and the Power of Practice	20	13	4

Table 2. Authors' activities and questionnaire response rates

which either a motivation or benefit was identified. These extracts were then grouped into categories in which two or more students had identified the same motivation or benefit. This resulted in quantification of the number of times a particular motivation or benefit had been identified. It was then possible to rank the factors identified in order of popularity.

Responses were collected from different activities with varying degrees of success as can be seen from Table 2. Higher response rates were achieved when students were asked to complete surveys before leaving at the end of the activity. Data collected from two of the activities (the railway activity and the Engineers without Borders (EWB) activity, described below) cannot be considered statistically significant. The activities have been included in this paper as survey responses nevertheless include some interesting insights. Although only four responses were collected for the activity Bounce (described below), this represents 100% of those who completed the activity, however. This is discussed in more detail below.

3.3 Informal conversation with staff from within the School of Engineering

Much informal conversation with the wider university staff regarding ILW has also taken place and this has been referred to below to give an impression of the general tone and attitude that exists towards ILW.

4. Results

4.1 Activities offered

Details of the proposed activities available to civil engineering students are provided in the first two columns of Table 1. Some of these were available across all disciplines within the School of Engineering and some only to civil engineering students. Most were available to students of all years of the degree programmes and mixing of years was encouraged. The five activities proposed by civil engineering academics are indicated in bold face in Table 1. The EWB/Royal Academy of Engineering (EWB/RAEng) workshops were proposed and developed directly by students. A further 18 ILW activities were proposed by School of Engineering staff from the non-civil disciplines, including the ten listed in Table 1 that were available to civil engineering students and a further eight available only to students of other disciplines and hence not discussed in this paper nor shown in the table.

4.2 Student response

The student response to the proposed activities is indicated in the third column of Table 1. Some activities attracted very few bookings, resulting in the activity not going ahead, as indicated in the fourth column of the table. Other activities were full. It should be noted that the activities proposed involved varying time commitments; for example, the trebuchet building and target practice was a 5-day activity, whereas the railway engineering could be undertaken for 1, 2 or 3 days and thus combined with other, shorter activities. Availability of places also varied widely, due to constraints such as room capacities and transport issues.

4.3 Survey results from participating students

Students who participated in the four activities, which were proposed by the authors and went ahead, were asked to complete a two-part questionnaire as described above. Table 2 lists the activities for which surveys were conducted and gives details of the number of students who took part along with the response rates for the activity.

4.4 Motivations for participating

The motivations for engaging in ILW activities varied greatly according to the activity for which students had signed up. The top-ranking factors for motivation to participate are shown in Figure 1.

4.5 Student perceptions of the benefits of ILW

According to the student survey, the top-ranking benefits brought from participation overall were as shown in Figure 2.

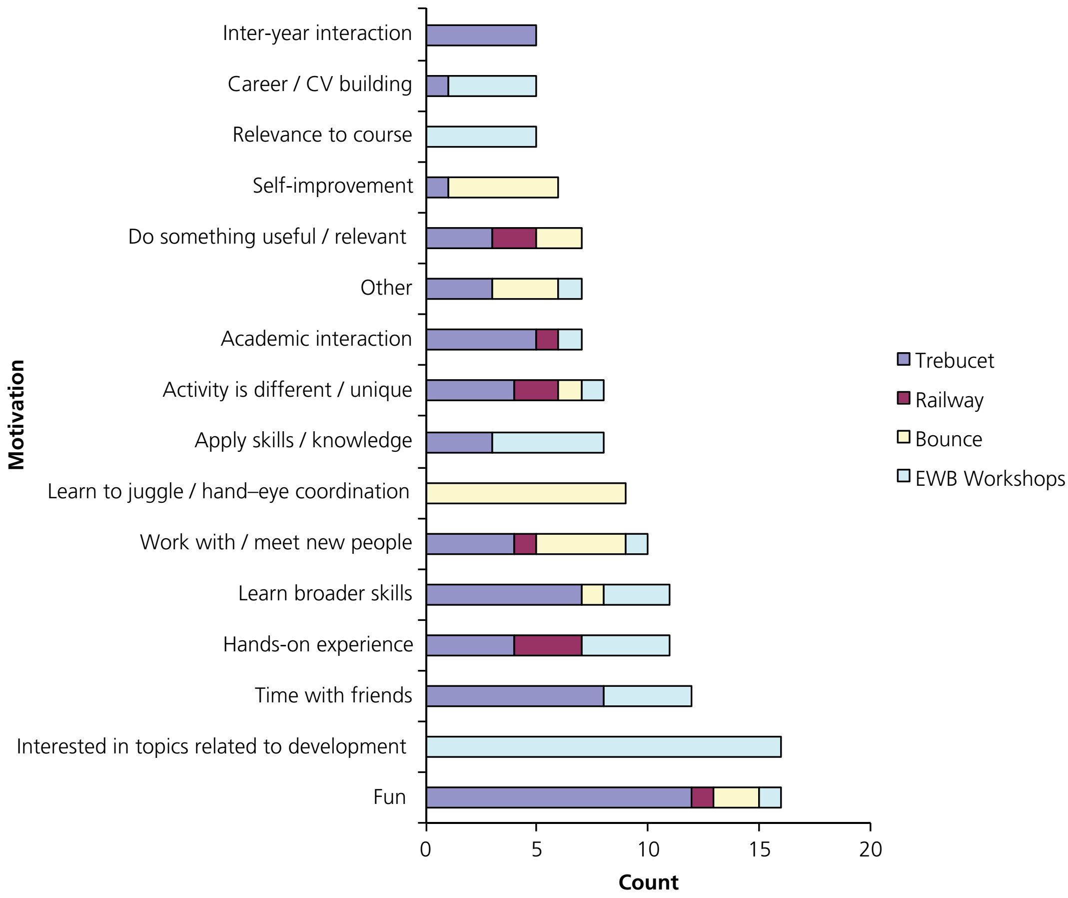

Figure 1. Reasons for engaging with ILW activities as given prior to ILW

These varied by activity, with each of the activities also producing unforeseen benefits, as detailed in Table 3.

5. Discussion

5.1 Breadth of ideas about what constitutes innovative teaching

ILW provided an opportunity to explore the response of academics when asked to contribute activities they consider innovative. Despite an element of self-selection, which arose due to academics choosing to opt-in or opt-out of organising ILW activities, the activities that were offered to civil engineering students suggest highly divergent ideas across the School of Engineering about what constitutes innovative teaching. This mirrors the range of opinion held more broadly throughout the academic community. The continued prevalence of the traditional lecture would seem to imply that many academics do not see the need for change, or are unwilling or unable to engage in change. Others, however, expound the need for new and innovative alternatives (see above). The literature reveals a variety of disparate views on the topic of innovative teaching methods to replace the traditional lecture.

At Edinburgh, some academics led ILW activities, which aimed to help students develop specific skills such as the use of software (Excel Expo), or workshop skills (G-clamp workshop practice). Others targeted scientific knowledge more or less related to curricula within the School of Engineering (Energy, Climate Change and Fossil Fuel Depletion Conference, visit to UK Astronomy Technology Centre, Sustainable Energy Systems seminars). Other activities were more unusual, but still classroom based (Change the World in a Week, Value of Water scientific communication). Others, including the four activities analysed in this paper (Table 2) were specifically aimed at being hands-on, practical activities carried on outside the normal classroom environment, and to develop skills, knowledge or thought processes that have not hitherto fitted into

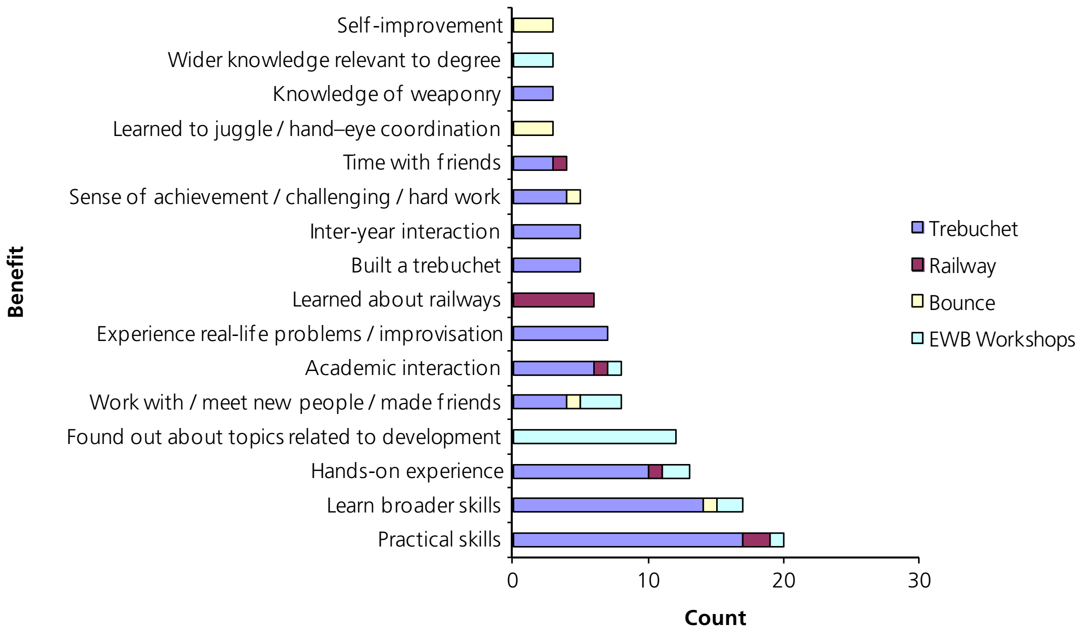

Figure 2. Benefits of participation in ILW from student survey

standard curricula and tended to be of a more affective or psychomotor nature.

5.2 Pedagogic issues for engineering learning

With specific regard to the trebuchet activity, it was notable that only two of the 11 designs actually worked. This was surprising to the authors given the information available on trebuchet design and the known ability of the students. Bearings and connections were almost universally weak points in the designs, and despite their extensive theoretical training in the preceding years of the curriculum, no students working on the trebuchets appeared to have done any design calculations,

Activity	Unexpected benefits itemised by the students
Trebuchet	Engineering judgement
	The ability to cope with failure
	Making use of limited resources
	Learning much about how wood connects together
	Understanding the difference between design and implementation
	Experience of real-life problems and the need for improvisation
	Thinking about things differently
	Sense of achievement
Railway	Meeting older generation of people working on the railway line
	Got to learn more than expected from professionals as they were open to any questions
	I was surprised how much dedication and pride the volunteers had for the railway
Bounce	Sense of achievement
EWB/RAEng workshops	Different viewpoints
	It made me realise charity organisation is not as simple as it seemed to me
	Think about things differently

Table 3. Unexpected benefits by activity

and the drawings submitted were artistic impressions rather than engineering communications. It is postulated that this was in part a result of students' initial perceptions that ILW was primarily intended to be fun and they would not be required to think.

The authors who teach design classes have noted that the standards of drawing and sketching – despite explicit teaching – remain poor. They also note that civil engineering students are not actually being given sufficient practical experience of designing and making things. Most curriculum laboratories are highly prescribed, and there is no opportunity to learn heuristically, by trying something and failing (or succeeding). Yet without a practical understanding of 'how things work' it is difficult for students to visualise a design concept and hence learn to draw or sketch it usefully. Through the trebuchet activity, many students had the opportunity to develop their emotional resilience as they experienced the failure of their development, whereas actually building something gave them an opportunity to develop skills in the psychomotor domain.

Failure was also significant in Bounce. This activity, based on Syed (2011), juxtaposed the idea of innate ability with that of purposeful practice to achieve a skill, and central to this is the acceptance of repeated failure prior to success. Syed gives the example of a skater who fell 20 000 times before successfully performing a quadruple loop, and notes that the idea of embracing failure seems to be generic among elite performers; they fail more than non-elite performers. This would tend to support the view further that students would benefit from more opportunities for heuristic learning.

The essence of EWB-style engineering is applying relatively simple engineering concepts to complex and often contradictory social circumstances. Through an introduction to 'appropriate technologies', the students had to think hard about the end-user of their designs, which is an integral skill to becoming a successful engineer in the UK industry, but difficult to teach in a formal university classroom environment. Their ability to consider their development from the perspective of another is a critical learning objective for engineers, which falls into the affective domain.

Teaching resources, not just staff and money but also curriculum time and physical space, are an issue here but the authors believe more can be done to teach open-ended design, making mistakes and going round the design cycle of conceive, visualise, refine, communicate, implement.

In passing it was noted that at least one student building a trebuchet did not know how to use a screwdriver.

5.3 Student response to the innovative teaching methods implemented

Signing up to ILW activities was optional for civil engineering students. Although some activities were fully booked, others did not run due to complete lack of interest in some cases, as shown in Table 1. In this way the students made clear their preference for particular types of activities. The survey conducted with those students who did sign up suggested that they opted for activities that they perceived as fun, hands-on and that offered an opportunity to mix with other students and academics, as shown in Figure 1. The students voted with their feet and those activities with psychomotor learning outcomes seemed to be the most popular. By contrast, activities that were classroom based and of a more cognitive nature were less popular. This is perhaps not a sign that students do not perceive the importance of cognitive learning, but rather that they too have observed that the regular curriculum provides plentiful opportunities for cognitive learning, but less for broader learning objectives, such as those that fall in the psychomotor domain.

In addition, some students opted for activities in a subject area in which they had a specific interest. For example, the railway activity attracted students with an interest in railways and EWB workshops attracted students with an interest in international development (Figure 1).

Those activities that were classroom based and of a more general nature tended to be less popular. For example, activities such as Change the World in a Week and the Value of Water did not run. Both activities offered students the opportunity to learn useful skills, but clearly did not match student requirements for ILW. A further issue may have been the differing levels of time commitment between activities, with some students wishing to take part in something, but avoiding activities that required the full week.

5.3.1 Outcomes of ILW for students

The outcomes of ILW determined from the student survey are indicated in Figure 2 and Table 3. The unexpected outcomes, which were all suggested without prompting by individual students, are particularly interesting. Many of the comments under the trebuchet activity echo the authors' perceptions regarding design teaching discussed above, but it is also salient that no student mentioned anything to do with safety, perhaps re-emphasising the continuing cultural gap in this area.

Although not a top-ranked benefit for any activity, one pervasive piece of feedback was that students overwhelmingly found the week fun; in fact, nobody who filled out a survey said they had not had fun. A selection of quotes in response to the survey question asking students if they had fun is included below.

- 'Yes, it was incredibly fun, innovative and hard work' (trebuchet).
- 'Yes, very enjoyable. Won't get a chance to do it anywhere else' (railway).
- 'Yes – Learned a new skill and learned that through deliberate practice it doesn't take long to learn a new skill or improve on one' (Bounce).
- 'Definitely. Amazing. Really enjoyed it' (EWB).

As noted by Willmot and Perkin (2011), 'A key challenge for universities is to provide motivators beyond those gained by the award of marks'. The students who took part in ILW did so despite there being no academic credit available for participating, indicating that the activities successfully motivated students to participate in engineering activities where no academic credit was available.

5.3.2 Student-led activities

ILW provided an opportunity for students to lead activities in which they have a particular interest. The EWB/RAEng workshops were co-ordinated by students themselves, with support from the EWB head office in Cambridge. This enabled students to take ownership of the learning opportunity, encouraging them to focus on design applications that were genuinely interesting to them, but still, of course, underlain by traditional engineering theory. By teaching on topics about which students were passionate, the workshop sessions were made more inspiring for participants than is sometimes the case with traditional teaching.

5.3.3 A growth mindset

Deslauriers *et al.* (2011) have demonstrated the benefits that 'deliberate practice' can bring in physics education. In the same way, through Bounce, it was clear that improved skills (in juggling) correlated with the amount of practice participants had put in. There was a high drop-out rate from this activity and it has not been possible to collect the opinions of those students who did not complete the activity. It is possible that those students who had not found time to practice their juggling decided not to attend the final activity session.

Of those students who did attend the final session, it was found in some cases that too much practice without resting made performance worse. This showed that for many there was an optimum practice/rest schedule. While those participants who attended the final session did some practice, only one person managed to practice for the target of one hour per day for the week; this is an important finding and leads to the question of what motivates someone to practice, or engage deeply with a topic.

The concept of a 'growth mindset', where great performance stems from careful practice, rather than talent, is highly applicable to any complex activity including engineering. In his book Syed quotes a figure of 10 000 h of purposeful practice (typically over at least 10 years) to achieve mastery, a figure that appears to be generic, leading to the question, 'How long does it take to become a good engineer?'.

6. Challenges for ILW

6.1 Safety culture

One important factor in some of the authors' ILW activities was safety. This was particularly significant in the trebuchet activity, which involved practical work using hand and power tools and relatively large pieces of wood and other components, and then shooting projectiles in a sometimes unpredictable direction; and in the railway activity, which involved relaying railway track, working with heavy components and tools and in proximity to road–rail equipment and with occasional works train movements.

Both these activities were subject to detailed risk assessment and safe systems of work, which included compulsory safety briefings. In the case of the railway activity the provisions of this were generally followed by the students, with only a few minor infringements such as standing between a rail vehicle and a bridge parapet and passing uncomfortably close to the road–rail equipment while it was slewing.

In the case of the trebuchet the safety message from the briefing seemed to have been less well absorbed. Students were observed entering the workshop sessions without safety footwear or safety glasses, sometimes repeatedly and after individual warnings. It was noted that some of the university's technical staff present were not a good example on this matter. Some students also failed to follow protocols when shooting projectiles and in one case two students were asked to leave the shooting area after being observed jumping on a piece of wood containing sharp screws while wearing only trainers – having changed out of safety boots slightly earlier.

Clearly the issue arises as to what can be done to instil a safety culture further in students (and staff, but the mission here is primarily to form the young civil engineers who will need to pass on this message in the future). It is postulated that a key difference between the two activities was that whereas both were unfamiliar to the students, the railway activity was very obviously in a new environment with very obvious hazards (trains and road–rail equipment) whereas the trebuchet building was taking place on university sports fields with which the students were accustomed as regarding as 'safe' in other contexts. This may suggest possible ways of teaching safety culture in the future by taking students away from the familiar.

A dilemma faced by staff with all the safety incidents was immediately to exclude the student from the rest of the activity, or simply to carry on emphasising the message with individual announcements to individuals or groups. The latter approach was the one taken, it being deemed both unnecessary and not conducive to learning to exclude students given the nature of the incidents that actually occurred.

6.1.1 Academics not contributing

At the time of ILW there were 16 full-time academic staff employed in the civil engineering discipline within the School of Engineering. Only six of these were involved with one or more proposed ILW activities. Across the school, around 30 academic staff proposed ILW activities, leaving 50 who elected not participate.

In part this may be because many are currently involved in delivering a number of initiatives that aim to enhance the student experience. ILW is just one of these initiatives. Contribution to ILW, unlike contribution to some other initiatives, is not compulsory for either students or academics.

An issue receiving continued attention in the science and engineering community is the debate over the relative importance of research versus teaching (for example, refer to recent articles in *Nature* and *Science* (Anderson *et al.*, 2011; Macilwain, 2011). The authors' perception following informal conversation with other academics is that with a limited number of hours in the day and stronger pressure to achieve research rather than teaching goals, many did not feel they had the time available to contribute to ILW activities.

6.2 Rewards for participating staff

Academics who did contribute to ILW activities did so with a clear understanding that doing so would not lead to any tangible reward such as enhanced promotion prospects, salary increase or other payment or compensatory time to spend on other activities.

However, the authors' experience in leading their own activities (Table 2) was universally positive. They enjoyed interacting with students in a more informal manner, seeing students develop new skills and knowledge, and developing new skills and knowledge themselves. As one author commented at the time, 'What a brilliant week, I'm proud of us!'.

7. Limitations and further work

A limitation of the research is the small sample of data collected for three of the four activities. That said, it is hoped that findings can still contribute to the important on-going debate into how further education institutions can best educate the next generation of engineers.

ILW will be repeated in 2013 and 2014, and further hands-on activities will be proposed and their effectiveness analysed to develop these themes. In the future it would be useful to collect more data about the participants. For example, it would be interesting to be able to compare results across year groups and by sex.

8. Conclusion

Activities available to civil engineering students during the University of Edinburgh's ILW in 2012 were examined. It was concluded that academic staff took a wide view of what constituted innovative learning, but that the activities most attractive to students were those with a 'hands-on' component involving making or doing. These practical activities exposed in some cases that safety culture messages still had some way to go to be embedded in the student mindset. They also suggested that heuristic learning incorporating the experience of failure prior to success was likely to enhance the visualisation skills needed for good engineering design, whereas the linking of achievement to purposeful practice rather than innate talent could inform teaching methods in the future. Despite the practical challenges of delivering innovative learning, it provided an opportunity to cover learning objectives that are crucial to engineers, particularly those classified under Bloom's taxonomy as affective and psychomotor, which are difficult to deliver in a classroom environment. The authors believe there is a strong case for making greater efforts to include this sort of teaching more widely in civil engineering curricula.

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Appendix: Student survey questions

A1.1 Beginning of week questions

A1.1.1 About the questionnaire

The purpose of this questionnaire is to collect your comments about your experience during ILW. The data collected will be used in two ways.

1. To help improve ILW next year.
2. To write an academic paper telling other universities and

teaching staff about the experience of ILW and the benefits and difficulties of carrying out such a week.

YOUR ANSWERS ARE ANONYMOUS

A1.1.2 Beginning and end of week questionnaire linking question

The questions are to be answered anonymously but we would like to be able to match your answers at the beginning of the week with those given in the questionnaire at the end of the week. This question will be on the end of week questionnaire – please give the same answer.

What is the name of the first street in which you lived?

A1.1.3 Questions

In which activity are you currently taking part?

How important were the following factors to you when you were choosing which activities to undertake? Please score between 1 (not important at all) and 5 (very important).

- how much fun the activity looked
- what you might learn from the activity
- which staff were organising the activity
- the time commitment necessary to complete the activity.

What other reasons contributed to your decision to take part in this activity?

What do you hope to gain from taking part in this activity? (e.g. skills – personal or professional, time to socialise with other students, mixing with the academics in a less formal environment, or other).

A1.2 End of week questions

A1.2.1 About the questionnaire

The purpose of this questionnaire is to collect your comments about your experience during ILW. The data collected will be used in two ways.

1. To help improve ILW next year.
2. To write an academic paper telling other universities and teaching staff about the experience we had of ILW and the benefits and difficulties of carrying out such a week.

YOUR ANSWERS ARE ANONYMOUS

A1.2.2 Beginning and end of week questionnaire linking question

The questions are to be answered anonymously but we would like to be able to match your answers at the beginning of the week with those given in the questionnaire at the end of the week. Please give the same answer as the one you gave at the beginning of the week.

What is the name of the first street in which you lived?

A1.2.3 Questions

Which activity have you just completed?

Did you enjoy the activity? Was it innovative?

Did you get what you wanted to out of the activity? (Please give details of anything you wanted to get out of the activity that you feel you didn't).

What benefits did taking part in this activity bring you? (e.g. skills – personal or professional, time to socialise with other students, mixing with the academics in a less formal environment, or other).

Were there any unexpected benefits from taking part in the activity?

What would you recommend is changed about ILW for next year?

Do you have any other comments about ILW?

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