

*working together to enhance understanding,
commitment and participation in engineering*



Engineering the Future

Seminar Report

June 2007

EPSRC Engineering and Physical Sciences
Research Council



Engineering the Future

Seminar: Ross Priory: 11/06/07

Report

1 Introduction

- 1.1 The Engineering the Future Project is committed to holding an annual seminar. This event was the first of these.
- 1.2 The seminar was intended to serve a number of different purposes. These included:
 - the opportunity to celebrate and recognise the work that had been done in the first year of the Project, especially by colleagues in schools and universities who had been collaborating on development work within schools
 - to allow these collaborative groups to see what others had done with a view to trialling next session
 - to review the work that had been done throughout the year
 - to use this review to plan ahead for the next year
 - to encourage all associated with the Project to contribute to this review and planning
 - to introduce themes which would be aspects of the next session's work
 - to share with policy makers and possible ICT partners emerging themes or issues within the Project

2 Participants

- 2.1 Members of the following groups participated:
 - the project team/operational committee
 - the Advisory Board
 - partner schools
 - university EEE participants
 - representatives of Education Authorities involved
 - representatives of educational bodies in Scotland (SQA, LTS)
 - representatives of possible partners in ICT/e-learning (Agilent, RS Components, TPLD)
 - EPSRC mentor
- 2.2 Full texts of the PowerPoint presentations, of stimulus and discussion papers used at the seminar, of the posters produced by the school collaboration groups, and of summary reports of discussions have been placed on the Moodle site and will be placed on the Engineering the Future website.

3 Programme

- 3.1 The programme was structured to allow for a variety of types of input and contribution. It was intended to ensure that all participants had an opportunity to make sure that their knowledge, experience and views were heard.
- 3.2 Following registration and the formal welcome, Gordon Hayward and Louise Hayward reviewed the points from which the Project had departed and outlined the work of the past year. Steve Mesure then ran a session designed to encourage discussion and sharing throughout the day and to set a tone which was both informal and serious.
- 3.3 All participants had an opportunity to attend the poster sessions at which representatives from the schools outlined the work that had been carried out by the school university collaborative groups.
- 3.4 In parallel with these sessions participants were able to attend discussion sessions either on developing young peoples' engagement with engineering as a profession or on the development of e-learning; the latter was led by Helen Routledge of TPLD.
- 3.5 The afternoon was divided into three sessions. In the first of these Noel Entwistle, who is a member of the Advisory Board of the Project, rehearsed issues with the whole group derived from his research into teaching and learning in engineering at undergraduate level. Discussion developed some of the implications of these for the Project both at school and university level.
- 3.5 After this participants worked in small groups on discussing a number of previously distributed scenarios which raised issues regarding collaboration between sectors, curriculum development, learning beyond the classroom, sustainability, CPD, e-learning. From these discussions participants were asked as a group to identify the main critical issues arising. The afternoon closed with a presentation from Louise Hayward on the main points to be taken forward in the next phase of the Project.

4 Engineering the Future: the story so far

- 4.1 Louise's initial input 'Engineering the Future: the story so far' reminded participants of the main aims of the Project:
 - to enhance awareness of engineering
 - to promote enthusiasm for engineering among school pupils
 - to increase the numbers of young people embracing engineering as a career
 - to develop excellent teaching of engineering and associated concepts in schools and universities.

This raised research issues such as:

- can we get a better understanding of what the problems are?
- can research in what matters in real change help?

practice issues such as:

- can we help pupils to develop a clearer idea of engineering?

- through innovative, exciting engineering opportunities across schools and universities with high quality learning?
- through good careers' advice?

and policy issues, especially:

- can we embed engineering in curriculum and assessment policy?

4.2 This presentation also afforded an opportunity to share some of the early findings from the analyses of questionnaires completed by pupils, students, teachers and university staff. These included:

- of the 869 school pupils who had completed questionnaires (in all years from S3 to S6 45% were female and 55% were male while of the 177 first year university students 5% were female and 95% were male
- of the school pupils who had completed questionnaires 96% had received advice on subject choices from some source
 - careers advisors (17%)
 - senior/guidance staff (54%)
 - other teachers (3%),
 - other sources [e.g. internet] (25%)
 - family/friends (86%)
- 65% of these school pupils had never considered engineering as a career choice - of the 289 respondents who had, 78% were male
- Over 50% did not note any encouragement to study engineering/take up career with 56 (7%) suggesting they had been discouraged by teaching staff but
 - 10% noted the encouragement of careers advisors
 - 30% said teachers had encouraged them
 - 32% noted the encouragement of family and/or friends
- 85% had not participated in any out-of-school activities related to physics or technological studies.

4.3 Of the University students 94% were aged 17-22 and only 0.6% were aged 26 plus; 92% come from Scotland; 97% are at both their first choice university and on their first choice course.

4.4 Students' perceptions (10%+) of essential/very helpful subjects for university were maths 90%, physics 88%, other technology-related subjects (computing often named) 30%, technological studies 16%. When asked about courses they would have found helpful or wish they had studied the following emerged: AH maths 19.8%, technological studies 19%, AH physics 12%, other tech subjects (computing often named)12%.

4.5 These students first became interested in engineering at different points in their lives: primary school 12%, S1/2 11%, S3/4 39%, S5/6 31%, later 9%. A significant number had family members in engineering - 56% with a further 9% noting a close link. The highest scoring 'encouragers' at 77% were family and/or friends and at 63% were university open days/visits, and at 58% teachers in school.

- 4.6 29 university & school staff, 16 from schools and 13 from universities had completed questionnaires. There were a number of clear statements arising from these:
- understandings of each others' curricula were poor - school staff knowledge of general engineering programmes was marginally better than their knowledge of EEE programmes
 - university staff knowledge of AH physics was marginally better than of other subjects
 - there is clearly a need and a desire to increase mutual understandings
 - school and university staff are agreed that most young people understand very little about engineering as university subject/career and that talented students are as, if not more, likely to look to other subjects such as medicine and law
 - AH maths and physics were university staff preferred subjects
 - most noted the need to engage young people in engineering related activities with clear relevance to their lives and concerns
 - obstacles to progress in schools clustered around time in an already crowded/prescribed curriculum, the need for change/ agreement from policy, funding/resources, teacher knowledge, buy-in/support from colleagues, parents, health and safety, pedagogy and curriculum, links and materials
 - ways of ensuring progress in this project focussed on overcoming obstacles above and building stronger links between universities and school.
- 4.7 In terms of practice the Project had identified a number of issues:
- there were some concerns about curricular inserts alone: need for other activities, eg, roadshows, opportunities to visit universities, engineering companies
 - developing awareness of major differences between school and university pedagogy and pace of work
 - recognition of the difficulty of ensuring for teenage pupils "deep learning" of complex concepts, including the nature of electricity.
 - discrepancy between what the SQA syllabuses require and what university colleagues would regard as up to date Physics/Engineering work.
- 4.8 In terms of policy the Project:
- had had an influence on Curriculum for Excellence (CfE) Science Review
 - been involved in discussions with Directorate of Learning and Teaching Scotland (LTS) which led to planned discussions on continuing professional development and GLOW
 - been involved in discussions with the Qualifications and Curriculum Authority for England (QCA)
 - had received support from industry
 - had built links with other groups, eg, Crescendo
 - was planning discussions with SQA, SEED, the Chief Scientific Officer and Careers Scotland

- 4.9 The CfE outcomes in science, as all CfE outcomes are expected to be, will be broadly defined, thereby allowing the greatest range of possibilities to schools as to how to take these forward. A couple of the CfE Science outcomes are already directly exemplified in development work being done in our programme.
- 4.10 This input concluded by indicating that the Project was looking for advice on:
- How do we communicate the essence of Engineering?
 - What advice should we be offering to the Curriculum for Excellence team?
 - What kinds of activities might we want to encourage beyond the classroom?
 - What might good e-learning in Engineering look like?
 - What good CPD would look like?
 - What do we have to do to involve other schools and Universities?
 - How do we sustain change over time?

6 Engagement with engineering

- 6.1 Elsa Ekevall had prepared a summary paper of the main research findings as to why young people do not find engineering an attractive profession. Those who participated in this session were asked to discuss these findings in small groups and to feed back their responses to questions on their own experiences in this area, on the factors that they perceived as most important, on the means that could be developed to encourage well qualified pupils to consider engineering as a career and on the strategies and approaches which they considered would be most effective in improving pupils' perceptions of and attitudes to engineering.
- 6.2 A number of practical suggestions emerged from this which can be taken forward by the Project next session. These included support for the work already undertaken such as curricular inserts, confirmation of the hypotheses being developed within the Project on current careers education, suggestions for practical improvements to careers education and practical suggestions for increasing the exposure of pupils to real engineers as role models.

7 E-learning

- 7.1 This session was led by Helen Routledge of TPLD. Helen argued that e-learning has great potential because in brief:
- A paradigm-shift has occurred: e-learning has become more significant than print as a means of learning and under-35s are 'digital natives'
 - Effective e-learning is not automatically facilitated just by the existence of the technology: it also exploits the potential of experiential learning; its key characteristics are that it is learner-centred, involves 'learning by doing' and is very engaging.
 - Games are 'powerful learning tools' which can improve learning, literacy, communication, teamwork

- All the learning and teaching aims set out in the ETF principles papers are promoted by e-learning.

7.2 The following points were significant in the discussion.

- Simulations differ from games in that simulations usually involve right/wrong decisions and/or are representations of “real life” made manageable for a learning/teaching situation while the key feature of games is to motivate engagement through their fun element.
- Though there is a potential marketing problem in the educational context because games might be perceived as ‘trivial’; they can be a means of ‘rolling out rich content’
- There will be a need to create e-learning materials that can be integrated in the curriculum and that can take account of cross-curricular issues important in engineering, such as marketing and economic growth
- There is a lot of physics in many commercial games which schools could exploit
- If we want to develop the potential of e-learning fully, we should be seeking the collaboration of ‘digital natives’ – young people themselves.

8 Poster sessions

8.1 All participants attended one of the two parallel poster sessions at which staff from the school university partnerships presented the work that they were doing. This allowed discussion to take place with colleagues who might be piloting these developments in their schools next session. Colleagues had been encouraged to relate their presentations to the ‘big ideas’ which had been identified from their questionnaire responses at an early stage of the Project and were also encouraged to consider these developments in the context of the implementation of a *Curriculum for Excellence*. They were asked to bear in mind the ways in which these developments might develop aspects of each of the four capacities: and promote such principles as challenge and enjoyment or personalisation and choice.

9 Teaching and learning in electronic engineering

9.1 Noel Entwistle presented for reflection some of the key messages which had emerged from the Enhancing Teaching-Learning Environments in Undergraduate Courses project which had been based around Edinburgh, Durham and Coventry Universities.

9.2 The main concepts used in the ETL project were:

- Ways of thinking and practising in the subject
- Teaching-learning environment provided
- Constructive alignment of teaching with aims
- Students’ approaches to learning & studying
- Students’ experiences and perceptions of the teaching-learning environment

- 9.3 A key message regarding constructive alignment of teaching with aims is summarised by John Biggs: ‘A good teaching system aligns teaching method and assessment to the learning activities stated in the objectives, so that all aspects of this system act in accord to support appropriate learning. This system is called constructive alignment, based as it is on the twin principles of constructivism in learning and alignment in teaching.’
- 9.4 Students demonstrated three main approaches to learning and studying:
- Deep approach - seeking personal understanding
 - by questioning, relating ideas and looking for patterns
 - Surface approach - reproducing lecturer’s material
 - by following routine procedures and memorising
 - Strategic approach - intending to get high grades
 - through awareness of assessment procedure, organised studying, time-management, effort and concentration
- 9.5 This presentation stimulated discussion on the implications for teaching in EEE including such matters as the concept of ‘threshold concepts’, the demands for coverage, the balance between knowledge and skills, and the importance (and possible difficulties) of encouraging deep learning.

10 Scenario discussion

- 10.1 George MacBride and Elsa Ekevall had prepared a set of six scenarios which participants were asked to discuss in small groups. These were intended to encourage reflection on certain key aspects of the Project (curriculum development, CPD, encouraging engagement through extra-curricular activities, the relationship between assessment and learning, cross-sectoral collaboration) and in particular how sustainable change can be fostered.
- 10.2 This led to a number of conclusions reported more fully elsewhere. Some significant pointers for sustainability as identified by participants were:
- the creation of a mechanism at national level to provide opportunities to share best practice:
 - sustainable change requires clear evidence of support at all levels including a clear allocation of time & reward (staff) & resources
 - all partners must see value in a project: school/university management; pupils; parents; teachers; university staff
 - while pupils must have ownership they will only work with change if they see that staff see the value and are willing to put in time and effort to plan
 - engineering inputs must be seen as a valued part of the course at school level and nationally, properly resourced and evaluated

11 Engineering the Future: to boldly go.....

- 11.1 Louise Hayward summed up some of the principal indicators from the experience of the day for setting the agenda and the direction of the development of the Project over the next year.
- 11.2 Policy – issues arising today:
- Availability of SQA qualifications in engineering at Higher/Advanced Higher levels?
 - Impact of age and stage flexibility for increased opportunities in engineering?
 - CfE relationship between science & technology?
 - CfE space within outcomes?
 - New government priorities – opportunities to explore links?
 - Discussions with LTS & SQA about curriculum & assessment in engineering
 - Discussions with government about the relationship between governmental, economic, social and educational priorities & issues arising from this project
 - Discussions with industry about joining-up & realising educational and industrial priorities
 - Discussions with Education Minister & national/local education directorates around implications, e.g. resources, staff development
- 11.3 Practice issues included:
- To put into practice the programmes already developed by school-university teams
 - To develop further programmes in other areas of the curriculum
 - To consider trying-out one other programme developed by a different team
 - To begin to review first year university courses
- 11.4 Research pointers included:
- disseminating findings from 3 questionnaires
 - conducting follow-up interviews to explore more deeply and test initial trends
 - analysing and disseminating findings from careers interviews and follow-up with new careers materials plus perception evaluation
 - exploring impact of engineering programmes on pupils' understanding of engineering
 - exploring what makes good relationships between schools and universities
 - disseminate findings from 3 questionnaires
 - conducting follow-up interviews to explore more deeply and test initial trends
 - analysing and disseminating findings from careers interviews and follow-up with new careers materials plus perception evaluation
 - exploring impact of engineering programmes on pupils' understanding of engineering
 - exploring what makes good relationships between schools & universities

12 Evaluation

12.1 Feedback was positive: some significant extracts from the summary paper:

1. Did the seminar meet your expectations?

Yes 100 %

2. Did you find the seminar useful?

Yes 94 %

4. Please rate in order how important the following session types are for next year's seminar (1 = most important and 6 = least important).

Discussing the curricular inserts (poster session)	2 nd
Formulating project strategies and/or recommendations	5 th
Hearing from invited speakers	4 th
Learning about project progress	2 nd
Sharing good practice (parallel sessions)	1 st
Working on case studies / scenarios	6 th

6. In what ways do you think the seminar supports the project?

Reinforcing commitment, motivating all - emphasising value of all involved.

To feed ideas, share concepts and provide an open discussion forum.

Allows interaction between people from different sectors.

Sharing good practice is always beneficial to all.

Involves key stakeholders and disseminators.

A necessary beginning - extending feelers.

Awareness raising; feedback.

Valuable opportunity to share ideas and understanding.

Focus.

Sharing ideas and motivating. Chance to present new ideas to the group.

Brings practitioners together as a community of equals - stimulating and challenging for participants, who engage themselves as a result.

More time in the future to discuss, demonstrate possible projects.

Communicating with other groups.

7. How do you see the seminar contributing to the future development of the project?

I now have more of an idea of what everyone's needs / wants are.

To feed ideas, share concepts and provide an open discussion forum.

Through acting as a conduit to input ideas to the framework and engage 'frontline troops'.

If more schools could be involved, even through just informing them of progress to date, expanding process - bound to have more impact.

Awareness raising; feedback.

Maintaining momentum / sharing ideas and practice. Continuous reappraisal of 'future steps'.

Some useful ideas about what needs to change to ensure sustainable development and changes in attitude and practice.
Very positive - follow ups necessary.
Communicating with other groups.

13 Thanks

- 13.1 Thanks are due to the staff of Ross Priory who ensured that the day was a comfortable and enjoyable experience for all participants.
- 13.2 Particular thanks are due to Lynn Morrison and Sylvia Whitelock in the offices of the Department of Electronic and Electrical Engineering in the University of Strathclyde for all their technical advice, administrative support, attention to detail and good humour.