The enquiring mind knows no boundaries: does teaching across the disciplines have to be so different?

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Abstract

Enquiry Based Learning (EBL) has been gaining momentum in undergraduate programmes internationally. It is argued [1, 5] that EBL provides students with a learning experience through which they develop professional and personal skills as well as attributes ranging from teamwork and leadership skills to problem solving and information literacy. They can also develop attitudes such as acceptance of responsibility for their own learning and actions.

EBL is crucially seen as a learning approach that supports the development of academic skills and generic research skills, hence operating at the interface between teaching and research and motivating students to learn in 'research mode'. At the heart of EBL is an environment in which the learners are supported in determining their own lines of enquiry: identifying what is already known in relation to the stimulus; what needs to be learned; what information is required; how it is to be acquired, processed and applied; and how it is to be shared with others [1].

Development of this general pedagogy attempts to engage with an increasing range of disciplines by building on well-established approaches to teaching and learning within those disciplines. These approaches may be described by terms such as Problem Based Learning (PBL) [5]; design exercises; investigations; case studies; and project based learning. The essential, common ingredient is that an initial stimulus (the problem, scenario, design specification, area for investigation or case) engages and motivates the learner(s) to pursue particular lines of enquiry, through which learning is achieved and new knowledge created. The learners, usually working in small groups, are guided through the investigation process by a tutor/facilitator, and are supported by a wide and diverse range of resources including online, paper based and human resources.

However, particular, discipline-specific, approaches to the pedagogy appear to evidence variations in practice, which may lead to differences in the learning outcomes achieved. These variations may be based on fundamental differences in the pedagogy of disciplines, or they may simply reflect the ways in which EBL is interpreted in the cultural and experiential context of the disciplines.

In this paper, we consider EBL practice in each of three Schools in a large, research intensive UK university in order to gain a better understanding of

teaching across the disciplines. Each School has introduced a large-scale EBL implementation, supported by a central development support unit and an external educational development consultant. An analysis of the literature of EBL has been used to underpin initial ethnographic and action research programmes, which have identified

- staff conceptions of EBL and their role as facilitators of student learning
- methodological approaches to EBL
- student learning experiences and learning outcomes.

This study has identified variations in EBL implementation which seem to be based on the traditional teaching practice within the discipline rather than on any pedagogic need of the subject.

Key words

Enquiry Based Learning, Problem Based Learning, educational developer

Background to the development work

Centres for Excellence in Teaching and Learning

The Higher Education Funding Council for England (HEFCe) announced its funding and support for74 Centres for Excellence in Teaching and Learning (CETLs) as the result of a competitive bidding process. These five-year initiatives were awarded in 2005. The University of Manchester was one of the successful bidders and established the Centre for Excellence in Enquiry-Based Learning (CEEBL) in April of that year. The Manchester bid was based on a claim for excellence in EBL and associated practices (e,g, student development, peer mentoring and peer assisted study) in many subject areas across the University, but particularly in the Faculty of Medical and Human Sciences. The ensuing strategy for promoting EBL through the CEEBL initiative centred around support for small-scale, largely module-focused developments (1-year) as well as large-scale Faculty projects (3 years).

Enquiry-Based Learning

The Manchester model of Enquiry Based Learning [2] puts students at the heart of the process. The students identify and pursue their own lines of enquiry and decide on the resources they need to inform their investigations. On being presented with the stimulus, they identify key issues and topics, explore and clarify what is already known, what information still needs to be gathered, and how it is to be evaluated, used and shared. It is an open, flexible, social and supported form of learning that values, stimulates and nurtures people's natural capacity for enquiry.

The model does not support the concept of EBL as an umbrella term, which 'gathers' Problem Based Learning, student projects, dissertations, research based learning, design studies and other student-centred learning activities under a common heading. Nor does it simply ‘badge’ these forms of learning as EBL without transforming them in some way. The model recognizes that the pedagogy has grown in a generic sense, rather than from within a particular subject or discipline, such as PBL (nursing and health education) and design studies (engineering). Hence the principles that apply are generic to learning and not specific to a subject.

Some of these principles include a change of role for the tutor as facilitator, sharing or letting go of ownership of the learning process and curriculum, giving responsibility to students for organizing their learning and promoting collaborative learning within and across student groups. The EBL process is often described as being organic and dynamic.

Although PBL is frequently described as ‘student-centred’, on examining the method as developed at McMaster University, Canada and Maastricht University, Netherlands, there appears to be a reliance on a very specific, prescriptive process, both in determining the approach to the task (McMaster 7 step process, Maastricht 5 jump process), [3, 6] where students are essentially led (or driven) through a learning cycle, and in terms of the curriculum, which is defined by the specific nature of the problems that are devised by the tutor. Design studies often also define the curriculum through the nature of the design exercise or the specification of resources available. The organic nature of the EBL process can reveal tensions that exist within tutor groups and teaching teams:

There is often a fear of ‘letting go’ of the curriculum.

- If the students take responsibility for following their own lines of enquiry how will the tutor know what they are going to learn?
- What about ‘coverage’?
- What about specified learning outcomes?

There is often confusion over the role of the tutor as a facilitator.

- How much information should they provide for the students, as part of the stimulus or during facilitated sessions?
- Should they be proactive or reactive?
- To what extent should they allow the students to continue to pursue a line of enquiry that may be interesting, but ultimately unproductive?
- Are tutors group leaders, members of the group or external to the group?
- How do you assess the EBL process? And should it be assessed?

In developing and facilitating EBL experiences for the students, tutors often make decisions, some times unconsciously, in regard to these questions.

CEEBL support for EBL initiatives across the University

Not all EBL programmes are initiated or supported through the Centre. Some are developed entirely outside the framework of the CEEBL, some are supported by the CEEBL, but are ongoing developments of existing work, and some are new developments that are supported from their initiation by the CEEBL. Three such developments are described below and are used as the basis for the research.

1. Prior to the CEEBL award, the School of Electrical and Electronic Engineering had introduced an EBL experience for students through an externally-funded consortium project. CEEBL involvement came after the first iteration of the development and focussed on supporting evaluation of the initiative.
2. The School of Dentistry had introduced PBL within the first and second years of the five-year dentistry programme in 1995 and its EBL development formed the large-scale CEEBL-funded Faculty project in Medical and Health Sciences. The initiative was led by a Faculty EBL ‘champion’ and had an element of support from the CEEBL team and an external educational consultant.
3. The School of Computer Science had no previous use of EBL, but introduced its EBL experience in a core first-year module. The development was supported from inception by the CEEBL team and an external educational consultant.

Electrical and Electronic Engineering

This single-credit activity has been accommodated into the first semester of the second-year tutorial system [4]. It is designed to prepare students for a 10-credit team project in the second semester. It provides an opportunity for students to develop and practise their team and project skills in the supportive environment of the tutorial prior to employing them in the higher stakes environment of the team project. It was anticipated that they would be able to engage with the team-project more effectively and earlier after this preparation. Consequently, this activity was modelled very much on the team-project, reflecting its subject matter, some of the technical aspects and its assessment, but the level of activity was proportionately smaller.

Approximately 145 students were divided into 29 tutorial groups of 4-6, each facilitated by a member of staff. The student groups met fortnightly with their tutor, to report their progress on the previous stage of the project and to plan the next. In the first year of delivery the stages of the project were delivered very much as discrete but connected ‘problems’. In the second year of its delivery, the stages were integrated into a single over-arching scenario, to make the project planning aspect of the activity more authentic.

The underlying *scenario* remained the same for both deliveries: to design a sensor system, based on the microprocessor controller board that they would use in the team project, to capture the temperature profile of a commercial, decorative tile kiln. This was seen as a suitably authentic task that employed electronic engineering in the context of providing a service to another industrial process.

The anticipated stages in the second delivery were:

- Project Planning: given the initial problem, the groups were to plan how they would address it and produce a project plan for the semester;
- Choose a Sensor: researching temperature sensors and selecting an appropriate sensor for the application;
- Design a Circuit: a signal conditioning circuit is required to interface the temperature sensor to the microprocessor controller board;
- Practical Implementations: the layout of their circuit should be planned. Students are also invited to consider wider practical considerations related to the harsh environment.
- Group Presentation: finally, students were asked to present their solution to the project and describe what they had learnt about the group processes with which they have been engaged.

Each stage maps to approximately a fortnight's activity.

The skills involved in this activity were supported by a series of lectures and student guides, specifically covering teamwork, project planning, searching for information and group presentation. In the second year of delivery the teamwork lecture was replaced with a workshop.

The assessment for this activity is principally formative, to illustrate how students would perform in the team-project. It is consequently based on assessment used in the team project. At each tutorial the facilitator allocates a mark on a Likert scale (0-Absent to 5-Excellent) for individual contribution. A team project mark is allocated for the presentation. An individual mark is calculated from weighting the project mark with the individual contributions. This allows the individual mark to vary up to 50% above or below the team project mark. In the second year of delivery an individual reflective report on teamwork was added, this represented half of the individual contribution.

Computer Science

This core 20-credit module represents one sixth of the students' first year experience. Spanning the full academic year, (i.e. two semesters) the module was designed to build the professional, academic and personal skills of the students. Approximately 150 students were organised into 25 groups of 6 and each group facilitated by a member of staff, the students' designated personal tutor. The student groups met weekly for a one-hour tutorial with their facilitator and were expected to meet at other times during the week. The aims of the module were based on 'the four i's': innovation, independence, interaction and intellectual development. The environment was one of self-directed learning in which the student groups were expected to set their own goals and were encouraged to be creative. The final deliverable of the module was a database-driven web application, defined, designed, built and marketed by the group. The module was organised in 5 phases of increasing timescale, complexity and proximity to the subject, as shown in figure 1 below.

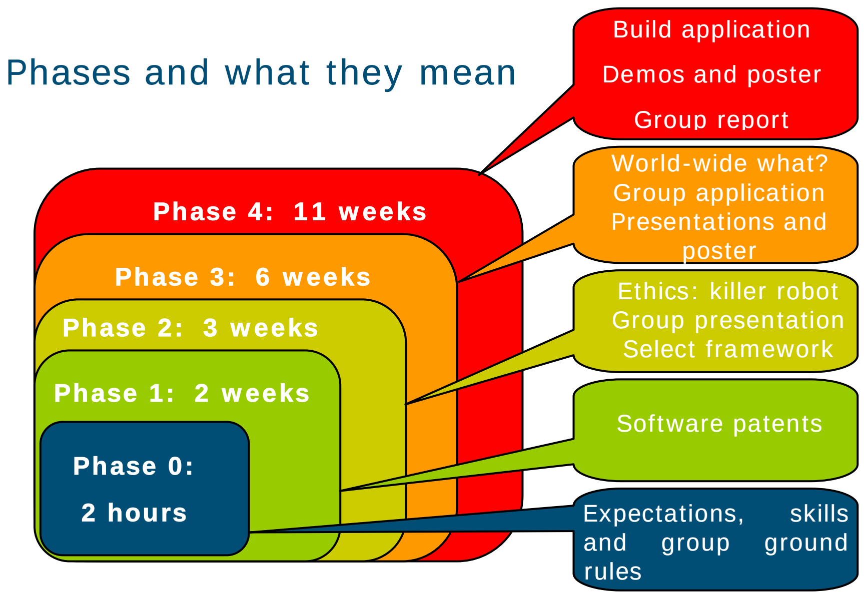

Figure 1: The phases of the first year project module in Computer Science

The induction (phase 0) introduces the students to the learning activities of the module and staff and student expectations are established. The groups are formed and each group identifies its combined skills and establishes its own ground rules for the rest of the year. In phase 1 (2 weeks), the students are introduced to the concept of patents during the first meeting, and, between tutorials, prepare for a debate in the second tutorial. Phase 2 (3 weeks) allows the students to study ethics in a computing context and to determine their own ethical framework for their application, drawn from a study of the literature on ethical frameworks. Phase 3 (6 weeks) consists of two major tasks. The first is to find out what the Web is and how it works. This involves extensive information gathering and discussions with the facilitator. The second task is to decide on an area and scope for the application they intend to build in the rest of the time available. They are required to outline their application in a group presentation and a poster, including an outline project management plan for the design and build phase. Following phase 4 (12 weeks), the students demonstrate a working web application, give a presentation and produce a group report on the design process as well as the technical content of the product. Each student presents an individual reflective essay. The students are supported through the use of the Moodle virtual learning environment (VLE), and record progress and group decisions on a group WIKI.

The School of Dentistry

The School had introduced PBL into its first and second years in 1995 and the new Dentistry project planned to expand the process by extending the environment to all five years and by developing Enquiry Based Learning approaches, beginning the expansion programme in year 4 before completing the process in years 3 and 5. The programme was organised into six academic themes:

1. Man in Health and Disease
2. Mouth in Health and Disease
3. Clinical Competence
4. Patient Management and Teamwork
5. Scientific Understanding and Thought
6. Communication Skills, ICT and Reflective Practice

The programme also has five 'year themes', as shown in Figure 2.

This model represents a systematic development and implementation of a new whole-school curriculum based around EBL for around 450 undergraduate students. The programme aim is to graduate a professional and ethical dentist who can demonstrate the ability to

- Take a patient-centred approach to clinical care within the dental team
- Apply the skills, knowledge, behaviours and abilities to independently practice safely and efficiently
- Be a reflective practitioner, committed to lifelong learning and CPD

The development builds on an existing PBL approach to years 1 and 2 which began in 1995 and followed the University's existing Medical School model that itself was based on the Maastricht model, with student groups working on two-weekly problems set by the tutors. The problem was outlined at the beginning of the first week, and the students investigated the problem and reported in week two. Each week, there was also a 3-hour workshop during which small in-class problems were investigated.

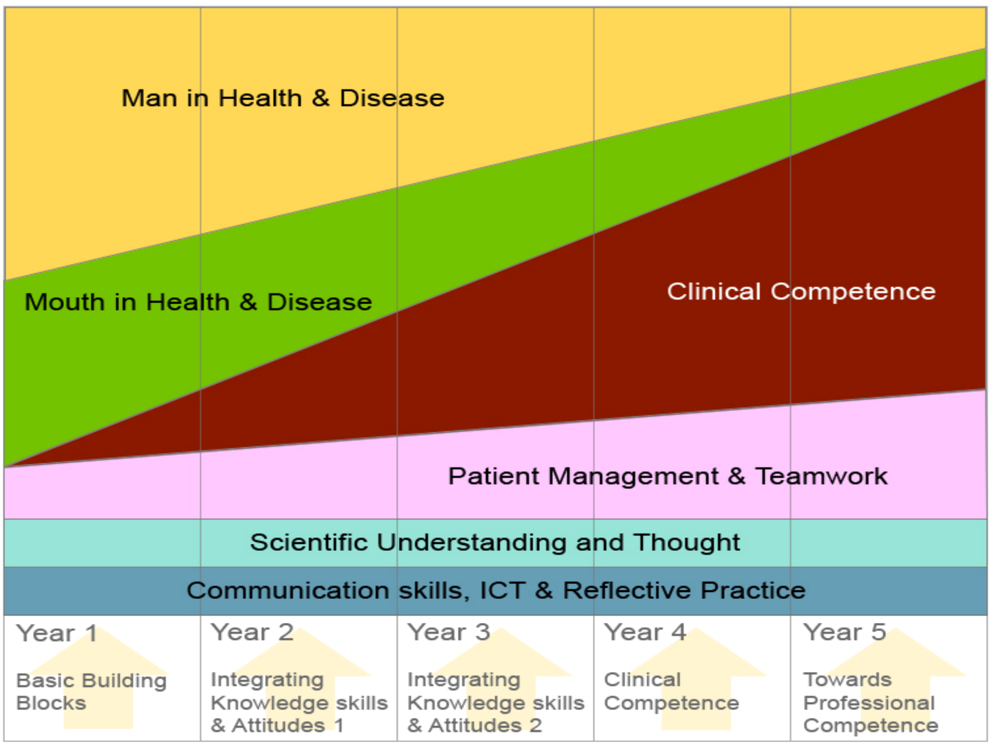

Figure 2 Course structure of the 5-year dentistry programme

Three principles underpinned the design process:

1. integration across the programme, particularly between the traditional divide of basic sciences and clinical teaching
2. EBL, with the emphasis on problem-based learning in the first three years, moving towards case-based learning and project-based learning in the last two years
3. teamworking, with dental students learning alongside other dental care professionals and working in cross-year groups – i.e. dental teams

Five staff 'theme' teams had responsibility for overseeing the vertical integration of the themes through the five years of the programme, consisting of a representative from each of the five 'year' teams. Development teams meet on a two-weekly cycle to share ideas and review progress. This ensured integration of academic and year themes vertically as well as horizontally across the programme.

The evaluation and observations

The evaluation involved a number of methods of gathering data and information:

- Analysis of the course documentation
- Structured interviews with the course leaders
- Evaluation feedback from students
    - Questionnaires and focus groups
- Staff focus groups and meetings
- Direct observations of student activity

Not all methods were applied to each case study.

The findings

It is important to record here that these are initial findings. They are based on the outcomes of the evaluations described above. The evaluations were not intended to test our hypothesis that EBL practice differs across disciplines as a result of tradition. They were independent evaluations, undertaken to provide evidence of the effectiveness of the separate practices. However, in comparing the outcomes of these evaluations, it became clear that, although there were consistencies in principles and purposes, there were significant differences in the ways that EBL was being practiced that could not be explained in terms of the essential pedagogies of the disciplines, but that these differences seemed to be borne out of tradition in the disciplines.

Our first finding is that, although EBL practice is not based on traditional pedagogy, nor has it emerged from a single discipline, its introduction in each of the three subjects is an attempt to move to the principles of EBL as they apply within the subject. However, the traditional pedagogy of the discipline does seem to influence some of the practice. In the cases where Educational

Developers (or similar) are closely involved, the involvement leads to a more radical or fundamental change away from the traditional pedagogy.

- The approach taken in Electrical and Electronic Engineering is based on traditional design studies in Engineering; the academic staff still referred to themselves as ‘supervisors’; and they ‘marked’ individual student contributions on a weekly basis (rather as they do in practical classes). The curriculum and resources are prescribed by the academic team, and the stages of design are established to a timetable.
- The Dentistry EBL development programme was based on what was for them a traditional experience of PBL, and led to a series of 2-weekly problems and a weekly in-class PBL workshop.
- In Computer Science, the change from the original tutorial programme was quite radical. The students were given much more control of their learning, the applications they chose, how their group operated and how they produced the application. The tutors were clearly attempting to take on the role of facilitators (indeed to this end the tutors were not all experts in the area of the curriculum or in the application chosen by their student group)

Other important factors in radical change include:

The timeliness of the intervention or change is important. In all cases, there was recognition by at least some of the staff that there was scope for improvement, that EBL was an effective learning process for students and that it might be successfully applied within their subject.

Strong leadership and a clear message from within the discipline were necessary to maintain the momentum necessary to bring about radical change.

However, a tendency for the staff to want to ‘regress’ to tradition was observed. Even when they appeared committed to the ‘new’ philosophy. In Computer Science, the staff were keen to provide several support lectures on programming and mathematics, to ensure that the student groups had the skills necessary to realise their application, and this had to be resisted by the programme leader.

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