Simultaneous development of management skills and behaviours in taught academic programmes.

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Abstract—Technical programmes frequently focus exclusively on the associated technical domain knowledge and skills with perhaps some generic skills development coincidently and perhaps accidentally included. If Higher Education (HE), as the main provider of competent graduates, is to enable employers to be able to respond to the key global challenges of the next decade, is a pure focus on technicalities sufficient? It is contended that the answer is no, graduates need to have competence in aspects of management they will face in the early stages of employment. This attitude is firmly adopted in the department of Electronics at the University of York where management is integrated into almost all in its undergraduate and some of its postgraduate programme portfolio.

The paper starts with a discussion of the justification for management teaching as a legitimate subject in the Electrical and Information Education field. This is followed by a literature review that considers the skills and behaviours managers need, appropriate pedagogies to develop these and assessment methods suitable to warrant them.

A case study is then described of the Electronic Engineering programmes at the University of York including, a dedicated taught Masters in Engineering Management. In the taught MSc in Engineering Management there is a consistent approach to the assessment of generic skills, a strong emphasis on curiosity-based learning and a structured individual learning log for every student. Statistics on student numbers and feedback on the programme from different student groups and the programme’s external examiner are given. The overall quality assurance measures taken for the programme are also briefly discussed.

The paper proposes a generic programme modular structure that provides space for technical content but also for management content and shows how managerial behaviours can be developed as an integral part of the programme. It also describes the approach taken to assessment and discusses the issues these bring, in particular scalability.

Keywords—generic skills; transferable skills; engineering education

I. INTRODUCTION

Higher Education engineering programmes are typically designed to develop students in a range of skills within the overall discipline (as in General Engineering programmes), major sub-disciplines (as in Electronic, Mechanical or Civil Engineering) or in more focused programmes (as in Engineering Management; Computer, Communication, Audio Engineering for example). In all such programmes the overall learning objectives are to develop graduates who can add value to a wide range of employers giving the graduate career choice. This is in contrast to the more tightly integrated study programmes sponsored by employers that have the specific aim of creating individuals more closely tailored to the specific needs of the company or industry.

In the general programmes there is a natural pressure to include a broad range of modules aligned to the technical topic of the programme, the technical domain skills. For example in a general electronics degree modules on mathematics, device physics, analogue electronics, digital electronics, software, systems, noise and so on are commonplace. The need to cover considerable breadth of technical topics to give the graduate the widest career choice makes the curriculum and timetable full and the student workload high.

Graduates of quality engineering programmes rarely remain “on the bench” for very long after graduation. Most are given projects and/or people to manage in the first instance before taking on further managerial responsibilities. Being a good engineer provides a solid foundation upon which to build a managerial career, especially in the technical area, but in itself it is insufficient. Knowledge of the aspects of management that surround the engineer such as project management, accounting and finance, marketing, management of technology, etc. are considered important and hence there is merit in building them into engineering programmes.

As should be expected the technical landscape is changing resulting, in no small part to the creativity of past graduates of our engineering programmes. There is a need for Higher Education Institutions globally to prepare graduates who are able to build and work in the technical world of the future. A way of looking at the immediate need is to focus on the recognized global technical challenges. The SALEIE Project [1] is targeting some of the technical challenge areas to define appropriate curricula for identifiable job roles and hence the required technical content. The challenge lies in the already full curriculum - space to cover non-technical topics such as generic skills, management skills, employability skills and
appropriate behaviours consequently becomes difficult for curriculum designers.

The need for the inclusion of generic skills in engineering programmes has been recognized as necessary for many decades and is embedded in a wide range of engineering programme standards [2] [3]-[7]. In the UK there has also been pressure to include employability skills in all academic programmes to better equip students for the first employment transition and subsequent personal career planning and management.

This paper starts with a review of some of the literature on the supply/demand balance of skills composition of engineering programmes, especially on the balance between technical domain skills and generic and management skills and on some of the educational initiatives in this area. It then describes the case study of the taught Msc in Engineering Management in the Department of Electronics at the University of York. This programme is offered as an example of one in which there is a heavy emphasis on the integration of generic and management skills and management behaviours into a technical programme. A number of novel approaches are taken to try to ensure the overall programme learning outcomes are achieved whilst giving the students an effective learning journey. Based on this case study and relevant published literature a generic programme structure is offered that emphasizes the tight integration of generic and business skills in an engineering programme without using a large amount of curriculum space. The paper ends with some conclusions and recommendations.

II. THE NEED FOR GENERIC SKILLS

The need for generic skills development can be seen in the literature on employability as well as by benchmark definitions included in the introduction. The idea of the higher education qualification as being more than the technical content and more as an “investment that will give them [the graduate] direct benefits in the labour market has been around for many years” [8].

An important question is what skills and what managerial behaviours should be developed in the programme for it to be effective in the provision of qualified graduates. The supply and demand for generic skills is replete with uncertainty and variable practices [9]. A stake in the ground is therefore required. One study that has informed the answer to this question and enabled a position to be held on what skills to include is the EIE-Surveyor Project [10]. One of the workpackages of this project was to review the supply and demand for generic skills across students, academics, graduates and employers across the Electrical and Information Engineering discipline set. The results of a survey of 3,275 respondents across 26 European countries showed excellent alignment in the perception of importance of the Tuning generic skills set [11]. The results show that the 32 stated generic skills grouped statistically into 5 sets labeled “Personal”, “Interpersonal”, “Professional”, “Entrepreneurship” and “Internationalisation” skills [12].

Generic skills are, as is well known, very different from technical skills in that they are learned experientially rather than by rote. Experientially learned skills require active engagement by the learner and a support mechanism around them to facilitate this learning, especially the reflective part of the experiential learning cycle. A different pedagogy is therefore required for these skills.

For similar reasons assessment of generic skills is different. Opportunities to practice, and formative feedback is required before any summative assessment will fairly assess a student’s ability. The value of any claim to ability in a generic skill lie in the context of the assessment and the credibility of the assessor and their institution. Generic skills are difficult to outcome-base due to the absence of benchmark standards of ability. The consequence is that the warrant, or certification becomes a generalization of achievement [13].

III. CASE STUDY

The need for graduates who are prepared for first and second line management positions in engineering roles has been recognized within the Department of Electronics in part as a result of the employment of experienced industry managers as academics over the past two decades and in part through discussions with members of our industrial advisory board. This need led initially to the integration of generic skills into our undergraduate programmes [14] and then to the specification and development of a taught masters programme in Engineering Management which saw its first cohort in the 2010/11 academic year. The target number of students in the business plan for this programme was 10 in the first year of delivery and 14 in the steady state. The actual number of registered students in the first year was 25 and the peak in number was 51 in the 2012/13 academic year. This significantly larger than planned cohort size has required considerable attention to be paid to issues of scalability, delivery team workload and the more general issues of ensuring consistency, equity and preventative measures of fatigue, especially in assignment marking.

The programme has attracted 100% international students so far. It was predicted that the majority of students would be international and this was planned for in the original programme design. In line with University regulations and departmental practices the programme is modular in form.

Fig. 1 shows the overall modular structure.

The overall programme objectives are described as “After having successfully completed this programme, students will have a solid knowledge of, and will have developed skills in those aspects of management appropriate to the Engineering Manager, namely project management; the management and marketing of technology; idea creation, development and communication; accounting and finance; enterprise; law as a fundamental basis; and international enterprise. This knowledge and related skills will provide students with appropriate grounding for careers in the full breadth of electrical and electronic engineering and related subject areas and in self-employment within these technical areas.” The development of transferable skills is an important part of the programme, full details of what skills are developed in each module are detailed in the module specification for each of the engineering Management modules, all of which are core. The
generic skills specifically identified in the module specifications are:

- Capacity for analysis and synthesis
- Ability to communicate with non-experts in the field
- Capacity for applying knowledge in practice
- Capacity to adapt to new situations
- Communication skills
- Creativity
- Decision making
- Information management skills
- Initiative and entrepreneurial spirit
- Interpersonal skills

- Patents and IPR
- Planning and Time management
- Problem solving
- Project design and management
- Public speaking
- Report writing
- Research skills
- Teamworking

The list is directly taken, and the skills are hence worded in accordance with the Tuning generic skill descriptions [11]. An explanation of the way the statement is interpreted and the context in which it is assessed are stated in the module specification.

The managerial behaviours considered important within the programme are:

- Concern for quality
- Recognition of the need for personal planning
- Recognition of the need for personal development
- Self organization and general professionalism in the approach to work
- Good quality presentation for technical presentations
- Working in meetings
• Time management and work ethic

These behaviours are encouraged through feedback during supervision sessions, at presentations and during programme related teaching and learning activities. They require the cooperation of all staff involved in the teaching and learning process including group academic supervisors. All these staff are briefed in what is expected of them in respect of the development of these behaviours.

In the individual module specifications each ‘technical’ learning outcome is placed in level using Krathwohl’s modified version of Bloom’s taxonomy [15]. For each learning outcome there is also a direct reference to which part of the module assessment that assesses it. In this way a fully ‘levelled’ and curriculum map showing where and how all the learning outcomes are assessed is easily created. For some modules there are multiple components such as an oral presentation as well as a written assignment. In the programme design attention was paid to the definitions of generic skills, such as that for ‘communication’, which, in the Washington Accord, the appropriate specification for our programme, the definition is: “Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.” [2]. This definition is a complex definition in that we consider the skill of being able to present to a technical audience and a non-technical audience to be subtly but none-the-less different skills [16]. As a consequence presentation activities of different specifications are integrated into the assessments.

The teaching and learning materials for all modules are available to students through the University Blackboard Virtual Learning Environment (VLE). All modules are assessed by continuous assessments except for Accounting and Finance, which is assessed by a closed book examination.

The programme has a number of what are considered novel features, at least novel to other taught Masters level programmes in the Department. The following are five specific examples:

A. Programme Induction

An intensive 3 half-day induction programme is included immediately before the first teaching day. The objective of this programme is to assign students into their supervision groups and to introduce the cohort to:

• The teaching and support staff
• Each other
• Expectations from the students and from the staff
• Teaching and learning at York (teaching and learning cultural adjustment)

B. Curiosity Based Learning session

Some cultures, the Chinese in particular, often start as passive learners, as a direct consequence of this, as part of the induction programme there is an introduction to curiosity based learning. The objective of this session is to try to help the students realize the value in good quality questions. The whole programme is designed to be interactive with the students engaging actively in their learning rather than passively listening to lectures. They are encouraged to ask questions and this session is the start of getting them used to formulating and asking questions.

C. e-Learning Log

An individual e-learning log is created, using a Google site, for each student. The log template is highly directive at the beginning of the year specifying what each student needs to do as a result of every specific teaching and learning activity, to a much more free entry format later in the year. Figure 2 shows the home page of an example site.

To illustrate the detail at the beginning of the students’ use of the log, one of the instructions after the induction is “Did you enjoy the session on Curiosity Based Learning (CBL)? What have your learned about the value of questions and getting the right question? How might you use this in your study?” As can be seen, there is a direct link between the requirement to reflect and the content of the preceding teaching and learning event. It is reasonable to argue that such high level of prescription is inappropriate or unnecessary. This approach has been chosen because of the desire to encourage an active engagement in the material and the development of managerial behaviours.

D. Assignment book

All assessments (except the closed book examination) are published at the start of the academic year along with the submission timetable and the assessment criteria. This was designed in to promote time and personal activity planning and management.

E. Generic skills assessment

Efforts are being made to move the assessment of the generic skills from the subjective space to a more defensible outcome based warrantable space. The skill that has received the most attention so far is public speaking. In this the use of an assessment rubric has been researched and the most appropriate published rubrics combined and refined to a new one specifically targeted at the assessment of technical presentations in the engineering field [16]-[18].
IV. PROGRAMME FEEDBACK AND QUALITY ASSURANCE

Feedback from the students in all cohort years has been excellent. The structure in particular has been praised as has the overall planning and information management. The strong use of team working and the development of generic skills have also received very favourable feedback comments.

Quality assurance is achieved through standard University procedures and specific programme review meetings. The standard University procedures include end of module student feedback forms (for every module), termly course review meetings and an end of year course review meeting. In each of these meetings feedback from students, teaching staff, results of assessments and comments from the external examiner are all reviewed. Suggestions for changes are proposed and discussed, if agreed they are promulgated through the standard University change process. In addition to the prescribed reviews, there are more frequent programme specific reviews at which operational issues are discussed where they arise, and where innovations and overall changes are discussed.

A significant amount of time has been devoted to scalability by the programme management team. Since the number of students registered on the programme is significantly higher than was originally planned, attention has been required on workload, especially in assessment to ensure consistency and the avoidance of marker fatigue. Applications for the programme have risen monotonically, and continue to do so, with the consequence that scalability remains a significant issue and priority for the team. The most significant component as far as assessment workload is concerned is the final individual project assignment. As part of the generic skills development, the students are assigned to groups at the outset and undertake a group project as their capstone project. University regulations require each student...
to submit an individual report. To make the marking of this scalable, the final project report is structured with a group and individual component with the individual component being a statement of individual contribution and a reflective essay on the project experience as a whole. Each individual is also required to comment on the contribution of each of their team members to the group’s progress and output. The group report requires marking once leaving the individual reflective essay, a much shorter component, being marked individually.

V. PROPOSED GENERIC PROGRAMME

Clearly there is no panacea generic programme structure. What is offered here are suggestions for how generic and managerial skills and behaviours can be developed simultaneously with technical skills. The following are specific suggestions:

a) A pre-start induction programme can lay a foundation of expectations as well as help to ensure the students hit the ground running when the main lectures start. The induction can be used to introduce students to assessment instruments such as a common assessment rubric (e.g. for public speaking) and given them the opportunity to practice using it.

b) The inclusion of a session on curiosity based learning as a means of encouraging active engagement in teaching and learning sessions.

c) Use of a balanced array of assessment instruments that test generic skills in different contexts – such as one presentation that requires the student to present as if to a technical conference and another as if to a non-technical audience.

d) The use of team activities to both develop team working skills but also to manage the assessment workload in a popular programme.

e) The publishing of all assignments upfront with the accompanying emphasis on the students to plan ahead in their personal diary for assignment completion but also for the accumulation of useful information for the assignments in a timely and professional manner.

f) The use of some form of guided reflective log to encourage but also help the students to reflect on their learning and to develop the ethos of continuous professional development.

VI. CONCLUSIONS

The call for integration of generic skills into engineering programmes has been around for many decades and is well established in programme benchmark specifications. The need for management skills and behaviours is perhaps less well established. This paper has described an example taught Masters level programme in Engineering Management in the Department of Electronics at the University of York. The programme aims to develop generic and management skills and managerial behaviours using a number of innovative techniques, specifically a dedicated extended induction programme including a Curiosity Based Learning session, an e-Learning Log, an upfront declaration of all programme assignments and a move towards standardized assessment of generic skills. These innovations have helped to enable international students to culturally adjust and to create a programme design that is scalable to enable cohort size growth. Feedback from key stakeholder groups has been very positive for the three years the programme has been running.

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