Contextualizing the teaching and assessment of engineering skills

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ABSTRACT

We are frequently being informed that Engineering graduates are not 'work ready', but lacking in a broad range of generic skills, despite these being mandatory for professional body accreditation. In this case study we present a newly developed second year undergraduate module which explicitly integrates the practice and assessment of generic skills with realistic technical challenges in 'scenarios' (week long intensive group projects). It is intended that this format would demonstrate the relevance of the generic skills to the students and hence improve engagement and learning. Observations by staff and feedback from students confirmed the success of this approach.

Conference Key Areas: Engineering skill; Curriculum Development; Attractiveness of Engineering Education

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INTRODUCTION

There are recurring calls for engineering graduates to be more 'work ready' than they currently are. The calls come from industry [1], and are picked up by the media [2]. Engineering has a reputation for being the worst subject area in this respect [3]. Accrediting bodies are well aware of the need for these generic skills, and they are prominent in the UK Quality Assurance Agency's Subject Benchmark Statement for Engineering [4].

However, as Karatas *et al* found, when students come to university to study "engineering" their understanding of the nature of engineering is often lacking a significant number of the aspects which are described in literature on engineering practice [5]. Thus, as well as learning these generic concepts and 'soft' skills, students need to develop an appreciation of their importance. Without this many students will quickly disengage when faced with lectures or coursework on apparently unrelated topics, such as ethics, law and communications skills. This is consistence with research that shows that the subjective value assigned by students to a task or goal has a strong impact on their motivation and hence learning [6].

We ask how we can teach these subjects in a relevant and engaging way, early in an engineering programme.

1 BACKGROUND

A few years back, the Engineering Faculty of our university embarked on an ambitious programme review to tackle this issue [7]. This resulting in a tranche of changes including two new modules to be taken by all first year engineering undergraduates across 9 departments. These modules were intended to introduce generic engineering and work place skills from the first week of the degree programme, and give opportunities to practice them within open ended group projects. We were tasked with developing a follow up second year module, tailored to our specific degree programme (Biomedical Engineering), reinforcing some of the generic skills and introducing more.

A review of these first year modules[2] indicated that students liked the 'scenarios' (intensive one week group projects, during which all other teaching stops), however there was too much other assessment in the modules (individual assignments addressing one soft skill at a time, e.g. ethics) and the students did not always understand the relevance of the taught sessions. Staff were also broadly supportive of the scenarios, seeing their benefit in developing the student's team work and project skills at an early stage but there was some concern that they left less time for teaching technical engineering skills, such as analogue electronics.

2 DESIGN OF THE MODULE

Our response was a module where each of the taught soft skills was explicitly linked with, and assessed within, and only within, one of four scenarios *Fig. 1*. In addition, we worked closely with leaders of modules covering technical engineering knowledge and skills, so that these skills, too, were reinforced and practiced within the scenarios.

[2] Review based on feedback questionnaires by ~700 students, student focus groups and interviews with contributing academics.

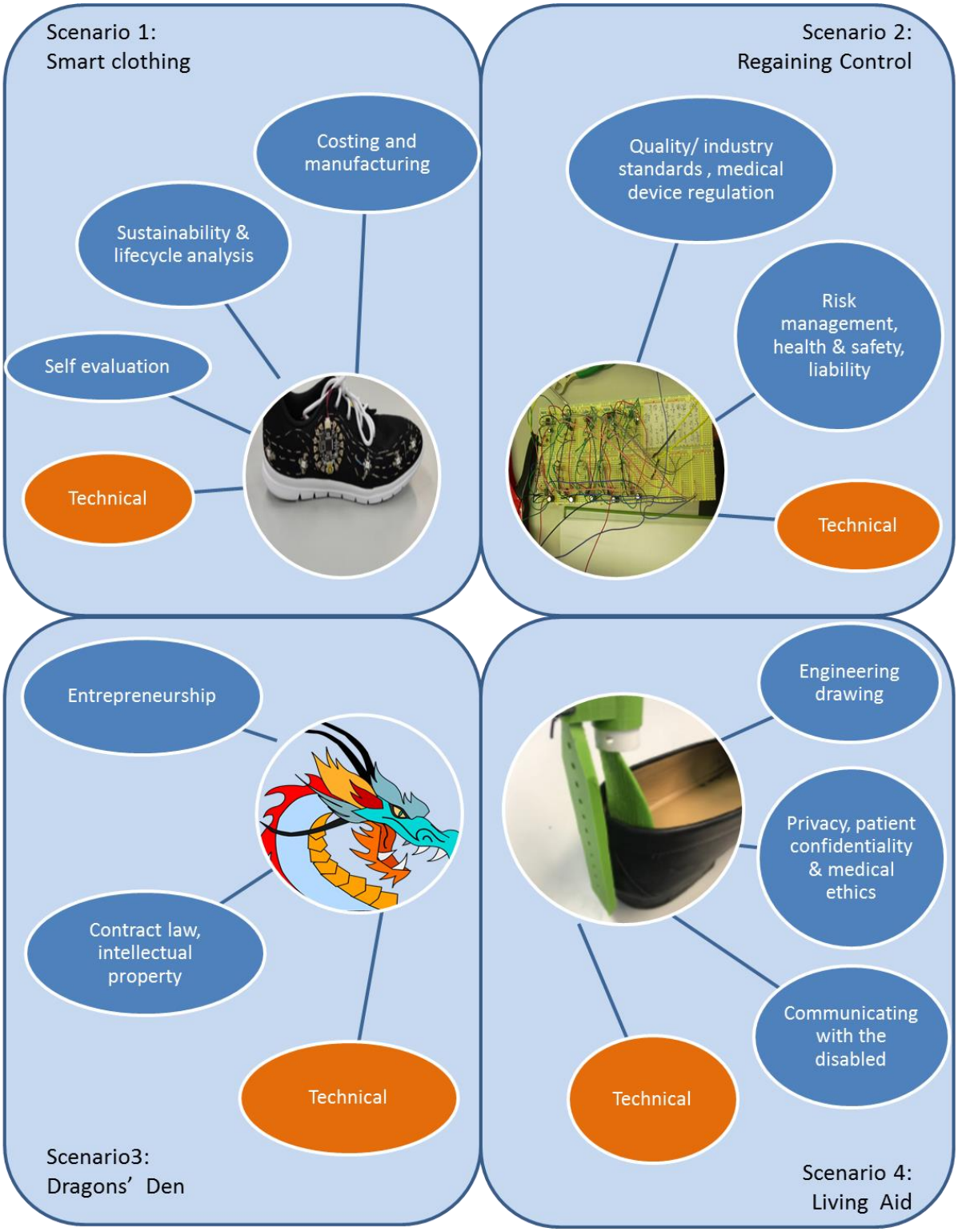

Fig. 1. Schematic diagram of the mapping between professional skills and the four scenarios

Prior to each scenario, students had 3 or 4 2-hour seminars where the linked soft skills were taught. A further way in which we contextualized these generic concepts was the extensive use of relevant case studies and guest lecturers within the seminars, and maintain a focus on why the subject was important to working engineers. For example the CEO of a spinout company taught about costing and manufacturing based around his industrial experiences, and, in another session, a clinical industrial engineer considered medical device regulations and its impact on a product he had developed.

Each scenario was designed with a realistic story line to contextualise the skills and illustrate how these must be used together within the work environment. In fact the final scenario involved students working with the charity REMAP (http://www.remap.org.uk/) to design a product for a disabled client[3], with the assessment covering their interaction with the client and their use of the design cycle, as well as the technical quality of the final prototype device. Concepts of patient confidentiality, privacy and medical ethics were assessed with the aid of an online quiz in the style of role play with students required to state what they would say and or do in response to plausible conversations with the client *Fig. 2*. The students also had to communicate with three different audiences, adjusting their language and style to match:

a) Discuss with a slightly deaf elderly lady of average education – the client - with respect to details of the design specification;

b) Produce a user guide for the device written in 'easy read' – a format designed for people with learning disabilities [8];

c) Give detailed instructions for making the product, aimed at an amateur craftsman.

All three represent audiences they are likely to interact with in their working lives, but all are different to the peer-to-peer and peer-to-lecturer communication students are used to.

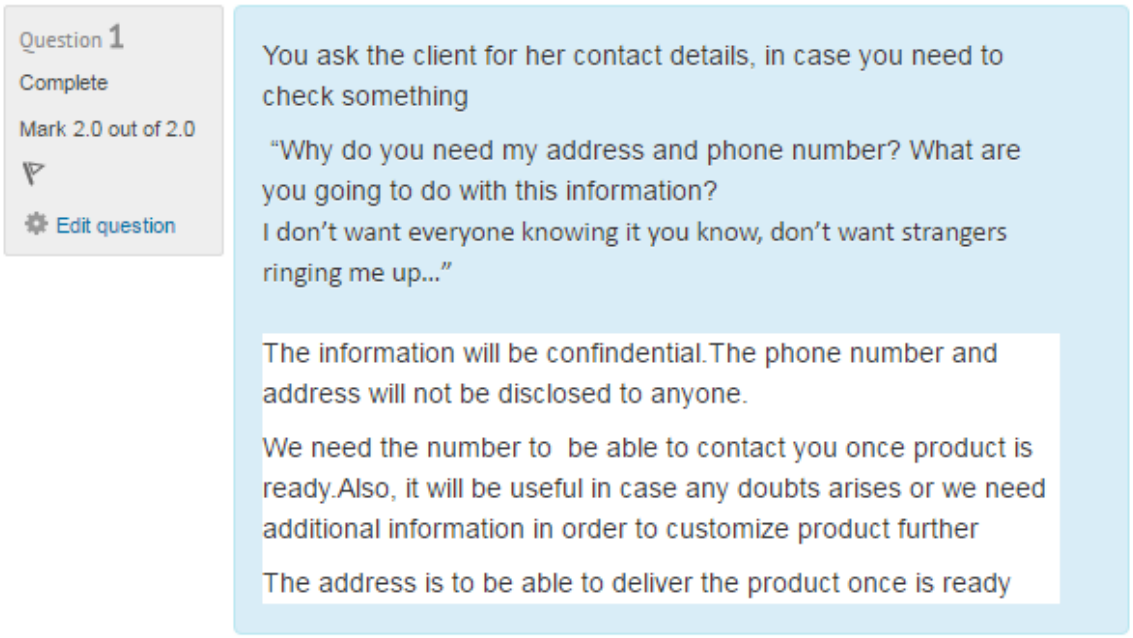

Fig. 2. Example question and student answer from patient confidentiality, privacy and medical ethics quiz.

Each scenario contained individual and group elements of assessment, and one of two mechanisms of moderating group marks to reflect individual contribution:

[3] For the first year the client required a product to enable her to fit and remove her glasses, despite being unable to lift her hands to her face. In the 2nd year the students sought to design a shoe fitting aid for a client whose specific bending and balance constraints made commercial devices inappropriate.

a) Team contribution questionnaire
b) Manual moderation by lead facilitator where there is was demonstrable inhomogeneity in the commitment/performance of the students in the group

3 FEED BACK

We have just completed our second year of running this module with mean overall module grades of 66% for the 1st cohort and 69% for the 2nd. The lowest mark was 55% for the 1st cohort and 60% for the second, despite individual components to each assessment, and individual adjustment of group marks where necessary. Being engineers, we followed the design cycle, seeking feedback from students (10 & 21 in 1st and 2nd cohorts respectively) and staff (4), and improving aspects in light of this. Students completed the department's standard module review questionnaire, and were encouraged to comment informally during personal tutorials and with the module lead during the scenarios. At least one member of staff was present, in the lab were the students were based, for the duration of each scenario, and we would informally brief each other as to the observed group dynamics and productivity. Some of these briefings were by email.

The first year that the module ran, students commented that it was the "first time that ever had to work as a proper team to get something done" and that they had "learnt much more than just electronics and programming skills". However as a teaching team we realised that we needed to be more explicit to the students, with respect to the role of the soft skills in the scenario and related assessment. It was also important to incorporate the soft skills and generic concepts into the story line in a plausible manner, to prevent the associated assessment from feeling like contrived add-ons.

So we made some minor changes to our plans for the next scenarios. These were evidently successful because at end of the third scenario (styled like the TV series 'Dragon's Den'[4]) our judging panel, which included an industry specialist, were impressed with the student's engagement, and one of the research groups we had partnered with asked the students to come back and share their findings.

Unsurprisingly, in the second year the module ran more smoothly, though we will be continually refining it in the years to come. Indicative of its success was the way the students handled the final scenario:

a) They were fully engaged and scored well in those sub-tasks which explicitly tested the generic skills assigned to this scenario.
b) It was observed that they required less intervention by the facilitators, and managed their time and interpersonal relationships markedly better than in their previous scenarios[5] – skills taught in the first year, but which, it was found, they needed further advise on.

Themes in the student feedback, free comments section, included preparation for "real life" ("In general, the module was rather helpful in placing me in real life

[4] Students, acted as entrepreneurs, developing and presenting a business plan for the commercialisation of a research output from a UCL research group.

[5] For example. During Scenario 2 facilitators noted, with concern, the disunity and poor group dynamics of one team. Despite intervention, this continued and was also commented on in the report of an independent staff member who assisted with part of the assessment (a mini viva). Individual debriefing/counselling sessions were held with the two students affected and when (the random generator) placed them together for the 4th scenario, they were observed by facilitators to be in a functional working relationship.

situations, allowing me to grow in teamwork."),enjoyment ("I really enjoyed the scenarios") and a positive sense of challenge ("The module was quite challenging but we learned a lot and used different skills in each scenario"). The only negative comment was from one student who felt that the group mark did not adequately individual effort. Additionally, in a general feedback session, a second year student responded to a first year's concerns about the relevance of taught material by describing how they had thought the same at end of their first year, but having subsequently used those skills, they now understand their importance, as well as the relevance of the generic skills taught this year. This further confirms the importance of teaching generic skills in context, and the success of our integrated approach.

4 SUMMARY

Generic skills are an essential part of engineering education, but teaching them in a meaningful way which engages students can be difficult. We have shown that by incorporating them into technical scenarios which give them plausible real-life contexts, students more quickly realise the important of these topics, and hence engage with learning about them.

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