Practice Sharing Paper: *Motivating computer scientists to engage with professional issues*

A technology-led approach

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Abstract— **Modules in professional issues sometimes sit a little awkwardly in the computer science curriculum. They can be seen as an island of discursive teaching coming from what Biglan might have termed the 'soft applied' field of study. In computer science the more usual context is of knowledge and skills based learning and activities of a 'hard pure/hard applied' fields of study. This gap may be particularly difficult in those countries where students arrive who have specialized early in subjects related to science, technology and mathematics.**

The authors of this practice sharing paper have had many years of experience teaching such modules to computer science cohorts, but have recently been faced with the challenge of consolidating two distinct courses previously taught in years one and two of the undergraduate curriculum. The resultant course was required to be one quarter smaller in terms of its notional hours, and there was a need to save on face-to-face contact time. There is a considerable challenge generated by the squeezing of content an contact while at the same time trying to motivate students with a strong technical motivation to spend time on a topic which is not, at first glance, directly relevant to their chosen specialisms.

The paper will present an analysis of the effort required to reshape the course, primarily from the perspective of the teachers and the small curriculum design support team. We will provide a detailed explanation of the rationale alongside a consideration of the impact and implications of this type of change. We will situate our rationale in the context of striving to motivate the learners' to gain a deeper insight into their own learning and technological preferences in such a way that they can take ownership of the new approaches to which they have been introduced in a way which they will sustain during their future individual professional development.

Keywords— ***STEM; Higher Education; Disciplinary Differences; Technology Enhanced Learning; TEL; Computer Science Education; Professional Issues; Blended Learning***

I. INTRODUCTION

The practice paper provides a case study style account of the working processed of a multi-skilled team who collaborated in merging two existing teaching modules into a single a blended whole. This objective was that the resultant module would, from the students' perspective, be highly interactive, combining online preparation, lectures, self and peer assessments, computer assisted assessment and portfolio work. From the academics viewpoint, there was a need to provide students with a rich range of relevant and useful activities, whilst avoiding an onerous workload in terms of marking and class administration. The design activities have been led to two experienced academics. Together they have a broad experience of curriculum design and redesign, educational enhancement and innovation of student learning activities [1-7].

The reluctance of students in technical disciplines to engage with topics such as professional issues modules is a phenomena which we imagine is familiar to computing faculty worldwide. The authors of this paper have, for many years addressed this issue head on. Both authors have taught on the predecessor modules from which this new module is converged and has been designed to replace. Furthermore they also have many years' experience of slowly evolving and enhancing the two preceding modules increasing the student's ratings of the teaching of those modules. Nonetheless students' rating of their perceived relevance of the modules at the time of teaching has remained low. They are acutely aware of the heavy faculty workload which can emerge as a result of trying to motivate technically specialist students to devote time to studying topic areas which, at least superficially, do not appear to be especially relevant to their chosen specialist area.

The remainder of this paper explains presents an account of the objectives, challenges and constraints. Section II introduced the educational context of such studies in the UK. Section III provides an account of the educational philosophies and objectives which underpinned the planning, and itemizes some of the institutional and departmental objectives which were influential in the final design. Section IV describes the structure of the initial outline for the module, relating decisions back to the factors outlined in section. Finally the paper considers the implications of the design and future development and offers some conclusions.

II. BACKGROUND

The work described takes place in a large, UK, research based university, which offers a number of specialist degrees in the computing disciplines. The department's teaching is highly rated, with strong competition for places to study in the department, so entry requirements are very high. Typical cohort size for which this module is designed is 150.

There are three distinct degree streams within the cohort: computer science; software engineering; and information technology in organizations. Students may take 3-year bachelors in science degrees, or 4 year taught masters degrees in their subject area. Between half to three quarters of students continue on the four-year degree. All degrees are accredited by the British Computer Society (BCS) who have views on the content of the professional issues curriculum. We also align our teaching with ACM curriculum. The department is currently remodeling all its taught modules from 100 notional teaching hour 10 credit units to 150 notional teaching hours 15 credit units. This module is being taught in the second semester during the first year of that change being implemented.

There may be some particular factors in this account which are a result of the UK context, for which it may be helpful to provide specific further explanation to those whose degree programs come from other educational traditions. As is typical in UK universities, although it is not a specific entry requirement, the vast majority of students will have already specialized in science, technology, engineering and mathematical (STEM) subject areas, particularly in their studies from age 16. Prior to age 16 they will typically have attained high marks in ten or 11 broad topic areas across the social science, arts, humanities and sciences and mathematics. Factors which are common across the UK, but which are described in terms of the profile of the cohort are as follows:

- Around 70% of the cohort are in degree steams which require mathematics at advanced level as an entry requirement
- The majority will have only studied subjects from the STEM fields of studies during their higher level immediate pre-university qualifying studies
- The majority of students (according to in-class straw polls) specifically chose a technical subject in order to avoid subjects which include any volume of required reading or writing.
- Students are taking a single major technical degree and do not intend to take any minors subjects outside that technical focus

The authors believe that this makes the challenge faced in our module teaching greater that perhaps it might be in other countries or educational traditions where later specialization in schools and major minor style degrees are more widespread.

III. Approach

A number of different educational and organizational perspectives underpin the manner in which we have addressed the challenges of this module redesign.

A. Disciplinary Differences

The literature on disciplinary differences which has informed this work dates originally from Biglan's studies in the 1970s [8-9]. Biglan's work makes a wide-ranging study of disciplinary differences. He draws distinctions between 'hard' and 'soft' subject areas and across those areas between those which are 'pure' and those which are 'applied'.

We find this interesting because we consider the degree specialisms of or sub cohorts all to be at the 'hard' end of the spectrum, while their content might fall at an intersection between pure and applied - the software engineers tending more to the 'pure', while those who study IT in Organizations to be more at the 'applied' end. Biglan bases these categorizations on a study of the approaches, content and epistemology of the subjects. To Biglan the study of professional issues would be squarely in the 'soft/applied' area.

Understanding these differences, is, we believe, a powerful aid to integrating professional issues into the wider computing and technology curriculum. This challenge is not confined to computer science and is one which might find resonance with many involved in education in the STEM disciplines. A number of scholars have undertaken studies following on from Biglan's work, specifically looking at the implications for teaching which may be associated with disciplinary differences. Appropriate teaching methods vary according to academic discipline [12,13]. The impact of disciplinary differences can also extend into to use of technologies for learning [14,15]. Furthermore technology affordances [16] may make some digital educational tools more appropriate for particular subjects than others [4]. In the case of working with our STEM based students, they may have preferences and existing familiarity with tools most suited to hard/pure, hard/applied and be less familiar, comfortable or willing to use tools with which students form a soft/applied background would already have as part of their established repertoire.

Thus conversations between faculty and learning designers would centre around whether and how to use tools such as reflective logs and portfolios, which whilst being constructively aligned with the proposed learning outcomes, might require careful crating into the learning process if they were to become effective

B. Approaches to teaching

Our teaching approaches can be seen to fall into a constructivist and social constructivist framework. Biggs has influenced our approaches to the design of this teaching in two related ways:

Firstly, he identifies three different levels of understanding valuable to teachers planning students' educational experiences. The most valuable, he suggests is Level 3: Understanding "what the student does"[17]. As faculty discussing proposed designs, and when explaining motivations to the learning designers, explaining what the student does has been a powerful vehicle for reaching design decisions.

Secondly, Biggs persuasively presents the arguments for designing and implementing a curriculum which is constructively aligned by starting with the outcomes of what we want the students to learn and designing assessment which are complementary to these outcomes [18]. A major part of our planning process has been concerned with designing efficient and effective assessments. Notwithstanding the perspective which Biggs offers, we observe in our regular interactions with students that Boud's claim that 'assessment drives learning' [19] is one to which we pay particular attention.

Some parts of our approaches to teaching which relate to professional issues have been informed by an experiential philosophy after Kolb [20]. Kolb explicitly made the link between education, work and personal development. Personal development and team working in anticipation of the workplace is integral to of our degrees. An induction activity which establishes team working and initiates personal development practices which is designed to link into the professional issues teaching was established a number of years ago. The first version of this event (now routinely run in week zero with new students before formal teaching begins) was developed collaboratively with training consultants and was explicitly based on Kolb's principles of experiential learning [21]. Subsequent iterations, run and developed by jointly faculty and students , have reduced the formal reflective components of the intervention, but the basic structure is unchanged. Furthermore, a large part of our teaching can be categorized as following an experiential earning cycle structure.

Also within the constructivist frame, we incorporate an understanding of the potential for learning technologies to work as a tool to achieve what Mayes dubbed "the iterative refinement of understanding"[22]. He argues that conscious use or deployment of different types of technology in learning can be generate increasing levels of student engagement, in turn leading the student towards this iterative refinement of understanding. There may be some evidence of such learning in professional issues. It is not uncommon for students, returning to the university for an alumni event to have commented that they now understood the relevance of the topic area. Incorporating this into the design is an important objective, as will be discussed under D below.

C. *Approaches to learning*

As a research-led university we are interested in students approaches to learning [23], particularly the value of supporting students to develop deep approaches. The design team has included a student intern who has participated in the two predecessor courses and who has provided insights into student approaches and attitudes. Methods already deployed have introduced self and peer evaluation and formalized reflection, we had also introduced students to the concepts of reflective practitioners [24] and community of practice [25]. These latter practices and traditions are not usually associated with technologists, and have been met with mixed results.

It is intended that the new module will enable students to individually build a matching knowledge and understanding of the context of their degree in the wider worlds which is complemented by skills and expertise which will enable them to operate effectively in a business environment. the design team faces challenge of how to effectively use information technologies to support these broad educational aims.

The predecessor modules must necessarily loose some of their content, and philosophically the response has been to plan to be more rigorous in effecting experience of the intended learning processes. For the academics in the team it is painful to sacrifice a favored or valued activity. But since the students will be new, they will know no different. Our task therefore is to ensure that we provide them with adequate opportunities and stimulation.

D. *Constraints*

A variety of external constraints beyond the immediate perceived needs of the students have been brought to bear during the design and planning stages. The learning designers are part of the team also work for a wider university initiative: the centre for innovation in technologies and education (CITE). The centre is working to achieve broad objectives which will make impact across the whole institution. These include a) reducing the demand for lecture theatres; b) creating replicable models of teaching which can serve as design patterns for future activities; d) creating teaching and learning activities equally valid for students on and off campus; e) integrating activities which develop digital literacies; f) streamlining teaching processes and reducing academic load.

From the departmental point of view the new module needs educationally to develop soft skills. Students who successfully complete the modules will have demonstrated broadly a) the ability to research and communicate technical information; b) an understanding of the legal ethical and professional issues relevant to an IT professional. The department is also concerned to help faculty manage their work life balance, this involves reducing pinch points which require large amounts of time for teaching administration and in the turn round of marking and feedback. Additionally the new method must not in any way jeopardize our accreditation nor interfere with student progression and retention.

IV. OUTCOMES

The plan which emerged was to use two of the three possible weekly lecture slots. One as a motivational lecture, and one as a feedback lecture. Self-assessment activities are scheduled and will be driven by the university VLE which is being used to control workflow. Resources will be stored in the institutional teaching repository (EdShare) ensuring they are available after the academic year-end, and even after graduation. As well as structuring workflow, the new system affords more opportunities to provide learning analytic style data. How much and how useful remains to be seen. We are endeavoring to at least partially automate complex activities such as group allocations and peer marking. Use of automated testing demands large volumes of work before the assessment is administered rather than during the marking period.

The model is to some extent one of a flipped classroom, where students are being nudged to prepare before lecture slots. Students will be invited to complete activities along a workflow driven timeline, and asked to self evaluate using the university portfolio. A sequence of tests, plus an computer delivered end of term examination worth 50% of the total marks, will be used to provide summative evaluations, and underline the value of completing suggested tasks on time. Although we adhere to strict guidelines relating the volume of student evaluations to the hours of notional teaching, the new design has increased expectations of the level of student preparation, and more ways in which it will be monitored and measured. In this way the reluctance of the students towards areas where the do not have a natural affinity is being addressed. Whether this will work remains to be seen. In line with departmental and university priorities, the speed and volume of student feedback should be increased. Though automated feedback, and workflow managed peer evaluations. This too may be advantageous in terms of overcoming disciplinary reluctance.

As with so many systems which make extensive and integrated use of computers the problems are predominantly socio-technical, and we envisage that a number of iterations will be required in order to effectively measure the impact on this new learning practice on the student culture within the department. A large amount of effort from faculty and the learning design team is being used to create the learning resources, although we are also seeking to identify relevant open educational resources and are integrating student activities which incorporate co-creation and collaboration in an effort to establish this practice in a generative manner.

V. Conclusions and Future Work

Much has been made in the past of the impact of technology bringing about changes in higher education, frequently described as the last cottage industry. The discussion has included suggestions that role of faculty will change from being a 'sage on the stage', to a 'guide on the side'. In this process it has felt more like being a planner with a (digital) spanner! As computer scientists we are acutely aware that some would argue that in an ideal world, a complex design as was described in this paper might have benefited from some kind of agreed design approach. As faculty working within a reasonably traditional university where the bulk of teaching is conducted face-to-face we are also aware that teaching is a dynamic and complex task which frequently requires subtle refinements. It is possible to argue that we are not working to produce industrial strength large-scale replicable solutions when devising teaching. As for the students, the timing of the module, following four intensely technically led modules in semester one, may be problematic. We have sacrificed a great deal of personal contact with this redesign. It remains to be seen if technology has been an effective partner which mediates our ambitious intentions.

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