Getting round pegs into round holes: getting students onto the right Engineering Programme.

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Introduction

The programme of study discussed in this paper is situated at level 3 in the English National Qualifications Framework. It is classed as a pre-undergraduate programme and is designed to furnish prospective undergraduate students with the skills and knowledge necessary to prepare them for undergraduate study. In a university context, these types of programmes are known as Foundation Years or Year 0 programmes. Typical profiles of students enrolling on these programmes are overseas students whose home education system have 12 years of compulsory education compared to the UK's 13 years, students who have studied subjects not relevant to their chosen undergraduate engineering programme or students who have not achieved the required entry criteria to enrol upon their chosen undergraduate programme.

The paper begins by discussing the skills required by contemporary engineers, how the new module addressed this, the assessment artefacts, feedback from the students and finally, reflections by the Programme Director on its implementation and execution.

1. Context

The existing programme had been running for many years with little development and as such, did not address the needs of the modern engineer. Many companies report they require multi-skilled graduates who have, amongst other attributes, the potential to manage projects and solve problems [1]. In addition to this there was evidence suggesting that many teachers and school children did not appreciate what engineering entails [2]. To ameliorate this position and work towards meeting the identified needs of engineering graduates, changes were made incorporating factors such as student engagement, validity of assessment, curriculum alignment and assessment for learning; in other words, the opportunity was taken to introduce a more student-centred approach to learning [3].

The new module was designed to give the students the opportunity to have a 'taste' of the different engineering disciplines offered by Aston University; the cohort were subdivided into four groups, with each group spending two weeks experiencing an introduction to a particular discipline. The design of the module was started by deciding on how it would be assessed using the constructive alignment model as proposed by Biggs & Tang [3]. In this model it is important to articulate the purpose of the assessment, how it will be assessed and how the assessment aligns with

student learning. The process of assessment comprises three stages: (1) Setting the criteria, (2) selecting the evidence and, (3) making a judgement. Traditionally the teacher deals with all three stages. In a more student centred paradigm, the student is more actively involved.

2. The Development of the Assessment Artefacts.

Since the aim of the module was not primarily about enhancing knowledge and skills but about empowering students to make an informed choice in relation to the branch of engineering they wished to study, the question of how to most legitimately assess was raised. After exploring options with the University's Centre for Innovation and Professional Practice, an assessment designed to motivate reflection by the student and to start them on the journey of autonomous learning was selected – namely a peer-assessed portfolio to include a reflective essay. Peer assessment being defined by Wilson [4] as 'Peer assessment is the assessment of the work of others with equal status and usually has an element of mutuality'. There are two crucial design imperatives that underpin successful peer assessment:

1. an acknowledgement that students do not know how to engage with peer assessment, either as an assessor or an 'assessee', and will need to be trained;
2. student learning emerges primarily from the role of assessor, not 'assessee'.

With this in mind the first session of the module comprised a briefing on peer assessment that included:

- A definition of peer assessment;
- The pedagogic rationale for deploying peer assessment:
    - Student ownership of the assessment process;
    - The value of negotiating assessment criteria with students;
    - The assessment for/as learning approach – peer assessment asks students to make critical judgments;
    - The need to negotiate with peers, leading to the development of negotiation skills;
    - The emergent learning dialogues that come about as a result of peer engagement in the giving and receiving of feedback.
- An honest addressing of students' concerns relating to peer assessment:
    - Perceptions of additional workload;
    - The perceived lack of legitimacy of peer feedback;
    - The perception of undertaking work that the 'lecturer is already paid to do';
    - The intra-group social dynamics that might be seen to inhibit fair and robust assessment;
- The introduction to the concept of a portfolio as an assessment artefact;
- The introduction to the concept and structure of marking rubrics;
- The facilitated student-production of potential assessment criteria.

[5]

The portfolio (one of the assessment artefacts) was designed to be the means by which students would be able to record significant events and critically reflect upon how their personal attributes came into play. In order to assist them in the

documenting process, the portfolio was divided into six skill sections: Independent enquirer, creative thinker, reflective learner, team worker, self-manager and effective participator. Each skill section was then given a number of sub-headings in order to guide the students in identifying events that would help them to articulate a particular skill.

The ethos of the portfolio was that students should be encouraged to take ownership of their learning [6] through being involved in the decision making process. In order to make informed choices they had to be aware of their personal attributes and how these attributes affect their learning [7]. For example: to be able to learn within a group (such as groups promoted by problem-based learning), the student must know how to work effectively as a team member. If they are unaware of the skill set required and whether they possessed such a skill, they would find group work challenging.

A less well-supported portfolio (without a reflective essay) was used with the previous cohort with less than satisfactory results. This pilot year revealed that students first of all, did not like having to complete a portfolio, did not understand the purpose of a portfolio and did not appreciate the value of being aware of one's personal attributes and how these impacted on their learning. Reflecting back upon the implementation of the portfolio, it was realised the students in their previous educational experiences were not given the opportunity to think about how their personal attributes impacted upon their learning. In addition to this, they were accustomed to being taught with little opportunity to demonstrate autonomy in their learning.

In the second iteration of introducing the portfolio, a more student centred approach was adopted in order to encourage the students to engage in all aspects of its implementation. Rather than impose a set of, what students sometime perceive as arbitrary assessment criteria, the students were given the opportunity to set the criteria themselves. This was done by using a piece of software called *Padlet* (see Figure 1). Put simply, *Padlet* is an electronic 'comment wall' where the students could 'stick' their contribution to the assessment criteria. The benefit of using such a system is that it is transparent and open so the students could see the contributions made by their peers. For any (perhaps shy) student who was reticent to become involved, this software provided the opportunity for them to get an idea of what was expected and make their own contribution. The 'comment wall' was organised so the six skill sections were listed down the left hand side and titles for the assessment criteria across the top. The titles were deliberately framed in everyday language ie. 'criteria for an excellent portfolio', 'criteria for a good portfolio' and so on. It was then left for the students to specify a more precise set of criteria which they would have to use to assess their peers' work. Prior to asking them to set the criteria a class discussion was held on what constituted meaningful criteria. The purpose of the discussion was to highlight the need to set criteria against which meaningful judgements could be made. It is interesting to note that some students used criteria that they have encountered in previous academic work. For example, in the skill section reflective learning, one student proposed 'Reviews progress towards achieving set goals' which is the sort of a criterion a teacher would set. This implies the strong influence of criteria they have encountered in the past whereas statements such as 'Reviewing what you've done right and wrong' is typical of the language you would expect students to use. In other instances, criteria were set that would be extremely difficult to assess. For example, 'Works confidently in a team and discusses issues to solve problems' would be extremely difficult to judge without direct observation of the episode where team work was undertaken.
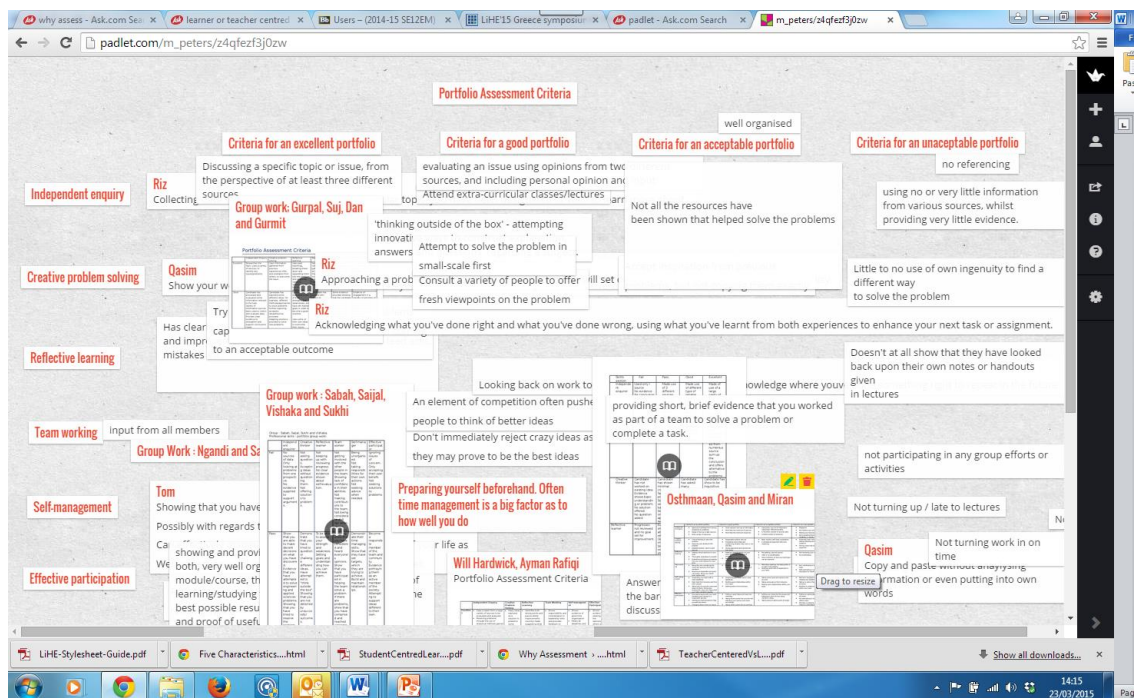
Fig. 1. Padlet with student responses.

The criteria setting process was started in the first introductory session of the module and continued into the second, keeping the *Padlet* 'comment wall' open in the intervening period. Once the wall was closed, the students were given the opportunity to decide if they either wanted the tutor to finalise the assessment criteria or for their suggestions to be used as they were. The cohort decided they wanted to leave the assessment criteria as they had posted it. To complete the three stages of assessment discussed above, the students would use the criteria they had set to assess the work of their peers. In addition to setting the criteria, the students were given the freedom to present their portfolios in whatever form they thought was appropriate; since presenting information in an appropriate way to a particular audience is a skill in itself. The only guidance given was their portfolio had to be structured in such a way that the assessor would be able to find any evidence to back up what they were claiming. For example, some students ordered their portfolios under the skill sections, others by subject and some by key episodes. They were also advised the skills were not necessarily independent of one another and therefore a key episode could encompass more than one skill. For instance, if they were working in a group on an experiment, they would employ group working skills, creative problem solving, independent enquiry and reflective learning. The challenge for them was to make clear which particular skill(s) was utilised within the resolution of the experiment. It was also emphasised they should include any unsuccessful attempts and any strategies they adopted to overcome any challenges in performing the task ie. they should reflect upon their experience and how it enhanced their learning.

The final assessment element for the module was based on a reflective essay. A reflective essay was chosen since reflection is 'a process through which social beings examine themselves within a cultural context' [7]; the cultural context in this instance being a university learning environment. The students were advised to use evidence from their portfolios to qualify any statements they made. They were also encouraged to incorporate evidence from other sources such as professional body websites. To assist them in gathering their evidence, a series of talks were organised where internal and external staff discussed their careers and what it meant to be an Engineer or Applied Scientist. By attending these talks the students were able to develop a sense of contextualising their studies in terms of the 'real world' of employment. All of the speakers willing engaged with the students and were only too pleased to continue discussions after the allotted time and give contact details so the students could request further information or explore possibilities of employment.

The essay provided the students with the opportunity to articulate reasons why they had chosen a particular engineering discipline. In the process of articulating their reasons, they would have to identify the engineering discipline they were interested in, find out the skills and knowledge required and critically examine why they found this particular discipline attractive. The only restriction imposed upon them was the essay should be no longer than 1000 words. The purpose of this restriction was to help them to think hard about their decision and only present what they considered to be the most important aspects of their choice.

The prospect of writing a reflective essay posed particular challenges for the student group, since the vast majority did not know about reflection and in particular how to link their reflections to their personal attributes. A number of sessions had to be organised in which the process of reflection was discussed and how it related to their personal attributes. In these sessions, the students tended to identify the areas they found challenging but were reticent to recognise and articulate what they were good at. It quickly became evident that the educational use of the word 'reflection' was the main problem. This is a word which is often used within an educational context with little consideration given to how students interpret it. The experience of discussing the term with the students highlighted the fact they considered it to be analogous with feedback in the sense it was about improving. This interpretation is understandable, since in most cases it is used within the context of thinking about when things have gone wrong. For example, people are often told if their behaviour has been unacceptable, to reflect upon the experience and articulate what they have learned from it. This 'everyday' use of the word soon becomes their accepted definition, and so when they are confronted with the more precise, educational use of the word, they apply their accepted definition. The outcome from this is they infer the whole process of reflection as one where the situation to be reflected upon is a negative one. To overcome this imbalance, the students were asked to reflect upon what they thought they were good at. A striking example of the difficulty they had with saying 'good' things about themselves was concerning group work. In all groups someone usually takes on the role as the leader, making decisions for the group, organising the work and so on. This could be done explicitly or more usually, someone assumes the role. When the group were asked 'who likes to be a leader?' no one would 'admit' to it. It took a considerable amount of persuasion to convince the students that it was acceptable to identify their strengths and to articulate them to other people.

Another term which proved to be problematic was 'creativity'. As was the case with the discussion around reflection, time was allocated to discuss this term. When the cohort were asked what creativity meant and, who were classed as creative people,

the discipline of engineering was not mentioned. They considered creative people to be artists, musicians and fictional writers. When asked if they considered engineers to be creative people, a stunned silence ensued. It was apparent they had never considered engineers as creative people. Once they had accepted that engineers were creative they were able to give examples which demonstrated creativity and hence formed a notion of what it meant to be creative.

3. Student Feedback

At the end of the first semester an interim peer assessment of the portfolios was undertaken. This gave the students the opportunity to experience assessing their peers and providing feedback. Once this session had been undertaken, they were all asked to complete a questionnaire regarding their experiences in undertaking the peer assessment process (Appendix 1). In response to the question 'How do you feel about marking someone else's work?' one student commented 'It's a big responsibility, one that I am less comfortable with being in the same position as them, as a student'. One response to the question 'How do you feel about one of your colleagues marking your work? was 'I am okay with it, so long as they are thorough. I wouldn't mind them marking directly onto the page in coloured pen so I can see exactly what's good and what's not'. When asked 'What I learned from the interim marking session' one answer was 'A few what-to-do and what-not-to-dos for my own portfolio. How to interpret a mark scheme'.

The informal discussions with the students after they had submitted their reflective essays revealed they found this form of assessment particularly difficult and challenging.   It is something that they did not expect to be involved in on an engineering programme and also it was something they had not experienced before and therefore did know what was expected. In other words, they did not have any episodic memories which they could use to formulate a coherent response. The combination of the reflective essay and the portfolio led some students to say how the experience has given them an insight into the assessment process and how it made them realise the importance of recognising, acknowledging and being able to articulate their personal attributes.

The reflective essays revealed that many of the students valued the opportunity to have a 'taste' of the different engineering disciplines offered by the university. As one student wrote 'I am grateful for the opportunity to taste the different engineering subjects as it helped me to decide what I wanted to do in the future'. Another student wrote 'even though I knew that I wanted to study chemical engineering, the chance to try electronics etc reinforced my desire to be a chemical engineer because I think my personal strengths are more like the ones required to be a Chemical Engineer'. It was interesting to read within a good proportion of the reflective essays that one of the main motivational factors for choosing a particular discipline was salary. At the time of writing, the highest paid engineers worked within the Chemical Engineering industry but this may, and probably will, change in the future. Some students linked their decision to their 'love' of a particular subject at school. The students who enjoyed Physics and Mathematics, tended to choose Mechanical Engineering whereas those who enjoyed ICT (Information Communications Technology) chose Computer Science or Electronics. If Chemistry was enjoyed at school or college, the students chose Chemical Engineering. The essay also revealed some students,

from an early age, enjoyed working out 'how things worked'. This curiosity led them to pursue a career in engineering.

4. Programme Director Reflections.

The logistics of implementing and administering this form of assessment were considerable. In the first instance, timetabling the taster sessions for approximately 160 students divided into 4 groups on a rotational basis, proved challenging regarding allocation of laboratories and lecture rooms. The marking of the reflective essays took a considerable amount of time but it was felt to be a worthwhile investment since feedback could be obtained on how the students viewed the 'taster' sessions and to gain an insight into some of the factors which motivated their choice of engineering discipline. It also afforded the opportunity to judge which aspects of the whole programme the students found valuable compared to what the tutor thought would be valuable. It could be said the end of module student feedback questionnaires are more appropriate but, experience has shown when the questionnaires are issued, the majority of students still attending are the ones who are more committed to their studies and tend to give more favourable feedback. The questionnaires, being an official institutional feedback mechanism, are viewed by some students as a 'tick box' exercise and whatever their responses are, they will not have any impact on the future delivery of the module.

The majority of students valued the sessions where staff and people external to the university, talked about their research, their careers or their company. From these talks, the students were able to see how important personal attributes like being able to work as part of a team, being creative, being capable of independent enquiry and importantly, having belief in oneself were valued and essential ingredients to being successful. These talks were used as evidence in their reflective essays and in their portfolios.

5. Conclusions

Overall the new module achieved its intended purpose; empowering the students to make an informed choice as to their future studies and ultimately, their future careers. Its implementation and administration required a considerable investment in time and allocation of resources. From a university perspective, getting students onto a programme of study suitable to their ambitions and personal attributes is important, since the students are less likely to 'drop out' and more likely to invest the effort required to be successful in their studies and ultimately successful engineers.

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