100 fears of solitude: working on individual academic engineering projects remotely

Michael Hush *

* Department of Engineering and Innovation, The Open University, Milton Keynes, UK

Email: michael.hush@open.ac.uk

Abstract

The UK's Open University has been one of the leading open distance learning universities for over 40 years. It currently has around 200,000 students. Its engineering programme supports several higher education qualifications. Central to them is the BEng(Hons). This general engineering qualification is partially accredited for Chartered Engineer by several UK professional engineering institutions and fulfils an important role in the provision of engineering higher education in the UK. One of its final modules is The Engineering Project (T450) which has been taken by over 2000 students since its introduction in 2004. It is now in its last presentation with over 400 students registered.

The project is intended to be open-ended, authentic and largely selected by the student. The module acts as the principal synoptic assessment for the BEng(Hons) where students are expected to bring together their learning from throughout their undergraduate studies. The project and assessment are based on the requirements in UK-SPEC, UK Standard of Professional Engineering Competences (Engineering Council, 2014) in particular *an opportunity to demonstrate their ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline*. It is now being rewritten ready for a first presentation in February 2016. This paper reviews the life of the current module; its structure, successes and lessons before looking at the options for its replacement, T452.

The approach of the module is constructivist with an emphasis on reflective practice. However, there is little opportunity, either in terms of time or facilities for students to work together. Instead, the close participation of the tutor is intended to provide guidance as well as supporting the student. One element of the review is to address the solitude experienced by many students. This solitude is not autonomy and undermines the importance of interdependent learning.

Keywords: final year undergraduate projects; capstone engineering projects; open distance learning

1 Introduction

While it may be comprehensive to enumerate one hundred fears it would not be particularly interesting. So with apologies to Nobel laureate for literature, Gabriel Garcia Marquez, nine or 100 to base 3 should be sufficient and will, hopefully, be more illuminating! This paper will consider the feedback given by surveyed students, the reasons students fail their final assessment and the experience of the module team on the Open University's capstone project module for its BEng(Hons). It will identify and analyse the principal fears, weaknesses and underlying anxieties of students undertaking an academic project remotely. They will be placed in the context of project based learning and of the expectations of the different stakeholders in professional engineering higher education.

Then the current thinking on final year projects will be reviewed to define a strategic response to managing these fears. The paper will be completed by a set of recommendations to shape the successor module, T452

1.1 Brief history of technical project modules at the Open University (UK)

The UK's Open University (OU) has been presenting open supported distance learning since its establishment in 1969. Its first qualifications were the Open BA and BSc degrees which were awarded once a student achieved enough credits at the appropriate levels. With the introduction of named qualifications and the more recent changes in student funding in England, students now study set pathways. The OU follows the UK's Engineering Council's accreditation of HE programmes (AHEP)'s guidance first introduced in 2003 and now in its 3rd edition (The Engineering Council 2014) to evolve its BEng(Hons). It, too, is now in its third version, Q65 (introduced in 2012) with the previous ones B24 (2003-2014) and B65 (2010-2017). One constant in these degrees has been the Engineering Project, T450. This is a 30 credit (15 ECTS) individual project which is presented each February with the submission of the final report in September. It currently has 420 students registered.

T450 was based on the previous IT and Computing project (TM420-27) with its emphasis on the assessment of learning outcomes, reflective practice and supportive assessment. The principal learning outcome and the students' choice of topic are based on the modules they took prior to commencing the project. Its assessment strategy comes from the OU's commitment to feedback on learning outcomes and supportive assessment as described by Dillon et al (2005) and Gibbs (1999). Similarly the assignments and structure of the module were influenced by the eleven conditions defined by Gibbs and Simpson (2004). These are given in the table 1.

Table 1 Eleven conditions under which assessment supports student learning (Gibbs and Simpson 2004)

Quantity and distribution of student effort
1. Assessed tasks capture sufficient study time and effort
2. These tasks distribute student effort evenly across topics and weeks
Quality and level of student effort
3. These tasks engage students in productive learning activity
4. Assessment communicates clear and high expectations to students
Quantity and timing of feedback
5. Sufficient feedback is provided, both often enough and in enough detail
6. The feedback is provided quickly enough to be useful to students
Quality of feedback
7. Feedback focuses on learning rather than on marks or students themselves
8. Feedback is linked to the purpose of the assignment and to criteria
9. Feedback is understandable to students, given their sophistication
Student response to feedback
10. Feedback is received by students and attended to
11. Feedback is acted upon by students to improve their work or their learning

2 T450 The Final year project in the OU's BEng(Hons)

Final year projects, often referred to 'capstone', are seen as essential to the gaining of an undergraduate engineering degree. This broad view is well described by many stakeholders across the engineering world. From the US

Degree programs must provide a capstone or integrating experience that develops student competencies in applying both technical and non-technical skills in solving problems.

(ABET, 2012)

Or from the UK

Graduates are likely to have acquired some of this ability through involvement in individual and/or group design projects.

(Engineering Council 2014)

It was in this context that T450 was created. The student is required to have studied a suitable final year module from the range of fifteen past or present modules arranged in eleven themes. The principal learning outcomes being assessed are the demonstration of:

- an understanding of and ability to apply the relevant principles within the context of the body of knowledge appropriate to an honours degree level project
- the ability to integrate engineering knowledge across traditional academic boundaries

2.1 Composition of T450 cohorts

The OU's final stage BEng(Hons) Engineering project module, T450 is in its twelfth and final presentation. There have been approximately 2000 students who have registered for T450 since its first presentation. The completion rate has averaged around 85% with the overall pass rate of those completing at 90%. They have all been continuing students (ie they are experienced open distance learners) with the very great majority pursuing a BEng(Hons) qualification. T450 is the compulsory project for the BEng(Hons) and most students take it as their final module. The majority of students will have had higher education experience prior to joining the OU. This will normally be the UK's BTEC Higher qualifications like HNC ie stages lower than the final BEng(Hons) stage. However, the trend is for this percentage to be coming down with it now standing at 56%. The percentage of students with previous qualifications on entry to the OU lower than A level (ie not suitable for university entry) is at 11% and those with A levels or equivalent university entry qualifications at 33%. The reason for this trend is unclear but is unlikely to be related to the change in student funding in 2012. The percentage of female students hovers around 7% which is similar proportion as students who identify as Black and minority ethnic.

2.2 The Engineering Project (T450) experience

The OU surveys its students on a regular basis. These surveys are an essential part of the quality assurance process of a module. Students who have completed the module are asked 40 questions with a 5 point Likert scale for their responses. They are also asked to add comments, either general ones or in response to standard questions. For example,

What aspects of teaching materials, learning activities or assessment did you find not particularly helpful to your learning? We would welcome any further suggestions or comments to consider for future editions of the module.

The number of students who take the opportunity to respond is often small but both the answers and the comments are valuable. T450 has over the past two surveys had response rates of around 30%.

Reviewing these two surveys reveal the following a range of concerns. These have been grouped under the following headings in Table 2:

Table 2. Students' concerns

• Isolation • Lack of guidance • Too much reflection on process • Uncertainty	• Feeling stuck and directionless • Lack of understanding of the assessment • Conflict with work expectations

As the student numbers have grown then inevitably the number of students whose reports are adjudged as being unsatisfactory has also increased. For the 2014 presentation there were 37 end-of-module assessments out of 305 submissions which were failed. As these students are permitted to re-submit in the subsequent presentation, they require feedback on what faults/flaws their original report had. An individual report based on the feedback and assessment by the markers is sent to each resubmission student. From this feedback the following themes have been identified

Table 3. Students' weaknesses

• Unambitious projects attributed to fear of failure • Avoiding engagement with theoretical concepts and modelling • Poor project skills like literature review, planning and reviewing	• Lack of time • Choosing projects to suit their workplace's aims and not theirs • Lack of direction and drive

It can be seen that there are similarities and differences in the two lists. For example, the lack of direction appears in both lists. It shouldn't be expected that they would be the same as they are answers to different questions. Also while the subject groups overlap they are not the same. However, as the aim is to produce an improved version of the Engineering Project then the lists need to be synthesised. They can be listed under the following nine headings.

Table 4. Students' concerns and weaknesses

Lack of confidence	Uncertainty	Conflict of interest
Isolation	Fear of failure	Lack of project skills
Directionless	Too little time	Dislike of reflection

3 Review of the philosophy behind final year projects

The expectation that engineering undergraduates will undertake an individual project is widespread. In their paper on final year Engineering projects, Vitner and Rozenes (2009) give examples from South Africa, Spain, Singapore, the UK and the US before going on to describe their experience in Israel. They define the development of their work-based projects and how they manage the process of supporting students to define and execute their projects. They also discuss the monitoring and assessment of these diverse projects.

From the Middle East, Al-Bahi et al (2014) describe the difficulties of presenting a suitably authentic context for final year, 'capstone' projects. However, there is a similarly wide variation in the form of project modules.

3.1 Project and Problem based learning

Endeavouring to find the differences between what we think of as project based learning and problem based learning is no straightforward task. At one end, there is the relatively simple distinction that Savin-Baden and Major (2004) propose, where project-based learning is more tutor led -students undertake structured tasks to a specific learning outcome and problem-based learning is more teams tackling open-ended problems. At the other extreme is the late Donald Woods' (2014) extensive detailed coding of different learning environments. He identified 32 which he analysed using different parameters such as degree of student empowerment; acquisition of knowledge and/or process skill; depth of knowledge. The learning environment which best suits T450 and includes both terms is the

Problem-driven research/inquiry or problem based synthesis or project based learning (problem used to synthesize previously learned knowledge and usually to develop process skill like critical thinking, or design: case method, inquiry, research or project-based learning. Often the solution to the problem is not known.

(Woods 2014)

Litzinger et al (2010), in an extensive paper on the development of Engineering Education and Expertise, look at the how students can practise the skills needed for the 21st century. They identify two key ideas from the work of others on expertise

The first is the importance of structuring knowledge in a domain around key concepts and principles of the field to facilitate students' abilities to access and transfer knowledge to new and novel situations.
The second is the central role of motivation in enhancing students' levels of performance in educational settings

(Litzinger et al 2010)

They go on to discuss the findings of Ambrose et al (2010) and Boshuizen (2009) which talk about the development of component skills and how to integrate them. The principal tension is that having the component skills does not necessarily mean that students can tackle complex tasks. It is this requirement to integrate different understandings and skills that makes project based learning (PBL) so attractive. Tempelman and Pilot (2011) reported how Delft University of Technology restructured their Design Bachelor programme so that technical theory wasn't left to 'happenstance' but was the 'cornerstone' of the practice. By having much more intensive practice based modules, they found that students' learning was significantly deeper. They concluded with three recommended principles when developing curriculum:

- Provide an authentic context
- Distinguish between knowledge, skills and attitude development and their synthesis
- Create a chain of meaningful activities interpreted reflectively

These principles are echoed by a number of other contributors to the subject of problem-based learning. Savin-Baden and Major (2004) identify the importance of Learning context, Learner identity, Transformational learning and Meaning construction to Problem based learning. They see that a safe, open and trusting environment is central to it where students can move towards autonomy.

If we synthesise the expectations of the programme, the professional engineering bodies and those of the students then there are some common themes but also some tensions. The accepted one is the opportunity to achieve deep learning, the sort that can sustain engineering graduates in their careers. A satisfying project should leave students with a sense of achievement as well as confidence that they have brought together the different elements of their undergraduate study. They should also have moved from the abstract to the particular and drawn justifiable conclusions. Their project management skills should have been tested and allowed them to tackle a problem multi-laterally. Savin-Baden and Major (2004) cite the work of Eva et al (1998) on the dimensions of a problem and the likelihood that students are able to transfer knowledge from one situation to another. They suggest that it is important to:

- Teach problem recognition
- Provide immediate feedback and guidance
- Emphasise the importance of problem solving as a valuable learning tool
- Provide numerous examples to demonstrate abstract principles

One aspect of problem/project based learning in engineering is an endeavour to 'mimic professional situations' (Stewart 2007). Generally, this is an attempt to provide authenticity as well as to introduce the multi-faceted characteristics of a real situation. T450, while looking to support actual projects, makes it clear that it is an academic project and so requires deliberate reflection and the achievement of learning outcomes.

4. Analysing the fears

The concerns listed above are still unwieldy so to enable a clearer view of them, they have been divided into three groups;

- ones that are ever present and need to be addressed by continual support
- ones that can be neutralised through advice and guidance
- ones which can be mitigated through teaching.

These distinctions should lead to proposals to include in the updated module, T452.

4.1 Fears to address

The Open University students are noted for their determination and perseverance and it is no different with the T450 students. In addition, there are some important characteristics that many engineering students share. Their aim is the BEng(Hons) so because T450 is a mandatory module, they are content to do it. However, they often don't have a solid desire to undertake an individual piece of work based on self-directed research. Reviewing the failures, it can be seen that the ones who struggle lack the research skills of literature evaluation and review. They often start the module believing they have them, so don't allocate time to learn or improve them. By the time they realise, they are then behind schedule and don't really catch up. Similarly they are often transfixed by a fear of failure. They have been conditioned by the OU's extensive support systems and find the unstructured nature of T450 challenging. With so much resting on the project, this raises the stakes significantly.

To improve these issues, the new module will provide much more structured teaching of research methods. Also since isolation is often the result of being pressurised but lacking direction, open student forums are promoted. The new module will encourage more participation, either in their tutor groups or in subject groupings. What is important to recognise is that these anxieties are part of the academic challenge. Students need to be supported through them.

4.2 Fears to neutralise

There is another group of fears which need to be designed out of the module. These can be characterised as being related to the students' personal situations. For example, a number of students will have their projects chosen or influenced by their employer. From one perspective, a project related to a pressing work-based problem is attractive. However, it rarely is. This is because the aims of an academic project often conflict with those of a work-based project. Furthermore, the schedules often clash. This conflict of interest can cause unnecessary stress for the student. Our advice is consistent in pointing out the pitfalls in this type of project. We need to strengthen this advice.

The other fear which affects a minority (but they are a vocal group) are those who dislike reflection. Much of this fear is caused by a lack of confidence in their capacity to make sense of the requirements. The assessment contains structured reflection and this needs more support for students to realise the benefits of it.

4.3 Fears to mitigate

These fears often manifest themselves in the tutor as well as the student. It can be seen in the lack of engagement that students have in their planning. Although they are specifically required to present a work breakdown structure of their projects along with a schedule early in the module, these are often poorly executed. This can be attributed to a lack of commitment and a misplaced sense of their own abilities. These can be mitigated by better and more explicit teaching of project management skills. Since the gaining of such skills is one of the principal learning outcomes, then the responsibility belongs to the module team. As more is being done in earlier modules of the qualification, it is expected that students will be better prepared to embark on an individual project.

5 Conclusion

What comes through most strongly in this review is that much of the responsibility lies with the module designers and programme managers. The changes required are throughout the module but disproportionately affect the early weeks of the module. By opening the moderated student forums well in advance of the module start then students can be encouraged to discuss their anxieties and queries together. It would also be a place for students to refresh their understanding of research and project skills. This will be in the form of structured activities with the Library systems and databases in particular. Similarly, with more access to information, advice and guidance (IAG) earlier in their project, then choosing the right subject at the optimum time should be more easily achievable.

One technically advanced improvement which will come with the new module is that all final project reports will be electronically available. It has been a regular request from new students to see previous years' reports. As they were all paper-based they were not easily available. The module team's view was that it was unhelpful to provide exemplars as they risked influencing students too strongly. However, if all were available in the form a digital library 'shelf' then students could sample and draw their own conclusions. This access to the look and feel of previous work would settle some anxieties without directing them away from using their own judgement.

The two remaining areas for strengthening are getting tutors to be more persistent in requesting and supporting student reflection. Many tutors already do this but more could be done. Similarly, tutors could be more consistent in using the learning outcomes as the focus for their feedback. As Gibbs (2010) remarks

However useful they are to course designers, students actually learn about goals and standards through a repeated cycle of practice and feedback, not through reading statements in their course guides

By using them at every stage, then their pedagogic purposes will become clearer and students will be able to respond to their advantage.

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