

TEACHING TEAMWORK AND PROJECT MANAGEMENT USING VIRTUAL PROJECTS

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ABSTRACT

Project management is one of four “management” modules taught in Liverpool science and engineering programmes. One of these modules is taken each year. The module described here is usually taken by second-year students. The problem was: The class typically contains 200-300 students from six or more major disciplines across engineering and science. It is not possible to assume a common set of interests or experiences, as would be the case if the class contained, for instance, only aerospace engineering students. Very few students (perhaps less than ten in a typical year) will have had any experience of project management and many will not have worked or studied in a team. There is usually a diverse range of cultural and ethnic backgrounds. For many years the class was taught by lectures only, with no formative assessment and no “active” element at all. Although of course most students passed the exam, they had never used any of the techniques described to them. The solution was: Without changing the intended learning outcomes very much, the material was re-cast into half the original number of lectures, supplemented by a virtual team project with five assessed deliverables at two-week intervals. The key characteristics of the revised module, and its associated virtual projects, are described in more detail in the paper along with feedback from the students who have taken the module.

KEYWORDS

Teamwork, project management, virtual projects, large classes

INTRODUCTION

Project management is one of four “management” modules taught in Liverpool science and engineering programmes. One of these modules is taken each year. The module described here is entitled “Project and Risk Management” (PM, in brief) and is usually taken by second-year undergraduate students and Masters (taught MSc) students.

This class was traditionally taught using lectures only, with no formative assessment and no “active” element at all. Although of course most students passed the exam, they had never used any of the techniques described to them. It was decided to make the module much more active, by halving the number of lectures and creating a virtual project for every student, so that PM techniques could be put into practice. One problem was: The class typically contains 200-300 students from six or more major disciplines across engineering and science. It is not possible to assume a common set of interests or experiences, as would be the case if the class contained, for instance, only aerospace engineering students. Very few students (perhaps less than ten in a typical year) will have had any experience of project management and many will not have worked or studied in a team. There is usually a diverse range of cultural and ethnic backgrounds and several levels of prior educational or work experience.

The approach to a solution was: Without changing the intended learning outcomes very much (see below), the material was re-cast into half the original number of lectures, supplemented by a virtual team project with five assessed deliverables at two-week intervals and a set of question and answer (Q&A) sessions. This resulted in the same number of timetabled “contact” hours but in less than half of them is a lecture delivered. Only seven formal lectures are now delivered.

To the original learning outcomes (listed in the appendix) was added a further small but important set relating to team and project working, viz:

- use the basic functions of Microsoft Project
- ability to work in a team
- ability to deliver work to a deadline

The virtual projects themselves were devised and developed, under the guidance of the author, by two students who had recently taken the earlier version of the module. The topics were chosen to be equally accessible to all students, regardless of their prior experience, and the projects were constructed so that every team could use a different set of quantitative data. The topics selected were the setting up of a specified type of restaurant in a specified location in the city of Liverpool and the building, by a charity, of a facility for a village in a developing country. In the first two years, among 500 students, only one has proved to have had direct prior experience of either of these tasks, while no team has found it difficult to understand the requirements. The two students developing the virtual projects worked for ten weeks over a single vacation, so the effort required was approximately 20 person-weeks plus about one week of the author’s time.

The projects were designed to have five deliverables (called “tasks”), at two-week intervals, each of which required one or two team meetings. The tasks, which are generic so that they apply to all projects, are listed in Appendix 2. Every task had to be submitted to the students’ virtual learning environment (VLE), on a pro-forma, to a firm deadline. The importance of the new learning outcome “ability to deliver work to a deadline” is that this module over-rides the university practice for late submission, which defines a mark penalty for lateness of up to five days. In order to meet the LO, no late submission is possible (except for good, usually medical, reason). The *quid pro quo* for this aspect of the contract with the students is that the module teachers undertake to mark the tasks within 3 days and to deliver feedback at the meeting of the class in the same week as their submission. In practice this has meant a submission deadline of 5pm on Monday, with feedback to the students at 11am on Thursday. Feedback (see below) indicates that it would be preferable to have a midnight deadline, but this removes one evening from the short time for marking. In the first year sixty teams of five students were established while in the second year forty teams of six were used. Marking the work of 200-300 students in this period is a challenge, and the way in which it is met is described in the following sections:

MODUS OPERANDI

The lectured material principally relates to definition of terms, explanations of concepts (such as Discounted Cash Flow) and anecdotal examples of the management of specific projects. The students are offered a weekly class with a lecture every two weeks, in which the next task is defined, followed by a consultation class in the intervening weeks. Each task explicitly involves applying the material covered (albeit briefly) in the preceding lecture. Most of the students have had no prior training in team work, although as the CDIO approach is embedded in their programme they will usually have experienced one team-based design-build-test project. The students are told that team selection will be at random, defined by the lecturer, who in fact attempts to prevent the formation of teams from a single ethnic background or with a single female. In the first year mixed teams were constructed from all

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subject cohorts, and this remains the educational ideal. However in response to student feedback (see below) teams in the second year of operation were constructed from within a single discipline cohort (e.g. from Aerospace Engineers, or from Civil Engineers) in order to facilitate team meetings, by only using students who share a common timetable.

All content and assessment is via the local VLE. The students are given access to a lecture handout one week before each lecture, the lecture Powerpoint presentation is released immediately following the lecture and (second running only) a video of each lecture is mounted within two hours of the lecture. On-line guides are available to:

- Team working and the role of the Project Manager and Secretary (who have to be different for each of the five tasks)
- Pro-formas for team meeting Agenda and Minutes
- The use of Microsoft Project
- FAQs

In addition to the five tasks, there is a short multiple choice question (MCQ) on-line test in week 7 (or a slightly longer one for Masters students). A summative MCQ examination is held at the end of the module. These elements contribute in the following way to the whole module mark:

- Tasks 1-5, 6% each
- On-line test 10%
- MCQ examination 60%

Each task is assessed in the following way, designed to minimise staff effort while retaining rigour and useful feedback: It is the responsibility of the PM for the task to coordinate the deliverables and distribute them to all team members. Every member of the team must submit an identical set of deliverables, but only the PM's submission is marked and feedback is only given to this submission. Feedback is then shared by the team members, usually at their next meeting. Other team member are given the same mark if, and only if, they submit the same set of deliverables. This means that only one-fifth of the students' work has to be marked while the remaining 80% is simply verified as being identical. In the case of serious malingering, recorded in the meeting minutes, staff reserve the right to adjust downwards the mark of any specific student. This has proved necessary in only a handful of cases.

Students are instructed that if they experience problems in the operation of their team they should first attempt to solve them themselves, that they should always record them in their meeting minutes, and that if they call on staff intervention, staff will only act on problems for which there is a written record trail.

FEEDBACK FROM THE FIRST COHORT

Student responses were sought to three specific questions:

1. What were the aspects of this module which were particularly effective and why?
2. This module could be changed in the following ways to improve my learning , and
3. What do you think you learned from undertaking this virtual project?

From a response of 264 student (90% of those registered for the class) 91% of students were pleased with the module and 87% claimed to enjoy the virtual project. In response to question 1, 104 students mentioned team work, 97 mentioned the virtual project and 74 the use of VITAL (the University of Liverpool virtual learning environment). Some comments include:

"I think use of VITAL was exceptional and that the team projects were an interesting and practical way of learning."

"The virtual projects were useful because it enabled us to apply what we learnt in the lectures to a real-life situation. It also enabled us to build on our team working skills and allowed us to use industry-standard tools for project management"

"The virtual projects were beneficial as they gave an insight into how engineers might interact in the real world while managing an important project. The module reinforced my group skills."

"It has to be the virtual projects and team work. By working on a project totally unfamiliar from our own comfort zone enables us to learn something different and understand what sorts of things involves in any project. And in the case of the team work I would have to say that, it gives great bit of knowledge how to handle and maintain a group work."

"Team work and virtual projects. Team work allows you to think in different ways."

"The high weighting of the Virtual Project (and the use of VITAL) were the most effective parts of the module. This was because it greatly encourages you to spend the necessary time on the project, therefore increasing understanding and knowledge of the subject."

"I believe that the virtual projects gave a very good insight into how a management project is run. I thoroughly enjoyed these projects and would like a career in the management sector. However the lectures themselves could have been made more interesting."

"Enjoyed the team work as normally I do not do the extra work but because other people depended upon me I worked much harder and learnt much more. I also like the use of VITAL as all the information needed is in one place, and allows me to get in contact with both the lecturer and my team members easily."

But also:

"Very little of this project was particularly effective. Given the nature of the subject, management is a very vague subject area and the overwhelming use of jargon to describe common-sense financial decision making behaviour I found to be more of a hindrance than a thorough explanation of the processes behind them."

The responses to question 2 (This module could be changed in the following ways to improve my learning) did not show any dominant attitudes, but 36 students commented unfavourably on the large class size for lectures (almost 300 students). However 23 students asserted that no change or improvement was needed. Specific comments included:

"Increase the deadline from 5 to mid-night on VITAL submission."

"Due to people being from different areas of university, ie ..maths , engineering, we all have things to do at different times of the week and it was sometimes difficult arranging times to meet up, maybe putting groups of civils with civils and maths with maths would mean people could meet easier."

"By making it more real , i.e. by introducing the students to real projects and having discussions with project managers of related fields so that we understand more deeply how a medium or large scale project is carried out in the industry."

"Submitting work on VITAL, very easy but deadline should be made to midnight to submit, then less arguments can occur about being in lectures or work."

"The lectures were quite boring to be honest, but I have no suggestions how to improve it because it's not the most interesting of subjects to learn or teach, I'd imagine."

“Less emphasis on team work, it would not have made much difference if I had done all of the tasks on my own as I did the majority of the work anyway and wasted a lot of time organising and then re-organising meetings.”

In responding to the third question (What do you think you learned from undertaking this virtual project?) students most often commented on their acquisition of soft skills such as team working and time management (78 responses). Specific comments included;

“I just realised that management is not easy as I thought.”

“I never thought that building a well could be that complicated and need precise planning. I learnt that no matter how small the project seems to be, we need to put serious effort on it as failing will give big consequences to community.”

“I have learnt the real time problems faced in a project, and the importance of team work.”

“It illustrated to me that even a minor project (in our case was the village barn) can be complex and highlights the importance of planning, management and control to the success of the project .”

“Definitely learned the importance of project management and organisation. Perhaps more importantly the fact that a project manager needs a good team behind him/her as well .”

“We learned how to create and set up a project, from identifying risks etc. to basic costing for a project. As I have never taken a module or class like this one before, I have learned a vast amount of information regarding cost and management of a project.”

“I did enjoy the project and it was the first time I had considered any of the project management/costing issues associated with a project. It was also a good learning experience to consider how one would go about setting up a restaurant. I felt like I learned a lot from this virtual project. It made me consider the management and financial side of things. I also learned a great deal about critical paths and how to professional manage a project to ensure it is delivered on time.”

“What it would be like to have our own business, dealing with real life situations etc. Very interesting, and thoroughly enjoyed.”

But three students actually responded: *“Nothing.”*

In response to the student feedback, several changes were made for the second running of the Virtual Project module. Some of these were pragmatic, in response to local conditions, while a few were for pedagogic reasons. The principal changes were: Team size was increased from 5 to 6, in order to enable the students to better cope with student absence and illness (and to slightly reduce the number of teams). Teams were restricted to students from a single degree programme, instead of being selected from a range of programmes of study. This was simply to make team meetings easier to arrange – a pedagogical approach would suggest that mixed teams are preferable. The class size for lectures was reduced to about 120 by offering the lecture twice. In this second year the two identical lectures each fortnight were given by different people, providing a seamless transfer from one lecturer to another. These changes were all popular but it remains to be seen whether they were educationally effective.

Apart from student evaluation of the module it is also possible to see the impact of the changes, and the virtual projects, on the assessment outcomes. The mean marks for the last seven years are shown in the table (every cohort was at least 200 students, so the means are quite reliable). These results are largely comparable because the majority of learning outcomes have not changed over this period. The additional outcomes detailed above are only 3 among 26 LOs, 23 of which remain the same (see Appendix 1).

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| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|-------------------|------|------|------|------|------|------|------|------|
| Class average (%) | 62 | 57 | 60 | 55 | 61 | 64 | 71 | |

The rise in 2008, the first year of the virtual project scheme, seems significant. The 2009 data will be inserted at the conference.

OTHER ISSUES

This module is offered to students at two levels, second year undergraduate (Level 2) and Masters (Level M). For the vast majority of both sets of students the material is new, but it is necessary to differentiate between the outcomes expected at levels 2 and M. This is done in three ways:

1. The on-line test is 50% longer for the M level students, but worth the same number of marks;
2. The pass mark for the module is 50% at M level but 40% at Level 2;
3. M level students have a sixth task, which is more reflective in nature. This is an individual (not a team) task and is described as follows. "In the context of your virtual project, write:
 - a) A substantial discussion of the lessons you learned from your team's SWOT analysis, followed by a set of recommendations.
 - b) A requirements document, i.e. the document you would use to brief the project team about the purpose of the project.
 - c) A critical analysis of the effectiveness of your project team in delivering the five tasks, followed by a de-briefing document which is intended to give advice to next year's teams."

These three differentiating elements require a significantly enhanced effort and depth of understanding from M level students.

CONCLUSIONS

The active module, with its virtual project, is popular with students. It succeeds in delivering its learning outcomes, including teamwork and delivery on time. The outcomes are much more completely met than under the previous "chalk and talk" delivery regime. It is a bit more expensive in terms of staff time, requiring team marking of the tasks but a computer-marked multiple choice examination. Using students to devise the virtual projects was a successful experiment.

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Biographical Information

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APPENDIX 1: LEARNING OUTCOMES FOR THE MODULE

On successful completion of this module, students should be able to demonstrate knowledge and understanding of:

- the meaning of a given set of common acronyms and terms
- the nature of a project, its planning and key elements of its management
- SWOT analysis and SMART objectives
- the breakdown of a project into tasks
- the management of risk
- the construction and interpretation of Gantt charts and critical path networks
- the nature of costs and how to apportion them
- the difference between direct and indirect costs, and fixed and variable costs
- the estimation of overheads and their absorption
- depreciation and several methods of costing
- break-even analysis
- DCF and NPV methods to appraise an investment.

Intellectual Abilities: On successful completion of the module, students should be able to demonstrate ability in applying knowledge of the above topics to:

- carrying out a SWOT analysis and developing SMART objectives
- constructing and interpreting Gantt charts and critical path networks (determining critical paths, slack and opportunities for crashing, etc)
- evaluating project risks
- estimating and analysing costs
- carrying out an appraisal of potential investments.

Practical Skills: After studying this module, students should be able to:

- use the basic functions of Microsoft Project
- manipulate straightforward cost procedures
- calculate net present value
- construct and use network diagrams
- construct a risk evaluation

General Transferable Skills: On successful completion of the module, students should be able to demonstrate the following aspects of key skills:

- manipulation of numerical (financial) data
- written presentation of management information
- ability to work in a team
- ability to deliver work to a deadline

APPENDIX 2: THE PROJECT TEAM TASKS

Task 1: Devise a SMART objective for your project and prepare a SWOT analysis (from a defined perspective)

Task 2: Devise a work breakdown structure for your project and present it in a Gantt chart using Microsoft Project. Identify the critical path

Task 3: A work change order has been issued: revise your WBS and Gantt chart; comment on changes to the critical path; identify the slack in your project plan.

Task 4: Identify the stakeholders in your project. Construct a risk register, calculate the severity of each risk and discuss how to mitigate the most serious risk.

Task 5: Calculate the depreciation of your equipment, the net present value of your predicted cash flows, and the overhead absorption rates applicable to your project.

Task 6 (Masters students only, as individuals, not as a team): With the benefit of hindsight and reflection: Devise a requirements document, a reflective discussion of the lessons you learned from your team's SWOT analysis and your analysis of the operation and effectiveness of your team.