Interdisciplinary group projects involving maths and engineering undergraduates

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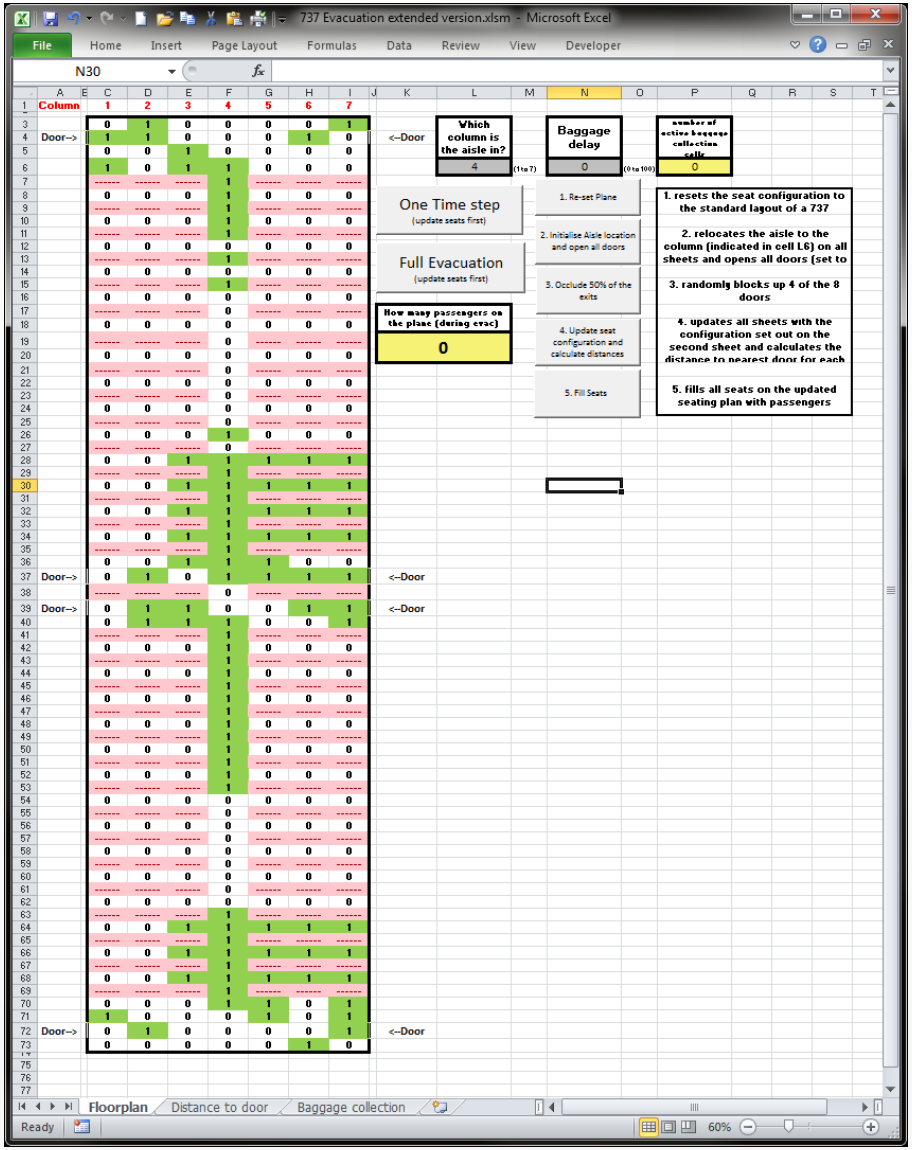
What we did, in a nutshell

- Second year Mathematics undergraduates took part in a group project with second year Aerospace Engineering undergraduates.
- Mixed groups worked on a problem of modelling the evacuation of an aeroplane, for credit.



Some negatives

- Administration, including
  - a single assessment contributing to two modules on different degree courses;
  - timetabling;
  - QA nightmare;
  - exceptional circumstances.
- Practicalities, including
  - staff from different courses agreeing on what and how to teach;
  - staff from different courses agreeing on what and how to assess;
  - staff from different courses even meeting during term;
  - two VLE sites for different groups;
  - marking consistency.
- For students, unusual and outside of the comfort zone.

So why do it?

- Original idea
  - graduate mathematicians working practices;
  - early idea in maths and civil engineering.
- Alex Crombie's PhD:
  - examining the impact of interdisciplinary teaching;
  - assessing the extent of barriers to implementation;
  - developing techniques to aid implementation of interdisciplinarity.

Interdisciplinary teaching

- Graduates now predominantly go on to employment in the private sector.
- Most roles require the collaboration of several disparate fields.
- The experience of higher education is at odds with the graduate experience of work.
- Work-based learning is becoming an increasingly important component of higher education.

Interdisciplinary teaching

- Students on traditionally organised degree courses are rarely given the opportunity to appreciate the value of their skill set.
- Through engaging in a task that requires their unique academic skill, their mastery of the subject is highlighted.
- Working on a problem with people from different backgrounds can demonstrate the existence of different ways of approaching a task.

What works for each course?

- Structure of the modules:
  - maths module arranged in six week blocks;
  - engineering module arranged in four week blocks;
  - so I had the mathematicians for six weeks, but we only had four weeks with the engineers.
- Assessment:
  - Engineering module willing to devote 10% of module marks to this.
  - Maths module had to assign 17.5% of module marks from this.
  - We felt that both sets of students should get equivalent credit from the work.
- This meant I had two extra weeks and 7.5% of module assessment with the mathematicians.

Assessment brief

- Brief explains that current certification for aircraft is changing.
- Currently, airlines must demonstrate evacuation of all passengers with 50% occlusion of exits in 90 seconds.
- Observed behaviour: while people behave well in tests, in practice some passengers stop to pick up bags, causing delays.
- Change: evacuate all passengers and 25% of hand luggage with 50% occlusion in 90 seconds.
- Airline says they can do this with 20% seat reduction. The brief is to tender for a solution that is less costly to the airline.

Teaching

- Modules:
  - Maths: level 5 mathematical modelling module.
  - Engineering: level 5 professional practice module.
- First week: separate groups.
  - Engineers: learning about regulatory environment re. retrofitting an aeroplane (legislation, ergonomics, cost and practicality).
  - Mathematicians: learning about agent-based modelling applied to evacuation scenarios.
- Weeks 2-4: mixed groups, group work. Some structured activities, but mostly student-led.
- Weeks 5-6: just mathematicians, separate individual work.

Assessment

- Groups produce (10% of module):
  - video presentation;
  - tender document;
  - group management supporting documents.
- Individuals complete peer assessment of group work contributions.
- (Maths only) Individuals produce (7.5% of module):
  - a project reflection, guided by a pro-forma;
  - focused on how agent-based modelling works and interdisciplinary working practices.

Marking and moderation

- All group work was marked by one engineer and one mathematician.
- Discrepancies in marks were viewed by a third marker.
- We all agreed adjustments to marks based on peer assessment of contribution.
- The individual work for maths was marked by Peter and blind-second-marked by Alex.
- Feedback and marks were then checked by the module moderator.

Evaluation – method

- Ongoing, via student Progress Files.
- Some useful comments via the maths students individual work.
- Pre- and post-intervention questionnaires focused on self-efficacy and false consensus effects.
- Post-intervention individual and group interviews.

Evaluation – some initial findings

Engineers:

- minority within each group - on average ~2:5 engineer:mathematician ratio;
- less instinctively used to this type of group work;
- reported a feeling of limited usefulness in completing the task.

Mathematicians:

- comprised the majority of almost every group;
- much better attendance;
- reported general feelings of group-role indistinguishability;
- predominantly made the final submission.

Evaluation – some initial findings

- Questionnaires investigated students' perceptions of the abilities of themselves and others.
- Maths students (majority of most groups): perception of abilities of others more strongly influenced.
- Engineering students (minority of most groups): perceptions of abilities of self more strongly influenced.
- Measured effects were generally more pronounced in the engineers.
- Possibly because there were fewer engineers, so both cohorts valued their contributions more strongly.

Evaluation – some initial findings

- Engineers approached problem differently:
  - "Their approach to problem-solving in comparison to the maths students was a less logic-driven; they provided a broader, more creative outlook on the problem."

Evaluation – some initial findings

- Added reality:
  - "We found several solutions which were better than the solution we used, but these were not feasible. Although we believed some of our solutions optimised the model, the engineers told us that the solution could not be used on an aircraft due to the engineering and laws regarding aeroplanes."
  - "It was pleasant to be involved in a topic that the mathematics course would not normally look at. In particular, having the opportunity to be challenged by the aerospace students by restricting our model from following regulations."

Evaluation – some initial findings

- Communicating with a non-maths audience:
  - "Working with a non-specialist audience made it harder, explaining everything was tougher as they didn't understand the small concepts we understand which makes everything click."
  - "Both sides of the group found themselves required to explain points of technicality with laymen, which contributed to the clarity of thought on the overall project for the whole group - explaining mathematical concepts behind the model to the Engineers deepened our own understanding of the project."

Evaluation – some initial findings

- Employability links:
  - "A large advantage I found with working with people from another course is that it represents an employment situation and is good practice to delegate areas of work to people with different expertise. Working this way also showed how my course experience could be used in a similar employment task."

Some thoughts for next year

- We'll have 6 weeks and 17.5% with the engineers.
- Two weeks apart learning the separate parts before coming together.
- An extra week of group working to run the presentations.
- Change of presentation delivery?

Revisiting the negatives

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Thanks for listening! Any questions?

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