Design and delivery of a new graduate skills module

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- I was invited to design and deliver a new final year module aimed at developing graduate skills via group projects (not for my current institution).

Big design questions

1. What learning outcomes to write?
2. How large are the groups?
3. How to allocate students to groups?
4. How much to use group projects?
5. How to deal with uneven contribution?

1. What learning outcomes to write?

Intended learning outcomes

- Problem-solving.
- Communication skills.
- Group work.

Intended learning outcomes

- Problem-solving:
  - The ability to **work in-depth** on a problem over an **extended period of time**;
  - Enhanced problem-solving skills, including the ability to apply mathematical knowledge in **real-world scenarios**.
- Communication skills:
  - Report writing skills;
  - Oral presentation skills;
  - Ability to communicate results **using different methods**;
  - Ability to communicate results **to audiences of differing mathematical abilities**.
- Group work:
  - Enhanced team working skills;
  - An appreciation of **how groups operate**.

Intended learning outcomes

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- Communication skills:
  - Report writing skills;
  - Oral presentation skills;
  - Ability to communicate results **using different methods**;
  - Ability to communicate results **to audiences of differing mathematical abilities**.
- Group work:
  - Enhanced team working skills;
  - An appreciation of **how groups operate**.
- Ability to articulate graduate skills.

2. How large are the groups?

How large are the groups?

- Told to expect about 20 students.
- Actually got 44.
- I decided to have large groups (8 or 9), so that tasks must be subdivided and to increase the difficulty of group dynamics.

Student feedback - group size

- “I felt this was really good as within the group, everybody had different skills so we could all sub-divide tasks accordingly.”
- “i now realise how much quicker you can get something done by splitting it up.”
- “I thought groups of 8 and 9 were too large. Trying to get your point across with so many other people wasn't always easy.”
- “It became very difficult at times to coordinate the large group.”
- “Very, very hard to make sure everyone has something to do if you are 'group leader'. If people shy away and pretend to help someone else then do very little work, it's hard to realise it unless you know your group well. Hard to avoid, so I probably wouldn't change it (was quite a good experience).”

3. How to allocate students to groups?

Possible methods

- Self-selection:
  - students prefer this; avoids “friction within a group” (MacBean, Graham and Sangwin, 2001; p. 8);
  - less realistic; employers seek “evidence that graduates can work in a team rather than the fact that they have participated in a university-style group project” (Chadwick et al., 2012; p. 49).
- Lecturer-assigned:
  - chosen by the lecturer or randomly assigned;
  - can be frustrating for students (MacBean, Graham and Sangwin, 2001; p. 9).

Bradshaw's method

- Noel-Ann Bradshaw (University of Greenwich).
- Aims to balance being “fair to the students” while providing “a valuable lesson about working with others” (Bradshaw, 2009; p. 7).
- Method:
  - invited students to form groups of three;
  - to each three, added three more;
  - allocation made “with respect to ability, friendship groups and preferred topics”.
- Bradshaw reports positive group dynamics and student feedback that the method was fair (p. 8).

However...

- I do not know the students!

My approach

1. Students form small groups (4 or 5).
2. Groups complete a formative task (Zin Obelisk, see NRICH, no date), make an audio recording and produce a group interaction transcript.
3. Student reflection on task and discussion with lecturer about group dynamic and members' strengths.
4. Lecturer pairs small groups to form larger groups (8 or 9), using what was learned from the reflection.

Person A	Person B	Person C	Person D
Right, I have all the information about the zin – it is 100ft high, 50ft in length and 10 feet wide. Chris, what is that?			
	50,000 feet		
		Each person works for seven schlibs a day because there are 8 ponks per schlib and each worker rests for 16 ponks, or 2 schlibs	
			Each worker lays 150 blocks per schlib
	There is only 8 people working in the gang because one of them is religious		

Person A	Person B	Person C	Person D
Arrange cards into categories			
	All responded		
Size of Zin?			
	55ft length	10ft width	100ft height
Calculate Schlibs/ponks			
	9 schlibs/day	8 ponks/schlibs	

Student feedback - recording

- Generally positive:
  - “Listening to the recording, it allowed me to understand how others see my role in the group and allowed me to build and change things if needed”.

Student feedback - allocation

- Generally positive (30 out of 35 thought it had worked well):
  - “I liked this grouping process better than random groups”;
  - “This was a really good idea as you still knew some people and then the others were new people so you still had to work with new people”;
  - “Thought that it was good how the groups were made to incorporate people who took various roles within a group”.
- Divisions along original group lines when disagreeing in one larger group.

Much more to say on this

- I submitted a piece giving more detail for peer review at *MSOR Connections* and this has been accepted subject to minor changes - watch out for this!

4. How much to use group projects?

How much to use group projects?

- I decided on three aspects:
  - a project to learn about group working;
  - a project to learn about working for a client;
  - a project to learn about communicating to 'the public'.

A project to learn about group working

- A real-time problem-solving task (2 hours, in class).
- “You work for a mathematical modelling consultancy. Your employer has received a call from a client with an urgent problem. The client’s employee car park has flooded and cannot be used. Employees will start to arrive for the evening shift in just over two hours. The client has agreed with a nearby school to hire a large field as a temporary car park. ... The client’s question is this: 'in order to minimise the repair cost, how can I arrange to park all the cars in the field so that as little grassland is driven over as possible?'”
- Mathematical justification for the boss and client justification needed.
- Based on a problem from the bank created by Benjamin et al. (2012).

Student feedback - real-time project

- “Felt quite rushed (I do, however, understand why this was).”
- “Helped me to understand how i work within a group”.
- “The task was useful as it highlighted the skills we lacked and therefore we had a chance to rectified.”

A project to learn about working for a client

- Working to model the guarding of a set of museums for a client with no mathematical expertise.
- Write an in-house technical report and a report to convince the client of the solution.
- Similar to something I've used previously, reported at CETL-MSOR 2009 and in:
  - Rowlett, P., 2011. Using Art Gallery Problems to develop mathematical and employability skills in a higher education group project. *In:* J. Waldock, ed. *Developing Graduate Skills in HE Mathematics Programmes - Case Studies of Successful Practice*, pp. 30-31. www.mathstore.ac.uk/hestem.

Student feedback - client project

- “I liked this as it was different because it applied maths to the real world.”
- “Having never experience anything like this before I felt that this task was highly useful, given the fact that my future job could contain something of a similar task.”
- “It was very good because it taught us how to articulate mathematical results to non-mathematical client. However, at times it was difficult since I was afraid it may be too patoronising.”

A project to learn about communicating to 'the public'

- During the Olympics and Paralympics, I ran a PHP script to save about 3 million public tweets.
- Offered students as much or as little of the data as they wanted (or could handle).
- They had to choose a question and design a project as a group (statistics, language processing, OR, graph theory (network theory), algorithm design, computational methods, etc. etc.).
- Assessment via mathematical report, public lecture (to staff), and via audio report (radio or podcast).

Student feedback - public communication

- “This was good as we had to learn how to explain something fairly mathematical to an audience without mathematical knowledge so that they can understand it.”
- “It was very different than what I had previously been used to in a Maths degree, as I have no experience in delivering or making presentations, but made the task quite enjoyable”.
- “It was a daunting task to talk in front of an audience but it is a key skill that i needed to practice so i felt this went well.”
- “We were given guidence on how to de-mathematise our presentation when it got too technical.”

Student feedback - greater freedom over task

- “I enjoyed this aspect since it taught us to use more initiative as opposed to just doing what we've been told as such. It also meant that we could do a project which interested us other than a set project.”
- "It was good to be given more freedom, but this was more than we ever had been before and took a while to come to terms with it all."
- “Felt that there was too much freedom in choosing our own project, this meant that we could easily put ourselves into trouble.”
- “I preferred that we were able to manage our own time, choose our own question and direct the project the way we wanted to, it makes a positive change compared to most other maths modules.”

Student feedback - greater freedom over task

- “It was good how you controlled us more at the start of the module but by the end we had a lot of freedom and more responsibilities.”
- “Although others in my group disagree i felt it was quite good as it gave independence and that if we got stuck we had to figure it out ourselves rather than being guided to the answer by someone”.
- “It was good to be able to interpret the question in our own way. However, it was frustrating when we couldn't get told if we were doing it right.”
- “I felt we should have been given abit more guidance.”
- “Of course people did their best on the project, but it must be exceedingly hard to mark.”

Non-group work

- Five individual assignments, to go along with the group projects (20% of the module mark).
  - Three reflective essays (300-500 words):
    - 'How our group operated and my part in it' (group project 1);
    - 'What the client wants' (group project 2);
    - 'The difference between mathematics at university and applying mathematics in the real world' (group project 3).
  - Two mathematical assignments, connected to group projects 2 and 3.
- Group management (via minutes of meetings) (10%).

5. How to deal with uneven contribution?

Previous experience of group work

- I had groups keep minutes of meetings and told them they could use these to bring me evidence of uneven contribution.
- None did so.
- In evaluation, students agreed minutes were useful but many said that uneven contribution still occurred.

Peer assessment of contribution

Your name: .....

You have 90 points to distribute between your group to reflect each person's individual contribution.

For example:

Bob Jones	10	<- Bob contributed an average amount
Sarah Smith	12	<- Sarah contributed more than her teammates
Paul Brown	7	<- Paul contributed less than his teammates

Do not show or discuss this form with the others in your group. When you are finished please fold your form and put it in the envelope without showing anyone.

This is either stolen wholesale or adapted from an approach by Barrie Cooper (Exeter).

Peer assessment of contribution

- Used the mean (nearest integer) of scores for each group member to scale individual marks.

$$\frac{\text{peer assessment score}}{10} \times \text{raw group mark}$$

- Checked self-ratings, but they were fine.
- Group project 2: range 9-12; mean 9.95, median 10, mode 10.
- Group project 3: range 6-12; mean 10.03, median 10, mode 10.
- 60% of the module mark was so adjusted.

Student feedback - peer assessment

- Generally positive:
  - “This is a good method because without this if a team member was not contributing enough then normally no one would do anything about it. However this is a discrete [sic] way to do so.”
  - “People probably felt committed to contributing due to the possibility of being marked down by their peers”.
- But:
  - “This is difficult because even though I wanted to reward others at times, it was very difficult to then remove the marks from another member of the team.”
  - “I feel that the peer assessment was marked mainly on how people got on with one another, rather than how much work they did.”
  - “I do often feel that people have a tendency to do the 'easy' thing and give everyone equal marks.”

Individual contribution

- Students appear to view individual contribution as whether 'everyone put in the same effort'.
- In a university module, I must mark students according to how well they met the learning outcomes.
- Does peer assessment of contribution really tell me what I need to know?

Individual contribution

- I have some preliminary ideas about using the marks from individual (individualised) work on the same learning outcomes, or a subset.
- By comparing individual marks to group marks, we might detect which students contributed well to the learning outcomes.
- More work is needed (and I lack the opportunity at present).

Overall feedback

1 - “Strongly disagree”	2	3	4	5 - “Strongly agree”
“I have enjoyed this module”				
1	3	4	17	17
“I have benefited from taking this module”				
0	3	2	15	22

Would you recommend this module to other students?	Yes	39
	No	3

Not for everyone

- “There was not much direction.”
- “What was being asked for was not clear.”
- “Needed less freedom on final project”.
- “Try to give students an idea of when they should have finished the mathematical part of the project, and how detailed this should be.”
- “This was unlike any maths encountered before... a little more basic help might be useful.”
- “Be clearer on certain aspects such as what is an appropriate level of mathematics for certain people.”
- “Maybe look in more to the group to see our individual roles, and tell us ... how [to] structure the team.”

End on a happy note

- Plenty of this:
  - “The module has taught me so many things that no other maths module can teachs us so I would definilty recommend it to others.”
  - “I have definitely increased in confidence.”
  - “Thank you very much for running this module!”

References

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