Building Capacity for Pedagogical Research in Mathematics

A collaborative research project in mathematical education

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HOW TO RUN A GROUP QUALITATIVE PEDAGOGICAL RESEARCH PROJECT

Where it all started

Context

- As you may be aware, our Department has a pedagogy group
- Part of a global move towards Education track
  - support to the Department through "Provision" (e-assessment, accessible notes, student feedback, ...)
  - specific benchmarks and promotion criteria
- Increasing focus on pedagogical research and scholarship, and encouragement from above to get involved

Challenge



None of us know what we're doing!

...

...but we have questions!

1. Do our students come prepared for university?
2. What does the process of learning mathematics look like?
3. How can we develop materials that are inclusive for everyone?
4. Are we assessing a wide range of skills? Are we giving good feedback?
5. How can we make lectures engaging and effective?
6. What tools and strategies do students use to learn? How can we help them to optimize these?
7. What are good ways to bring mathematics outside the university classroom?

1. Transition from school
2. Mathematical cognition
3. Accessibility and Inclusivity
4. Assessment and Feedback
5. Student engagement, Active learning
6. Student support
7. Outreach and impact

A collaborative effort

Collaborative research project

- Almost everyone in the group is involved.
- Three "parallel" projects: same process, same timings, different research questions.

Main goals:

- Develop skills and experience in qualitative research.
- Answer an important question for the Department.

How do students use [insert text here]?

3 versions of the question:

- How are students using...
  - ...lecture notes?
  - ...feedback (from written work vs e-assessment)?
  - ...external websites/resources?

- Two divergent branches:
  - Why do students want to study Maths into Schools?
  - Why do they want to study Representation Theory?

Why did we choose this question?

This is a good question to use because it's:

- directly relevant to lots of conversations happening in our department
- not (readily) answered in the literature already, and the answer is always changing
- very adaptable for lots of people to try to answer.

Methodology

Our plan

1. Run focus groups based around each of these topics.

2. Conduct thematic analysis on the responses.

3. Write up our analysis of the results individually, and within each topic.

4. Write a meta-paper about our experience of the whole ordeal.

Why focus groups?

- Qualitative research (good opportunity to learn something new, for all of us).
- Doesn't need too many students to work: feasible to run several at the same time.
- (In theory) fairly self-contained: one afternoon of running them, reasonable scale of data to analyse afterwards.
- We used "Doing pedagogical research in engineering" by George Brown and Sarah Edmunds (2010) to help us structure and prepare,

Thematic Analysis

- Frequently used and accessible approach to qualitative data.
- We're using Braun & Clarke's book "Thematic analysis: a practical guide" (a very thorough introduction to the topic), and their paper "Doing thematic analysis in psychology" (aimed at a slightly less advanced audience).
- So far, we're at Step 4: reviewing themes.

Phase
1. Familiarizing yourself with your data:
2. Generating initial codes:
3. Searching for themes:
4. Reviewing themes:
5. Defining and naming themes:
6. Producing the report:

Table 1 from Braun & Clarke (2006)

Reflections

- Bigger project than we initially thought.

- Timing has been more of an issue than expected. (ethics....)

- We built skills along the way
  - Submitting ethics forms
  - Qualitative research experience
  - Learning the "social science" aspects (specific languages, importance of positionality, ...)
  - ...

- Important to set expectations early, and keep checking in.

RESULTS: STUDENT USE OF FEEDBACK

Use of Feedback

- We have had some automated e-assessment (using STACK) since 2019
- It is now used in most first year, and many higher level modules
- In most modules, e-assessment alternates with traditionally marked written assessment
- E-assessment has been popular with staff, and, at least at lower level, we believe that it can offer the same level of feedback, but we're not sure how popular it is with students

What is good feedback?

- Tells you what you need to work on in the future and is actionable
- Highlights positives but is honest
- Appropriate level of detail
- Motivates the student to do more, pushes them to be better, and shows that the lecturer is paying attention
- Helps the student understand what the lecturer wants

How good is feedback at Durham?

- Some of it good and some of it bad.
- Both traditional assessment and automated e-assessment have good and bad assignments
- Within traditionally marked assessments the variation is within the modules
- Within e-assessment assignments within modules are consistent – variation is between modules

How is feedback used?

- Key point repeated by everyone is that feedback from automated e-assessment comes a lot faster than from traditional manually marked assessment.
- If feedback takes over a week students do not have time to go back to review it. They may go back to it during revision.
- Students have more motivation to review the faster automated feedback. They have the opportunity to redo a randomised version of the question.

How is feedback used?

- Manually marked homework feedback is not necessarily more detailed but can be more personalised.
- Automated e-assessment can be very good if a question is split up into sub questions – guides you to a solution.
- Ultimately students said they like a mix of both.

How is feedback used?

- “The main difference is the context of when you receive it”
- “Since [e-assessment] feedback is immediate, you can apply it back to the question”
- “Some modules lend themselves better to e-assessment”
- “Gradescope feedback can be more personalised but less detailed”
- “E-assessment is practice … while Gradescope is more do you understand what you’re doing. Gradescope feedback is better for revision”

Comparisons to literature

"improvement to student learning comes almost entirely [from] the actions of the students to close the gap between their performance and the requested standard"

Chickering, A.W. & Gamson, Z.F. (1987) **Seven principles for good practice in undergraduate education**, American Association of Higher Education Bulletin, 39(7), pp3-7. https://eric.ed.gov/?id=ED282491

Comparisons to literature

"imperfect feedback from a fellow student provided almost immediately may have much more impact than more perfect feedback from a tutor four weeks later."

Gibbs, G. & Simpson, C. (2004) **Conditions under which assessment supports students learning**, Learning and Teaching in Higher Education, 1(1), pp3-31 https://eprints.glos.ac.uk/id/eprint/3609

RESULTS: STUDENT USE OF LECTURE NOTES

Reflections on Initial Analysis

- On the first pass, it was hard to work out how detailed to make codes.
- It took a long time to get through!
- "Pollution" from interviewer input.
- First pass: 90 (unstructured) codes, 208 references
- After review: 37 (tiered) codes → 157 references. Two primary categories; six subcategories
- Convergence to themes during discussion relatively painless!

Broad (Initial) Observations

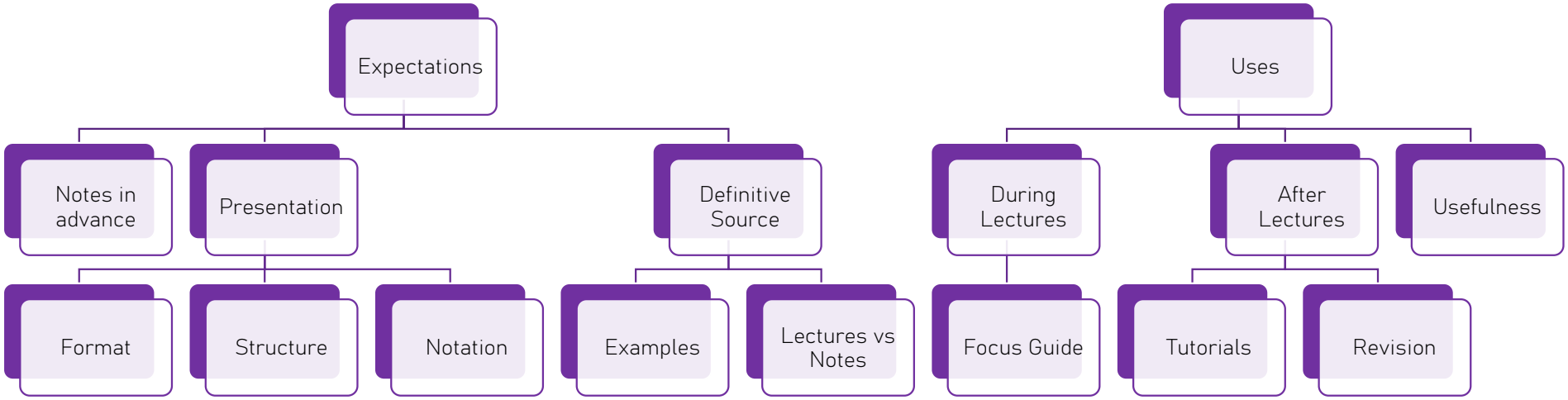
Lots that one would expect:

- Students hate inconsistency!
  - "And also the notation in the book is different to the notation we're using...
    [Multiple(?) audible gasps, multiple laughs]"
- Presentation of notes is important.
- Use changes over time (in semester).
  - "I think for me it also depends on the time frame. So during while the course is running, official notes, King."
- Variation between students!

And some (maybe?) less so:

- Students use lecture notes... not notes from lectures
  - "in previous years, spent ages writing them, and never looked at them because I just reverted back to the official notes. "
- Quite strong opinions on format!
  - "I am PDFs till I die. I don't think I've ever opened an HTML lecture note unless by accident and then promptly closed it."
  - "I really like those [HTML notes]"
- Goal-oriented approach to notes

Structure of Themes



Quotes

- On examples:
  - “It's like doing a GCSE question in the lectures and then, you know, a STEP question or something in your assignment”
- Mapping between question and notes:
  - "you can look at it [the notes] and think, I'm trying to find something that, to answer this question, involves this thing. Literally skim read it, see it [in the notes], and see how you would use that to solve it”
- Primacy of notes:
  - “I sort of lump the official notes and solutions, so every course material Durham course material is the thing I reference most often.”
  - “Um...yeah, I mean I thought the most is probably useful one is the official notes.”
  - Um so, yeah, I guess my go to is like the official notes, given by university.”

Analytical Lenses and Future Questions

- Can student preferences and expectations for notes be understood through the "definitive source" lens?
  - Do they implicitly expect a one-to-one mapping between problems and the notes?
- How prescriptive should (or shouldn't) we be when writing lecture notes/managing learning outcomes?
  - Our feeling is that students generally have a very goal-oriented approach
  - We want students to learn a topic/skills, not learn our notes!
- Clearly expectations affect actual use.
  - Can we find more specific links? Can we use those to write better notes?
- There are varied opinions on the usefulness of taking notes in lectures.
  - Do they just do it because that's the prototypical view of university? If it's not useful, can we speed up that realisation?

RESULTS: STUDENT USE OF EXTERNAL RESOURCES

Are students using external resources?

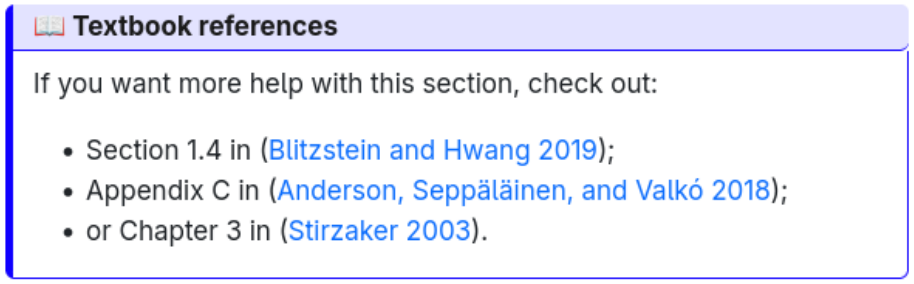
- Yes, but reluctantly:
  - "Yeah, for me, realistically, I don't actually use these that often. I usually just use the lecture notes and that's enough to get me through unless ...for analysis...that's the one I understand the least, so I'd use YouTube the most for that, but for most of it I can understand it from the lecture notes."
- As in the "lecture notes" group: what we give them is the gold standard and they're reluctant to use anything else:
  - "What they [lecture notes from elsewhere] have could be slightly different to what you need in your exam, and the way they do it might be different, but then it still helps for understanding."

Barriers to access

- For certain resources, students seem to think that they need to **already understand the topic** before they can be used.
- Because textbooks don't have the same notation, or the same interpretation, as our notes, it can be hard to find the right sections:
  - "if you already don't know what you're doing, then I go to a maths textbook and I'm even more confused."
- Asking lecturers for help is even worse:
  - "sometimes I'm really stuck on a question, but I'm just being stupid so I don't want to waste their time with something easy"
  - "I'd imagine it's all easy to them. And then we look like an idiot in all aspects."

What do they want?

- More time: things move fast at University, and they don't feel they have enough time to go over topics they understand moderately well.
- Signposting where to look in the key textbooks would help.
- They want lecturers to be more available to them
  - (just not via office hours)
  - (or at the end of lectures)
- One student did say:
  - "There is so much at our disposal. You must already be putting an enormous amount of effort beyond your own research. Why are you asking us 'What else do you want to do?' Like? It seems crazy because you are doing so much already."



What about AI?

- The undergraduates (mostly home students) really didn't trust AI:
  - "I wouldn't recommend giving it the question and copying the answer because many times it's just been wrong."
  - "I just don't think ChatGPT is that helpful."
- They said it can be useful for completing assignments, or understanding the steps in a method, but they wouldn't use it to build understanding (and don't trust the final answer)
- The postgraduates (mostly international students) used it much more:
  - "I put AI in the 1st place, because I think if you tell AI 'Please teach me like a child' to explain the basic concept for me. So the AI can give you a really simple and a concrete answer about it, and then I go to Google or YouTube"
- They still mistrust it a bit: they talk about using it for fundamental concepts, or smaller pieces of the question, rather than a full solution.

CONCLUSIONS

Conclusions

- Students can be uncertain about what works best for them
- We identified some key gaps in communication / understanding between lecturers and students:
  - Students need more guidance on using teaching resources
- We received guidance on what to improve:
  - More consistent notes
  - More personalisation in e-assessment feedback
  - Lecturers could signpost more resources
- A lot of new ideas for research:
  - Why don't students use some of the support we already provide?
  - Can the results be replicated with larger groups?

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