Embedding chemistry education research into an undergraduate degree programme: lessons learnt

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Aims

• Share my story: how did I get started in chemistry education research?

• Explain how I embedded CER in the UG curriculum, with some examples

• ‘Lessons learnt’ to help you do the same
Contents:

1. My ‘journey’ in CER
   How did I get started?
   Where am I now?

2. Barriers to UG CER*
   What could prevent the involvement of UGs in research?
   How was it embedded in the UG chemistry programme?

4. Example projects*
   Case studies of some research projects carried out by my UG students:
   - Transition to and through a chemistry degree (A. Tyson, 2015)
   - Factors contributing to problem solving success in physical chemistry (N. Richardson, 2017)
   - How does dialogue between instructors and students facilitate learning in a laboratory? (M. Gerrard, 2020)
   - An investigation into the use of video as an assessment technique in undergraduate laboratories (S. Alcock, 2020)

5. Conclusions
   Lessons learned
   What next?

*Audience activity
1. My ‘journey’ in CER

How did I get started?

Where am I now?
1. The ‘journey’ and biography bit

- PhD in Crystallography
- Secondary Chemistry Teacher
- RSC School Teacher Fellow
- Teaching Fellow / Senior Teaching Fellow / Associate Professor (Teaching*)
- Director of UG Studies / Deputy DoEd
- Sole CER researcher in Department

*Research not ‘allowed’ – focus on ‘scholarship’.
1. The ‘journey’ in ChemEd Research (CER)

- ‘No’ CER background, but teaching experience
- PG Cert
  - Developed ideas of ‘data’ and analysis
  - Social science??
- PG CAP
  - ‘Research’ assignment
  - Language barrier (‘Thematic Analysis’)
Department context

• MChem programme has a (‘proper’) research project (80/120 credits)

• BSc has a (‘proper’) literature review (20/120 credits)

• Why not have CER examples of both?

…turns out, there were many reasons!
I am still feel like a ‘scientist’ and I like to count things and measure things… It never goes away!

‘Words’ as ‘data’ (with no numbers) is still a weird concept to me…

…but I’m getting there!
Barriers to involving undergraduates in chemical education research (CER)

What initially prevented me involving undergraduates in CER?
2. Barriers to UG CER research - personal

1. Ethics frightened me
2. Stats frightened me
3. Non-numerical data frightened me
4. Qualitative data analysis was new
5. I’d never done any CER..?
6. I’d never published any CER
7. Job title requires ‘scholarship’ not ‘research’
2. Barriers to UG CER research - external

1. Perceptions: ‘It’s not: proper chemistry/proper research/hard enough’* or ‘You’re not qualified’
2. ‘It will affect our RSC accreditation’
3. ‘It’ll prevent students going on to Chem PhDs’
4. ‘It’s only suitable for weaker students’ (!)
5. Assessment criteria were focused on lab work

…and others

*delete as appropriate
2. Barriers to UG CER research – other challenges

1. No PhDs / PDRAs to support UGs / community building?
2. No space for students
3. Ethics system designed for lab-based projects
4. Project titles needed (ideas?)
5. Project titles needed some ‘chemistry’
Thinking time (2 minutes):

How many of these barriers are (were) relevant to you? Which resonate most?

Are (were) there any others not stated?

[Please share in the chat if you feel able]
The rebuttal

Overcoming some of the barriers
Overcoming the barriers - personal

1. Ethics:
   Re-frame ‘ethics’ as ‘project planning’.
   Be clear about the research questions
   Consider: consent, anonymity, privacy, physical or mental impact, data storage and GDPR
   Then apply common sense and write it down…

   What do other departments do?
   System/process issues? Design the system
   (but don’t reinvent the wheel)
Overcoming the barriers - personal

2. Statistics:

Read.

Study.

Attend MICER.

Don’t be afraid of the unfamiliar.

Explore institution researcher training.

Ask: are ‘complicated’ stats necessary to complete the project?

Learn alongside your students
2. Overcoming the barriers - personal

3. and 4. Non-numerical data / qualitative analysis

It’s all common sense
The methods are established
Read the text books* to interpret the terminology
‘Words tell you themes’

2. Overcoming the barriers - personal

5., 6. and 7. New to it / never published / scholarship

Imposter syndrome!
Network
Talk
Tweet*
Listen – research talks
Read others’ work (CERP)
Redefine ‘scholarship’ for my own context
Get on with it!

*@jacquierobson #MICER20
2. Overcoming the barriers - external

1. Others’ perceptions:
   - It’s not proper chemistry
   - It’s not proper research
   - It’s not hard enough for science students
   - It’s too hard for science students

• Research definition: ‘a form of systematic enquiry that contributes to knowledge’
• Ignore critics! Then share the research…
2. Overcoming the barriers - external

2. ‘It will affect our RSC accreditation’*

- The project, which can include those in computational and theoretical chemistry or in chemical pedagogy, would normally be completed in the final stage of a programme. It must be of an investigative nature and contain a substantial amount of advanced chemistry, drawing on the chemical and related literature.

2. Overcoming the barriers - external

3. ‘It’ll prevent students going on to Chem PhDs’
4. ‘It’s only suitable for weaker students’ (!)

First student: first in class. PhD in physical chemistry (Durham).

Exams vs project work. Define ‘weaker’?

Destination of leavers include: Teaching, City, Patent Law
2. Overcoming the barriers - external

5. Assessment criteria were focused on lab work
   Reviewed Intended Learning Outcomes
   Looked at terminology
   Clarified wording so that ‘research skills’ were being assessed.
   Used them anyway!
2. Overcoming the barriers – other challenges

1. No PhDs / PDRAs to support UGs / community building
   
   *Group meetings. Group brand.*

2. No space for students
   
   *They didn’t want it!*

3. Ethics system designed for lab-based projects
   
   *Initially, designed my own (borrowed template)*

4. Project titles with some ‘chemistry’ needed
   
   *Student-led, based around my (research) interests*
The projects

Training and support

Case studies
Running the projects (80 credits) - timeline

1. Students select research area (CER)
2. Pre-reading Bryman and reading CERP
3. Project title decided by discussion
4. Research seminars in education
5. Data analysis training as needed (self-study or in Education department)
6. Ethics training and completion (first term!)
7. Literature review (ongoing)
8. Data collection and analysis
9. 60 page report, poster, presentation, viva
Case study 1: Transition to and through a chemistry degree (A. Tyson, 2015)

Ethics

Free text question response analysis: what is ‘independent study’

ASSIST questionnaire¹ to probe study approaches comparing first and third years

Conclusions:

• incoming first years think ‘independent study’ means ‘working alone’
• third year students are more ‘strategic’ in approach. Frist years think they are ‘deep’ learners.

Impact: induction process changed; third year course reviewed

Case study 2: Factors contributing to problem solving success in physical chemistry (N. Richardson, 2017)

Students used LiveScribe Echo smartpens¹ and talked through their approach to tackling physical chemistry problems.

Analysis of question types and student background and smartpen output.

Conclusions:

- ‘Problem-solving’ question in our course were mostly ‘algorithmic’
- No difference in Physics/Maths background – success depends on learnt algorithm.

¹. https://www.livescribe.com/en-gb/smartpen/
Case study 2: Factors contributing to problem solving success in physical chemistry (N. Richardson, 2017)

Impact:

- review of physical chemistry questions used
- review of staff resources for question writing training
- poster presented at VICE/PHEC 2017
Case study 3: How does dialogue between instructors and students facilitate learning in a laboratory? (M. Gerrard, 2020)

Audio recordings of students in lab completing simple experiment

Analysis of transcribed data using three techniques: thematic analysis, conversation analysis and ESRU model¹:

Case study 3: How does dialogue between instructors and students facilitate learning in a laboratory? (M. Gerrard, 2020)

Conclusions and impact:

Student-student interactions are not harnessed but very important

Further study to happen next year
Case study 4: An investigation into the use of video as an assessment technique in UG laboratories (S. Alcock, 2020)

Video recording of students completing lab experiment

‘Proof of concept’ – can we assess ‘skills’ this way

Video data analysed

PG marker watched video and attempted to apply a rubric to assess lab performance

Conclusions:

• Video could be a useful way of self- and peer-assessing lab skills

• PG observer judges many ‘soft’ skills not on the rubric
Case study 4: An investigation into the use of video as an assessment technique in undergraduate laboratories (S. Alcock, 2020)

Impact:
More ‘skills’ to probe and consider
Concept ‘proved’ – more to do
Thinking time (2 minutes):

What could your UG students investigate?

What does your department need to know?

What do you need to know?

[Please share in the chat if you feel able]
Conclusions

Lessons learnt

What next?
Lessons learnt

• Be brave!
• Don’t reinvent the wheel – ethics / stats training / student training
• Find a CER buddy, either from this network or from within your institution (maybe in social science / education)
• Students motivation is high when they decide the title
• Students are adaptable.
• Aim for groups of 2 - 4
• Re-visit the assessment criteria for project work
• Be prepared to be amazed how good their work is!
CER trajectory to present day – where next

• Innovation development projects (internal and external)
• Lots of reading and learning
• 12 MChem undergraduate CER research projects (from 2014-15 to 2019-2020)
• MICER/conference attendance
• Co-researcher ‘buddy’ found
• Recipient of seedcorn funding
• Co-I on ESRC grant bid
• 5 MChem UG CER students for 2020-2021
• …making a ‘proper research’ land grab!
Thanks

• Helen Cramman, School of Education
• All Robson (and Robson/Cramman) group members past and present
• Michael Seery and Aishling Flaherty / #MICER20

Questions?