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21 Student-led research groups for supporting education research projects

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This chapter describes how to set up an education research group (herein referred as ERG) to support students conducting education research projects in chemistry degrees. It shows how session activities, framed by the Trajectory of Professional Development (TOPD) model (Ralls *et al*., 2018; Patel *et al*., 2017; Bianchi, 2017), can create the opportunity for students to move from individual participators in learning to collaborators in group practice.

The work described will show how regular meetings of staff and students' which include reflective activities enhance and enable:

- student collaboration, through group feedback and reflective discussions;
- student understanding of their own transferable skills and employability;
- student voice to decide on the nature of the group and its development;
- change from academic-led to student-led meetings.

Establishing and maintaining the group meetings offered benefits and posed challenges. The practical, cultural, curricular, assessment, and academic implications are explored in this chapter so that practitioners can consider these approaches in light of their own context. The approach is independent of subject context and applicable to other teaching environments where there is interest for students to transition from participating in academic courses to collaborating and leading independent study.

Influence of Professor Tina Overton

Tina Overton's work has highlighted concern amongst employers and recent graduates regarding the preparedness of graduate chemists in terms of transferable skills. She has called for higher education institutes to act upon this skills deficit. This work inspired our Educational Research Group, which aimed to expand opportunities for transferable skills development and enable students to identify their own skills development.

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Introduction

This chapter describes how to set up an education research group (herein referred as ERG) to support students conducting education research projects in chemistry degrees. The approach described took place in a UK Higher Education Institute (HEI). In English HEIs, undergraduate chemistry degrees are generally awarded at two levels; a three-year Bachelors of Science, known as a BSc, and a four-year Masters, which can be awarded as a Master of Science (MSci) or a Master of Chemistry (MChem). "Chemistry with" degrees can be taken which include a year in industry or abroad and all degree programmes culminate with an element of independent project work in the final year. In all cases, UK HEIs must provide aspects of project work for final year chemists if they are to achieve accreditation of degree programmes from the Royal Society of Chemistry (RSC, 2017).

Three key theories were used to inform the development of the ERG approach and activities within them. Overton's work highlights concern among employers and recent graduates regarding the preparedness of graduate chemists in terms of transferable skills (Sarkar *et al*., 2016, Hanson and Overton, 2010). Her work inspired the development of the ERG, with the aim of embracing and expanding opportunities for transferable skills development. Within ERG sessions, activities would need to enable students to identify their own skills development. The creation of a supportive environment to facilitate students' engagement to move from passive participation in meetings to proactive collaboration drew on two key development models. Using Tuckerman's small group teaching (Tuckman and Jensen, 2010), activities were ordered to enable increasing levels of student empowerment. Opportunities for the group to *form*, through informal introductions, *norm*, through shared reflective practice, *storm*, through peer critique, and *perform*, through group consultation, were developed sequentially. Bianchi's (2017) Trajectory of Professional Development (TOPD) model aided staff to identify key staging points within the group's development, offering a common language with which to refer to how the students were demonstrating collegiality and engagement. Bianchi's work focuses initially on the progression from pre-engagement to participation to collaboration. What was key for staff was to consider the shift in approach that was required from them and the students, when moving between these staging points, and the degree of facilitation and support that was offered so as to enable students to progress to proactive and collaborative engagement with each other.

The aim was to create a student-led research group for undergraduate students on MChem degree programmes who were involved with education-focussed projects, which would:

1. improve practice and associated student outcomes, in developing employability and transferable skills;
2. identify key barriers relating to student projects and introduce activities to address these areas of challenge;
3. create a supportive environment where students were supported and empowered in moving from participants to collaborators and leaders.

Method

Our experience has involved supervising staff, project students, and key teaching staff, including a School Teacher Fellow (a teacher seconded from a local secondary school), the Director of Teaching and Learning and a specialist in in-service teacher training and school engagement, from the Science and Engineering Education Research and Innovation Hub (here in referred to as SEERIH). Permission was obtained from students for use of quotes, minutes and grades offered in this chapter. Each student selected a project that took place within the existing MChem course unit. Integration in this way required the students to practice assessed skills, such as formal presentation, formal writing, planning, and time-management. Academic staff also integrated key elements of knowledge, skills & group culture not developed elsewhere in chemistry degree programme.

Prior experience of coordinating student-school based projects in two UK HEIs highlighted key questions that needed consideration. The ERG sessions were developed in response to these issues.

1. How could students be supported to understand educational settings, so that outcomes were not hindered by lack of knowledge of the context they were working in?
   Group meetings brought in expertise from school teachers and teacher training specialists to develop students' knowledge of the school setting.
2. How could students benefit from heightened awareness and knowledge of qualitative research methods, to sit alongside their quantitative and practical research skills?
   Group discussions identified learning theories and qualitative methods appropriate to the projects and knowledge was developed by the students through journal clubs.
3. What could be done to limit the sense of isolation students might feel when undertaking project work outside of the university setting?
   Meetings were scheduled to provide a regular opportunity for students to share experiences, seek support from peers and review progress.

Table 1 summarises the intended learning outcomes of the course units and the drivers that prompted these. Table 2 shows an overall timeline of the approach used. Details of the how the session activities were implemented and the intended outcomes from the activities are given in the examples below.

Projects spanned September to May, with the group timetabled to meet every three weeks. Sessions were designed to include formal and informal presentations, independent planning, and group work involving constructive critique of peers' research and sharing knowledge. Reflective activities encouraged students to consider their own and other's skills strengths and areas for development. Regular revisiting of skills audit maps and reflective impact statements supported students to reflect on their development needs and gains, and to articulate them in a supportive environment. Table 2 shows an overall timeline of the approach used, with further detail of the session activities given below.

Example 1: Students collaborated with staff to lead and direct their own learning
Student leadership was actively promoted through their input as tutors, and acting as project supervisors. To facilitate students as collaborators, staff undertook the same learning activities as students or were given specific roles during meetings; for example both gave informal personal introductions to the group and contributed personal reflections to the skills mapping audits.

Meetings were designed to balance the leadership roles of staff and students. An active decision to ask staff to take the role of scribe encouraged them to take an openly supportive role, and limited the opportunity for them to lead discussions. This gave more time for students to be in a position of leading the talk within the group and offering their own suggestions to each other. As meetings progressed, students were encouraged or asked to direct discussions. For example, where a students' research was of interest to the wider group, that student would be invited to contribute a workshop or presentation at a later meeting, reinforcing the students' role as 'expert' in the group. Students also chaired meetings, with staff acting as minute takers and offering insight when invited to contribute by the student members.

Table 1: Summary of the skills, knowledge and culture development opportunities for the ERG (HA is Hanson and Overton (2010), RoP is reflection on practice, and CR is course requirements)

Development Area	Intended Learning Outcomes	Identified through		
		HA	RoP	CR
1. Skills	1. Verbal presentation, including the use of PowerPoint	x		x
	2. Confidence in discussion with experts outside of field		x	
	3. Evidenced defense of conclusions			x
	4. Critical writing including evidenced use of qualitative data	x	x	
	5. Reflective evaluation of own and others progress, including critique of project, writing, presentation etc.		x	
2. Knowledge	1. Understanding project intended learning outcomes and assessment criteria			x
	2. Understanding the school landscape		x	
	3. Techniques for engaging learners		x	
	4. Research at forefront of chosen topic, as appropriate to chemistry			x
	5. Techniques for collecting, analyzing and using qualitative evidence		x	
3. Culture	1. Sharing information without plagiarism	x		
	2. Building trust to critique each other		x	
	3. Encouraging student ownership of projects and group		x	
	4. Appreciating broader impact of own project and group		x	
	5. Providing direction for project, group and broader university teaching	x		

Example 2: Reflection activities related to personal skills mapping stimulated discussion about personal strengths as an education researcher, encouraging the group to establish an open culture of sharing and trust

All group members contributed to a discussion of the skills required to be a successful education project researcher. The group's contributions were then formed into a skills map (Figure 1). The skills map was shared with students and staff after the meeting. All group members were encouraged to complete the map before the next meeting. At the next session, students and staff shared their skills maps with each other; staff members discussed their self-ratings first to role model the process and encourage trust and openness within the group. A collective skills map was collated and revisited at three further points during year.

Example 3 - Students in the ERG were offered formal learning in teaching and learning theories and qualitative research methods

An early session involved students sharing individual questions and concerns about their project, which

Table 2: Timeline showing roughly the stages of implementation of the example session activities

Session Activities	Beginning (0 - 3 months)	Middle (3 - 6 months)	End (6 - 9 months)
Example 1	Establishing student-staff collaboration	Maintaining student-staff collaboration	
Example 2	Initial reflection on personal skills	Revisiting and updating personal skills maps	
Example 3	Introducing formal teaching and learning theories and qualitative research methods	Using qualitative research methods	
Example 4	Academic-led sessions	Student's critical reflections used to structure following ERG sessions	Student-led sessions
Example 5	-	-	Student's in-depth reflections on the wider value of their project

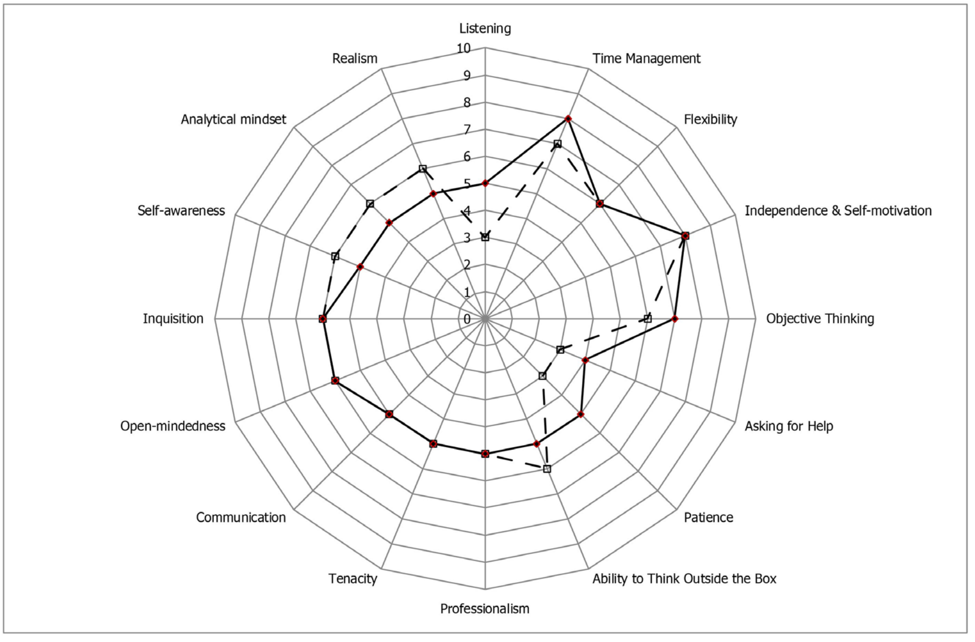

Figure 1: Exemplar results from Skills Audit — the solid line shows the first self-assessment, and dashed line indicates subsequent self-assessment

were captured on a whiteboard by a staff scribe. A group discussion followed, with staff responding to these concerns by raising key concepts and terms (such as constructivist, didactic, problem-based etc.) and qualitative analytical methods (for example interviews, surveys, focus groups, etc). Table 3 shows the topics captured from the initial student-led discussion and the summary of the group's discussion, in terms of terminology, starting point resources, and related points to consider. Topics were then pursued by individual students. Staff offered starting points for the students' reading, such as TED talks, and popular press articles as opposed to original academic papers, based in sociology or psychology. A follow up meeting was designated as a journal club, with the expectation that each group member would present a summary of their findings. In this way each student led their own literature research. Feeding back to the group through presentations created a shared resource of terms, references and definitions for use throughout the projects.

Example 4: Reflection activities were designed to reflect on the positive, negative, and interesting moments from their specific project research

A *Plus-Minus-Interesting* (PMI) grid (see Figure 2) was used at the end of the first semester to stimulate consideration of these aspects, and particularly highlight the interesting happenings. These were of particular significance in that they often led to the student considering further exploration of things that had surprised or puzzled them. Subsequent group discussion provided stimulus for preparing agenda items for future meetings that were responsive to students' needs. For example, in Figure 2, the student's interesting point of how to defend an educational project against traditional assessment criteria led to the sharing of draft reports and practice presentations allowing for feedback and direct linking to the assessment criteria.

Pluses – what's going well?	Minuses – what's causing difficulty, concern or not going quite right?	Interesting – what surprises, questions or opportunities are arising?
Lots of data Interested in project Clear direction of where to go next Starting to see some solid themes in data and clear link between data sets I actually understand what's going on in my project!! Potential for results of project to be useful/interesting/expanded upon in the future	Completely different direction to originally expected Won't really know what data/sources are relevant until it has been collected and analysed Potentially entire data set may end up being disregarded after spending a long time analysing them Difficulty in obtain data/mailing contacts (i.e. schools not responding to emails) Concern that I may end up with no clear/significant outcomes to project	How data heavy project is The amount of new skills I'm learning (e.g. grounded theory) How much I actually enjoy data analysis How interested other people are in my project How I will defend my project to "traditional" chemistry professors?

Figure 2: Reproduction of a student's PMI Grid (spelling, grammar and punctuation reproduced from original)

Table 3: Topics from initial student suggestions and a summary of the group's discussion around the topics, which acted as starting points for literature review. Note: references quoted are not included here; details given exactly as summarised in meeting minutes

Topics from initial discussion	Summary of group discussion including useful terminology, references and related points to consider
How people learn	Start with Bloom's taxonomy (1956), note a revised taxonomy was published by Anderson & Krathwohl (2001); see: http://thesecondprinciple.com/teaching-essentials/beyond-bloom-cognitive-taxonomy-revised/ Also Vogotsky's "zones of proximal development" and scaffolding for learning, as well as Piaget's "Theory of cognitive development". Note overlaps with *How groups learn*!
How groups learn	Start with Tuckerman's small group development (1965); consider also social constructivism (collaborative learning through peer interaction) for example Palinscar, 1998 or Grice's cooperative principle (Grice, 1989). See also Cox, Andrew M. (2005) What are communities of practice? A comparative review of four seminal works. *Journal of Information Science*, 31 (6). pp. 527-540. Note overlaps with *How people learn*!
Analysing qualitative data	Consider qualitative research study design (Morse *et al*., 2002, Verification Strategies for Establishing Reliability and Validity in Qualitative Research and Agostinho, 2005, Naturalistic Inquiry in eLearning Research). Consider also coding and grounded theory (see http://groundedtheoryreview.com/2010/04/02/the-coding-process-and-its-challenges/). Note overlaps with *Surveys and question types*!
Surveys & question types	Consider Likert scales (Likert, 1932, see also https://www.simplypsychology.org/likert-scale.html). Consider also question types (see Andrew, 1980 or Braddock *et al*., 2008) and electronic *vs.* paper surveys (Hayslett & Wildmuth, 2004, Pixels or pencils? The relative effectiveness of Web-based versus paper surveys). You may also wish to consider: Spradley, James P. (1980) *Participant Observation, Harcourt-Brace-Jovanovich*, ISBN:0-03-044501-9. Note overlaps with *Analysing qualitative data*!
Growth mindset	See http://www.temescalassoc.com/db/el/files/2015/02/Growth-Mindsets-Lit-Review.pdf Consider A Level growth mindset e.g. https://www.alevelmindset.com/ Note overlaps with *Engagement & motivation*!
Engagement & motivation	See: *Principles for good practice in graduate and professional student engagement*, Pontius & Harper, 2006. Consider Maslow's hierarchy of needs (1943, "A theory of human motivation") and impact on learners or "Motivational processes affecting learning", Dweck, 1986). Note overlaps with *Growth Mindset*!

Example 5: Project final impact statements stimulated student's in-depth reflections on the wider value of the project, for themselves and others — including that beyond themselves and the University
Impact statements were based on Guskey's impact of professional development (Guskey, 2016), including the four key areas: the impact on themselves as learners; on school teachers; on school pupils; and on the wider educational community (see Figure 3). These were constructed as PowerPoint slides, which could be used directly in a student's final presentation.

What are the key outcomes of the project?		**How have you impacted "teachers" (this could relate to University/School practitioners)?**	
1. Who were you aiming to impact? 2. How did you seek to make impact? 3. What have been the barriers to achieving outcomes? 4. What have you achieved? (If you struggle with this section, try revisiting your positive-minus-interesting review first).	Notes for your presentation / report.	1. Specifically who has your project impacted? 2. How has your project made an impact for these practitioners?	Notes for your presentation / report.
How have you impacted "learners" (this could relate to University/School students)?		**How has the project impacted you as a learner?**	
1. Specifically who has your project impacted? 2. How has your project made an impact for these learners?	Notes for your presentation / report.	1. What specific elements of your project have impacted you? 2. How?	Notes for your presentation / report.

Figure 3: Student final impact statement prompts

Findings

Quantitative data, including end of year grades, showed project outcomes were good with all students achieving a project award in the upper second or first class degree classifications. Three key findings emerge in response to the original project aims.

Aim 1 outcome: Students identified and articulated the impact their engagement in the group had on their employability and transferable skills
Findings suggest that students were able to identify and acknowledge their own skills and how they had developed over time. Creating and sharing the skills audit maps were found to have stimulated trust-

building in the group, and in particular between staff and students. The periodic reflections, revisiting the maps over time, were found to support students to identify the progress they had made and to identify the transferable skills that they had confidence in applying to new areas of work. Students demonstrated increased self-awareness and agency to articulate and discuss their skills and were found to bring their maps into discussions during meetings without prompting. The maps provided a common language for focused group, and shared reflection:

> *…lots of skills I have improved: communication through meetings, representing the university in schools; being flexible when things don't go as planned; organising in collaboration with other people; independence in a way I haven't been before.* ***Excerpt 1 from Group Meeting Minutes***

Students noted not only the building of skills but also instances where they mapped a decreased use in a particular skill and the relevance of that in practice. This led to discussions about Dunning-Kruger effects and enabled them to understand how such effects might influence their own project analysis from a personal and tangible perspective (Pazicni and Bauer, 2014; Dunning, 2011; Bell and Volckmann, 2011). The following excerpt from Semester 2 meeting minutes offer insight into this:

> *Student A "I feel I've improvement in areas but when I revisited [the skills map] I had to shift skills down."*
> *Student B "I felt the same but I scored myself higher where I felt it was improved."*
> *Student C "I had gone down in some skills area."*
> *Student D "Yeah, in open-mindedness and inquisition. It's interesting seeing starting point and what has changed."*

There followed a group discussion of their weakest skills:

- *Tenacity (everyone)*
- *Time management (Students B and D – Student A found this an improved skill)*
- *Patience (Students A and B – patience with self; student C commented on the fact it depends on state of mind and therefore whilst it is a useful indicator, it is mood and moment dependent).*

This was followed by a group discussion of what they want to improve next:

> *Student A "Thinking outside the box, such as linking research and practice."*
> *Student D "Analytical mind set and inquisition, you know, being concise and critical but also interesting.*
> *Student E "it isn't on the skills map but we need to be creative (especially with resources) and it isn't always the easiest thing to do (more used to being analytical, precise etc.)"*
> *Student B "I want to be creative now to build these skills – to have better outcomes for the end of the project but also for myself as a person."* ***Excerpt 2 Group Meeting Minutes***

Aim 2 outcome: Students demonstrated increased confidence to be constructively critical and learn from mistakes

Critically questioning each other and offering constructive advice were increasingly observed and noted in group meeting minutes during the lifetime of the ERG. Excerpt 3 demonstrates how students offered critique and advice to support the development of each other's projects.

> *Student F described developing video per-laboratories for schools.*
> *Student G shared feedback on his experience of video demonstrators – issues with technical knowledge of how to set up column or carry out technique. Advice would be to be prepared to repeat it a few times.*
> *Student G agreed to share his videos with student F.*
> *Student H asked if there would be speaking over the video. If recording the voice as doing the video will be difficult to map the two things together. This was acknowledged and there was a brief discussion of using Camtasia to voice over video, to avoid this problem.*
> *Student G asked how the pre and post practicals would be evaluated – what are you comparing the impact of the pre-laboratories too?*
> *Student F outlined how she had observed practicals without it before Xmas.*
> *Student H asked if the fact the experiments are different will impact the validity of the results.*

Student F acknowledged this limitation and that time and logistics inhibit this type of comparison.
Student I pointed to making a cross-comparison between the two practicals and resource and discussed the ability of grounded theory coding to pick out key themes.
Student G discussed the difference between open and closed questions and how including open questions could avoid missing commentaries that are not expected. ***Excerpt 3 from Group Minutes***

The creation of a supportive environment through the group culture is evidenced by some fantastic failures, an idea developed within the school sector over the past decade with the introduction of Carol Dweck's work on growth mindsets (Dweck, 2008). Adopting positive mindsets around things that don't go to plan, offers opportunity for understanding what didn't work as opposed to examining that which did. In this case, students felt sufficiently safe due to the established group culture and secure in the knowledge that critical feedback could be offered in a constructive way, that positive judgements emerged out of negative happenings (Excerpt 4).

Student G reporting on the progress of their project:
Student I asked if it isn't a bit late to bring the direction of the project into focus.
Student G admitted that this is a potential weakness of his project but he also acknowledged that he has spent this time learning what it is that needs to be done and how it should be structured. He now has the benefit of knowing what needs to be assessed, who impacts it and how changes might be made effectively.
Excerpt 4 from Group Minutes

Using reflection as a constructive group activity helped facilitate a supportive group culture. Towards the end of the group's lifetime, students were well versed in reflecting on their own development, however, they were less clear of the impact their project had on school teachers or the university community (see Table 4). For this reason, students were encouraged to revisit their impact statements, as part of their constructive criticism of their writing plans. Individuals sometimes offered negative impacts, such as their impact on learners in the classroom leading to false positives in their analysis or negative impacts on teachers offering their time to support projects. This facilitated group understanding, as concrete examples enabled peers to understand the impact of their own project. Impact is not usually an assessed aspect of final year research projects, nor is it met in other or earlier parts of the course. So it was important to allow additional time for students to gain insight into the idea of impact.

Table 4: Comparison of student's discussions of impact when re-visiting impact statements

	Excerpt from Educational Group Minutes, Month 6. Students had worked with the impact slide prior to the meeting (see Figure 3).	**Excerpt from Educational Group Minutes, Month 7. Students were asked to work their impact statements into their writing plans prior to the meeting.**
Student B	*"If the project works then it should impact student understanding positively."*	*"Students confidently ask questions and for clarification… [students] discuss their work and talk through what they are doing."*
Student C	*"Impact on me? Not really sure about this point."*	*"Extra challenge of dealing with 'fluffy' data has developed new skills. Stretching and stimulating to consider myriad of non-physical variables. Findings have forced me to 'think outside the box'. Project also almost entirely self-conceived and self-driven!"*

Aim 3 outcome: Students demonstrated behaviours that moved them from participators in learning to collaborators, and some leaders
Over the course of the ERG activity, findings suggest that students moved from participators in the learning experience, whereby they would attend and absorb information from traditional seminars or lectures, to active collaboration within the group. Using a collective approach to generating journal club themes and disseminating information via the journal club enabled a large amount of knowledge to be shared amongst the group, without individual students being over-burdened. It facilitated students as collaborators, as their expertise in the topic grew, and were able to subsequently direct peers to useful sources of information during later group meetings.

A change away from a traditional master-apprentice (academic-student) hierarchy was also seen through shifting staff and student roles. Using reflective practice in PMI tasks supported students to reflect on their own development needs and in turn, to use this reflection to decide the agenda for following meetings, enhancing student-led learning. Staff also benefited from directed and specific roles, such as scribe for a discussion or minute-taker for a meeting, which actively prevented them from moving into traditional behaviours. As such, the learning process became one that was done with students, as opposed to something that was done to students.

In Your Context

To evaluate the implications for practitioners and the adaptability of the ERG as an approach, the authors used a key questions framework derived from Wiborg and Richardson (2010).

Question 1: What are the practical implications for an ERG in my practice setting?
Practical resources, such as space or equipment, are minimal and less than that of laboratory-based research projects. There is, however, a greater demand on staff and student time. The social nature of the group, its collaborative style, and its sequence of meetings require administration, planning, and follow up by staff. Time is at a premium as discussions need the opportunity to develop, and as such academic line-managers are encouraged to acknowledge the time commitments of staff attending group meetings.

Staff will need to consider the practical implications for students, such as considering how school visits might fit alongside the academic timetable, allowing time for travel to schools as well as the optimum time for group meetings to ensure all students can attend. The impact on students should not be underestimated and staff would do well to identify pinch-points, for example where school terms clash with university exams. While cost implications are minimal, some budget will be required to cover travel costs to facilitate school-partner interactions and to allow students to attend events in the community which might be of use. In this case, funding was elicited from a supportive charitable foundation.

There are some administrative issues which are worth considering at a very early stage. If students are working in a secondary school setting, facilitating child protection checks at the very start of the semester prevents unnecessary delays. In most cases these checks are offered as additional reassurance to school teachers. Each university will have its own guidelines. Furthermore, some schools may require character references from supervisors, so it is worthwhile completing these at the earliest possible time. Having project ideas in place before projects begin is essential for recruiting students to projects and helping students see the diversity of projects and what is involved. However, projects must be flexible to change, as discussed later.

Question 2: What are the cultural implications for my practice setting?
The style of group work requires academic staff to adopt a collaborative role, with students acting increasingly as equals and peers. The removal of traditional teaching hierarchies requires staff to find a balance between encouraging students to lead their own learning whilst maintaining high standards of teaching quality, sharing expertise, and guiding students towards successful learning outcomes. Encourage students to lead the group but be aware that this can only occur where staff are willing to relinquish control. We would advise discussing the role of staff as a team very early, before projects begin. Negotiate within the supervising team and come to an agreement on what roles members of staff will have – and don't be afraid to remind each other of the agreement during term.

Staff must support students to take ownership of the project. This can be facilitated by students and project partners, working in the initial stages to develop a proposed project theme into something that they both value, with support from the academic. Facilitating this school-student collaboration needs careful consideration, expectations on both sides should be set to account for the lifetime of the project and the time students will have to visit schools. It is important for staff to identify both the benefit and impact for the host school at an early stage, so all project partners are aware of them.

Question 3: What are the curriculum and assessment implications in my practice setting?
Learning outcomes and assessment methods require adapting to allow for the group activity to be recognised and rewarded, whilst maintaining subject-specificity in line with the undergraduate course. The authors found that the assessment of presentations and reports suited existing modes of assessment, but did not integrate the commentaries of school teachers. A possible way to approach this may be to consult with teachers using electronic mail or to ask that they also attend presentations. Such additional time commitments from all parties, guidance for commentaries, and careful moderation by academic staff are all issues that need to be examined further. Notably, similar challenges have been addressed in similar assessments, such as industrial placement projects.

Acknowledging the value of impact in research projects at this level is essential. This goes beyond the current approach. Since impact statements are becoming a key contributing factor in successful grant applications, we see no reason why this practice is currently omitted from our undergraduate projects.

Question 4: What are the academic implications?
The language, terminology, and contexts of education research are different and may pose challenges to academic staff trained in the physical sciences. The benefit of cross-faculty working practices whereby science-focused academic staff work alongside educational colleagues can support the shift from scientific research methods to social science approaches.

Using a group discussion to generate themes and share learning within a journal club, between staff and students effectively built a body of knowledge in a short space of time and supported student-led learning. Due to time pressures and student familiarity with such topics, the authors found most benefit when students were offered topical and practical resources, such as TED talks, and popular press articles linked to relevant themes as opposed to original academic papers, based in sociology or psychology.

Despite being education-based projects, the focus of the students' work was based in their subject specialism (in this case chemistry). This is essential to ensure credibility, authenticity, relevance, and overall maintainence of equity with projects undertaken by students completing bench chemistry projects. Supportive project descriptions offered at the start of the course helped students clarify what previous successful projects looked like.

Adaptability and Transferability

Despite the identified challenges the ERG approach was found to be beneficial. The approach is independent of subject and adaptable in other teaching scenarios where students transition from participating in the course to collaborating and leading independent research. The same activities for building group culture could be used. Key to adaptation would be acknowledging the knowledge and skills development appropriate for the given context. The approach offers a broader approach to standard teaching and could be used in other research group settings, such as where students are undertaking lab-based research, in earlier years for group work, or for industrial placement projects.

An ongoing challenge for any practitioner will be how to measure the effectiveness of this approach. To this end it will require a progressive set of criteria to be developed against the required learning outcomes, just as evidenced here in Table 1. Once established, these criteria can be used to facilitate planning and act as a framework for evaluation.

We would caution practitioners against using project outcomes (such as grades and staff feedback) exclusively. Whilst quantitative measures offer evaluation of success, student reflections and commentaries are informative and enable practitioners to ask questions such as: what language did the students use?; when did they use it? (Chatwin *et al*., 2012). Likewise, observation of the group can be useful but needs careful planning to eliminate observer bias (Norcini and Burch, 2007; Grove and Overton, 2013). However, observation can be useful as an evaluation tool, to answer questions such as: how did students address each other?; did they look to staff for direction or were they comfortable to drive the discussion themselves?; did they stay on task?; how often did staff have to step in or redirect the conversation?

Conclusion

The undergraduate ERG sought to use reflective practice to develop students as leaders and collaborators. Establishing this within existing university frameworks, in particular those related to assessment regimes, posed particular challenges. Despite challenges, students responded well and were observed to move from passively engaged participants to proactively engaged collaborators in the learning process. They described and developed their transferable skills such as open mindedness, tenacity and realism — skills relevant to future employability and research of any type.

Reflective practice in this approach supported students to develop as leaders in their own learning. It also supported staff to adopt a teaching style that embraced a culture of equity whereby they developed knowledge with students, as opposed to giving knowledge to students. If practitioners want to do this, they will need to establish reflective practice as a matter of course, through progressive formalised activities which gradually demand more of the student and through sharing reflections of all members. Staff will need to be prepared to relinquish control of both the project topic and their role in meetings. Once in place, these activities can enable a culture which allows students to take part in assessing their skills in an open and trusting manner.

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