Student and Staff Perceptions of Teamwork in Group Writing for Science Honours

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Abstract

Scientific practice is essentially collaborative. Most research publications list multiple authors making collaborative writing a key skill for scientists. This paper reports the student experience of a collaborative writing task for honours students in experimental science and juxtaposes these with academic scientists' views on the relevance of these tasks and skills. Honours students were asked to work in groups of five to research and construct a scientific literature review suitable for publication in a peer-reviewed journal. Students submitted a piece of individual writing as well as the final group literature review and were also asked to assess the contribution of group members. Students found group work demanding and this appeared to overshadow the experience of collaborative writing. However, at the same time, students strongly agreed that teamwork skills and collaboration were essential for successful research. Interviews with academic scientists involved in reviewing and reflecting on the honours collaborative student writing task post the event highlighted the difficulties of attempting this type of task at honours and the need for a more naturalistic immersive, emergent and organic model of teamwork. This dichotomy between the need for collaborative skills and the difficulty of putting this into practice highlights the need for greater development of teamwork skills in the undergraduate curriculum in preparation for research training. This paper aims to highlight various 'traditional models' and 'riskier' innovative models that stretch 'comfort zones' to inform how best to prepare honours students for the realities of scientific work, writing and practice.

Introduction

Teamwork and collaboration are vital for any scientist to evolve their research and writing for publication. Although conventions and styles vary between scientific disciplines, the dominant forms for publication in scientific journals are primary research articles reporting new experimental data or analysis and literature reviews, which collate and evaluate key information in a field. Most publications in science, including reviews, have multiple authors acknowledging a range of contributors to the preparation of a publication (Sonnewald, 2007). This reflects the predominant working environment for science where scientists work in research groups in the same laboratory, and often also between institutions and even between countries. Collaboration and teamwork skills are therefore essential skills for a successful research career for both the practice of science and the communication of its results.

In Australia, research training usually begins with a 4th year honours undergraduate year. The honours year for most disciplines is a mix of coursework and an authentic research project undertaken in an operational research laboratory. The honours student moves from a role as a student in a large class to an apprentice researcher working alongside experienced researchers, and usually with one-to-one supervision. During this year, students practise the conventions of *performing* and *reporting* research. The honours year emphasizes individual

personal development and achievement. Entrance into an honours year can be very competitive as places are usually limited by the availability of research supervisors. Individual academic achievement in the preceding undergraduate program is usually a key selection criterion. At the completion of the honours year, students who wish to continue with research training compete for scholarships to study higher degrees. Again, scholarships are usually awarded on the basis of individual academic achievement. However, since the traditional working unit for science consists of a team of researchers, students must also learn about the collaborative nature of research and hence research writing.

Collaborative publication is the norm for many scientific research fields. Bibliometric analysis of the authorship of scientific publications demonstrates that the number of authors and acknowledgements in papers has increased for some decades (Sonnewald, 2007). Conventional research training introduces students to collaboration during their research apprenticeship where they work alongside and are mentored by senior scientists (Florence & Yore, 2004; Hunter, Laursen, & Seymour, 2007). However, undergraduate courses tend to create competitive and individualistic learning environments (Tanner, Chatman, & Allen, 2003) rather than collaborative learning unless this is a specific learning outcome. This can be seen in an emphasis on individual assessment tasks in undergraduate science courses (Johnson, Maddox, Quinton, & Burke da Silva, 2010). In particular, students compete for access to research training places as they progress towards the completion of their first degree.

Many universities emphasize the value of both writing and teamwork skills in information about their undergraduate science courses. Both of these attributes are explicitly included in the science standards developed by the Australian Teaching and Learning Council with comprehensive consultation with scientists and science academics (Jones, Yates, & Kelder, 2011). Undergraduate science students are routinely asked to write scientific (laboratory) reports and essays, although this style of writing may not reflect authentic scientific practice (Braine, 1989; Moskotvitz & Kellogg, 2011).

Some higher education institutions do support undergraduate students to publish authentic research writing through undergraduate research journals (Tatlovic, 2008). These journals are more popular in the United States and the United Kingdom. The University of Tasmania in Australia has hosted an undergraduate science, technology and engineering journal, *Nexus*, but it is not currently in regular publication (Jones, personal communication, 2012). The task reported here was designed to develop collaborative writing skills using a research writing task. The nature of the teamwork collaborative writing task fits into the development of graduate attributes as broadly described across the Australian higher education sector (Barrie, 2004, 2005, 2007; Jones, 2009). Even though Inquiry-Based Learning and undergraduate research experiences are becoming more visible in undergraduate curricula in the UK, US and Australasia (Healey & Jenkins, 2009), the question remains how best to incorporate the collaboration skills in an honours year.

In this study, we trialled an authentic group writing task for honours students in experimental science. Although the task was designed to focus on collaborative writing skills, evaluation of the student experience uncovered some interesting responses from students regarding teamwork. We also invited two academics in the department a year later to reflect on the task and student responses and changes made to the honours program. The aim of the paper is to inform how we might infuse collaboration and teamwork development and skills into the

honours year. We first outline the methods used, and then summarize the student and staff results. We then discuss and reflect on these outcomes and implications for practice.

Methods

The honours year in this scientific discipline at La Trobe University includes a significant coursework component (40% of assessment weighting) with the remainder of assessment arising from an individual research project. The style and content coursework component varies each year as different researchers take responsibility for the design of associated assessment tasks. Tasks are reviewed by the honours management group to ensure intended learning outcomes and standards are consistent.

In 2010, two of the authors (Johnson, Maier) designed a group writing task for the honours cohort to foster collaboration and experience of an authentic writing process for potential publications. The task was to construct a literature review of sufficient quality for publication in a peer-reviewed journal. The broad area for the literature review was selectable markers, which are experimental tools for selecting organisms with desired phenotypic characteristics. Three literature review topics were proposed to students with suggestions for focus within the broad topic, although students were encouraged to refine these or consider alternatives. The broad topic was relevant to most students' individual research projects to some degree but not a key focus for any of the research projects. Authentic scientific writing at this early stage of research training is limited and subject to breakthrough experimental data. However, students have ready access to primary research publications and can reasonably be expected to review the literature in a defined area.

In 2012, two academic staff in the department who have been involved with the honours program were invited to be interviewed jointly in a one-hour semi-structured interview to reflect and comment on the student data and outcomes, as well as to provide their views on how best to foster teamwork and collaboration skills at honours. One staff member was a senior academic professor/leader and well-respected academic in his field with global collaborations and local experience who had mentored many students to PhD completions and postdoctoral study across the years. The other staff member was younger, again with international PhD experience, and a junior researcher/lecturer who had recently been involved in revising the honours program and so had experience of honours students first-hand. Both staff had supervised students at various levels and led research labs and teams at La Trobe; they were invited to participate because of their in-depth understanding and involvement in the honours year.

University human ethics approval was obtained for all of the data gathering stages of the project for student and staff involvement and data processing and publications purposes, hence all the data was de-identified using pseudonyms, as well as not specifying the subject title or code.

We outline the various phases and data instruments of this research study for the students and then the academic staff next.

Student teams and task organization

The fifteen students in this cohort were asked to self-select into groups of 5-6 to write a joint literature review. The task was split into two phases: a scoping phase including individual work and a writing phase for construction of the final literature review (Table 1). Each phase

included a planning workshop with staff and then subsequent independent work. The whole writing task was spread over an 8-week period while students continued with laboratory experiments in their research projects (Fig 1).

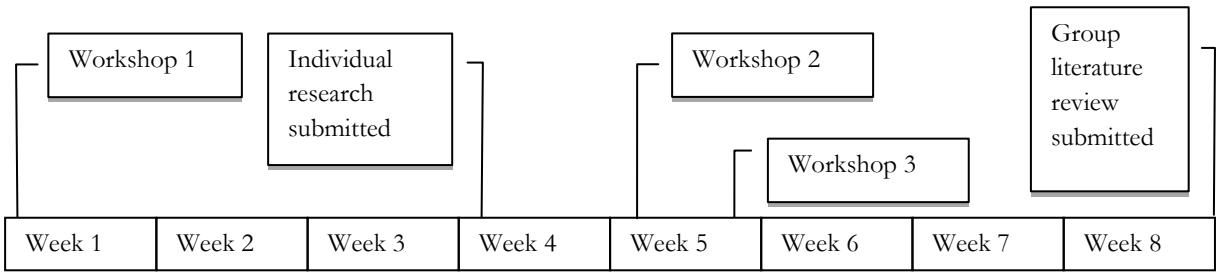

Figure 1: Timeline for writing task

During the scoping phase, the group decided on a topic for investigation and developed a research plan with each member of the group researching an aspect of the topic. Students submitted a short report of their own research for individual assessment.

Table 1: Stages of writing task

Stage	Teaching activity	Output and feedback
A: Planning and individual work	***Workshop 1***: introduction to task, assembly of self-selected groups, initial group discussions ***Self-directed groupwork:*** construction of draft plan for literature review	Draft plan submitted with feedback provided within one week
	Self-directed study: group allocates individual research topics according to group plan; each student prepares and submits a literature review of their allocated sub-topic	Comments on review provided to students within one week
B: Group writing	***Workshop 2:*** Editing skills ***Self-directed groupwork:*** Draft of group literature review to integrate individual pieces with introduction and concluding remarks.	Draft group review with comments on review provided to students within one week
	Workshop 3: feedback discussion on draft literature review with whole group ***Self-directed groupwork***: Finalize group literature review	Final group review

In the second phase of the task, students were asked to write as a group using the individual research from phase one as a basis for the literature review. One class was held to discuss the roles that individuals could play in constructing the literature review: planner, writer, illustrator, editor, proof-reader. Groups were asked to develop a strong theme or argument that would be attractive to a journal editor and to ensure the final literature review had a single consistent voice.

Feedback to students

Each group submitted a draft of their joint literature review for detailed feedback at least two weeks before submission of the final literature review. The authors involved in teaching the subject at the time met with each group and provided written feedback and a half-hour discussion with the group focussing on strategies for improvement. The discussion reviewed

the quality of the writing, content covered and considered what would make an article attractive to a journal editor.

Assessment

The distribution of marks for components of the task are given in Table 2. Both the individual reports and the final review were double-marked by the authors using common criteria. Marks for the individual report were divergent suggesting the marking rubric needed refinement. Marks for the final review were more consistent between markers. Final marks were determined by moderation.

Table 2: Assessment weighting of task components

Component	Assessor	Time for Task Completion	% of Final Mark
Individual report (800 words)	Staff using marking criteria with internal moderation	3 weeks	40
Group literature review (2500 words)	Staff using marking criteria with internal moderation	4 weeks	40
Team	Peers using simple marking scheme	Student submitted an individual group evaluation at the end of the task	20

Students were asked to assess the contribution of each member of the group. They were provided with a simple marking scheme which asked them to consider contribution to background research, discussion and writing to arrive at a final mark out of ten. No formative work was undertaken to prepare for this assessment apart from the workshop considering roles and effectiveness within the group. All students had previously had an experience of assessing peer presentations in preceding undergraduate subjects but had not all been asked to evaluate less defined work.

Students were offered support after assessment to further develop their literature review for publication in an international undergraduate research journal. One of the three groups expressed an interest but did not proceed as they felt they did not have sufficient time to work further on the project.

Student evaluation

The student perceptions of this new task were collected using a paper survey followed immediately by a focus group discussion with an independent facilitator. The survey included 17 statements with a request for students to register their level of agreement with each statement using a 5-point Likert scale. The statements explored student perceptions of the task and the role of teamwork in research science. Students were also able to respond with written comments to two open-ended questions.

In the focus group, students were encouraged to discuss the task and the communication and teamwork skills needed by scientists. The session was recorded and transcribed. Comments from the transcription and the written comments from the survey were collated by the categories that emerged in the data. Key themes were identified and reviewed with the session facilitator to ensure the intent of the session was captured.

Academic staff interviews
The two selected academic members were chosen because of their involvement in the current honours program and their experience and potential to provide valuable and reflective insights (Schön, 1991, 1995). The following three questions were asked of them in a joint one-hour semi-structured interview conducted by one of the authors. This also facilitated dialogue and reflection between them both.

1. As an experienced scientific researcher, describe how teamwork and collaboration are important in your own research.

2. If teamwork is important, when and how do your research students learn and practise effective collaboration skills? What level of skill would you expect of an honours student (e.g. do you expect them to be able to allocate roles and take responsibility for contribution to the group)?

3. Most scientific publications list multiple authors. In your experience, do scientists write collaboratively? If they do, what do you think is the most effective way of training students to write collaboratively?

The benefit of a joint interview was that the two staff could reflect collectively on their various and varied experiences. The interview was transcribed and de-identified (Barrie = senior academic staff member and Tim = junior academic staff member), and member checks were conducted. Themed analysis of the 21-page interview transcript was conducted to juxtapose them with the student views.

Results

We first outline the results from student feedback and then outline the academic staff interview themes.

Student perceptions of the teamwork task
This task was not popular with students. Responses were neutral (neither agree nor disagree, mean response was between 3 and 3.8/5) for statements exploring the quality of feedback, group effectiveness and content of the task. Students also recorded neutral responses when asked if the task had improved their own skills (Table 3).

Table 3: Student survey responses regarding skill development

Survey Statement	Mean	St Dev
The task improved my ability to collect and evaluate evidence	3.5	0.8
This task improved my ability to construct an argument	3.5	0.7
This task improved my ability to describe scientific concepts	3.5	0.8

Interestingly, students recognized the importance of teamwork skills in research at the same time that they reported a preference for individual work. This dichotomy is likely to be related to the effectiveness of the group process and previous experience, although the students reported neutral responses when asked about group function.

Table 4 highlights the student survey responses showing disagreement (response 3.8/5): responses were recorded on a scale of 1 (strongly disagree) to 5 (strongly agree) with 3

representing "neutral, neither agree nor disagree". The mean score and standard deviation for all responses is reported (N= 15).

Table 4: Student survey responses regarding perceptions of teamwork

Survey Statement	Mean	St Dev
Students disagreed with statement		
I like working in a group	2.8	0.8
I enjoyed working on this task	2.8	0.9
Students agreed with statement		
Discussion with colleagues helps to clarify my ideas	3.9	0.8
Experience with writing in a group will help in the future	3.9	0.6
Research scientists need to work effectively in groups	4.5	0.7

Students were asked to respond to statements regarding the function of their team (Table 5). All statements on this topic elicited a lukewarm response, although the data is limited by class size and the experience of three teams. The students felt underprepared to work in a team and also felt that the task did not strongly develop teamwork skills. It is interesting to note that all students had worked in pairs or teams in laboratory classes throughout the preceding three years of their undergraduate degree.

In Table 5 Student Survey Responses Regarding Team Function, responses were recorded on a scale of 1 (strongly disagree) to 5 (strongly agree) with 3 representing "neutral, neither agree nor disagree". The mean score and standard deviation from all responses is reported (N= 15).

Table 5: Student survey responses regarding team function

Survey Statement	Mean	St Dev
Statements on team dynamics		
My group regularly met to discuss our work	3.9	0.5
Everyone in my group contributed equally to the final article	3.1	1.0
I have had lots of opportunities to practise working in groups in my degree	3.3	0.9
Sufficient guidance was provided in how to work in a group for this task	3.4	1.0
I received adequate feedback from the group on my contribution	3.5	1.0
My group succeeded in working as a team	3.5	0.7
Work was fairly allocated between group members	3.5	0.8
This task improved my ability to work in a group	3.6	0.7
My group was able to organize itself effectively	3.7	0.9

This interesting data on student perceptions of group work was further explored in focus group discussions and in written responses to open-ended questions on the student survey. Two themes emerged regarding teamwork skills and the student experience of group function for this task.

The students found working in a group challenging. Students listed a number of factors outside their control that were both positive (formative feedback provided during the task) and negative (competing demands from research projects, boring topic for the task) which affected their experience. The organization and function of the group was primarily determined by its members with staff providing guidelines for group activity during the

introductory and feedback class sessions. During evaluation, most of the discussion in the focus group and written comments from the survey concerned group function.

Students recognized that group work requires an investment of time and considerable negotiation. They suggested that, for this task, a smaller group size would be more effective.

> *Sam: That's where I think the five people made it difficult, because, like in the last stages of editing, we all would go away and, you know, read the final thing and write down our own comments on what we thought needed to be changed. Then we all had to get together and go through it all. It was just like a lot of input from a lot of people all at once. It was just sort of a lot to kind of handle I thought.*

> *Terry: In that way though, yeah. 'Cause the idea, I remember (author) saying to us, try and get, give yourselves tasks, so if you're an editor, you're an editor, you're not a proof reader. But there's that ... it's very hard to detach yourself from it… 'cause you want… it's easier if everyone comments, but then it also gets confusing 'cause then you have to agree about that…*

Students were reluctant to assess their peers but did recognize differential input from group members. The weighting for peer assessment, which assessed contribution to process, was significant but considerably less than the weighting for the written work (product) (see Table 1). The intention of the authors to empower the students by engaging them in the evaluation process was not initially recognized by the students. Students found it difficult to make an objective judgement of colleagues in a complex situation.

> *Jess: But each person had different circumstances, different commitments. We all have different methodologies. Some of our methodologies are extremely time consuming, other people find they're time consuming. I think you should learn to trust people if you're in a group, just got to have some level of trust that someone is trying their best and can't do anymore, but nor are they doing any less. I think you just need to draw that line.*

The task incorporated both individual work in the initial research stages of the topic and teamwork in the final stages in the construction of the final writing product. Students had mixed responses to this approach. Some found it difficult to convert individual work into group task, but in other cases comparison of individual work uncovered new research questions through discussion at the group level.

> *Sam: …One of the main issues I had with the whole structuring of the assignment was the fact that we were given these broad topics and then given examples of individual things to write about, but we were then supposed to join into a, a review article... the individual pieces on individual things that we had to bring together that didn't necessarily work so well…*

> *Frida: …See I liked that though. I thought (in) our group, we were discussing that easily. And we ended up finding it quite …, like as a group, I thought it was quite good because that really got our communication going, really got us thinking about it …*

Comments regarding group work skills and group function dominated both written comments and the focus group discussion with little mention of writing skills. When asked specifically about skills required for communication, students listed process skills such as "patience" and

"listening" rather than skills related to writing in particular. Students did not feel the task had changed their writing skills. One out of twenty-four of the unstructured comments from the student survey addressed communication skills.

Students reported that group work was crucial for scientific research in their experience. They recognized that research was a combination of individual work and collective literature review.

> *Jim: Workplaces hold multidisciplinary teams these days because each area of research, each area of knowledge is incremental, you know, knowledge gets pooled, it doesn't just happen, so it increases slowly. And even then (in) most workplaces that I've been aware of, you end up working in a multi-disciplinary team and then you've got pools of knowledge actually coming together to find solutions.*

> *Sal: Yeah, well when you write-up results there's probably ten (team members); you're using other people's results as well but when you're actually doing the work it's more individually focused.*

Academic staff reflections

The two academic staff provided rich and insightful data on the nature of *doing* science and the *training* of scientists. They also commented on the modifications made across the years to the honours program, as well as on the results and outcome of student feedback on the group writing task of 2010. In Table 6, some of the major emergent themes from the interview with the two academic staff are summarized under three categories: *Teamwork in Science* which refers to the nature of collaboration amongst scientists, *Developing Collaboration Skills* which collates factors which are important to the development of collaboration in research training, and *Research Training Models* which reflect their descriptions of research training.

Table 6: Emergent academic staff themes

Teamwork in Science	Developing Collaboration Skills	Research Training Models
Science is an individualistic pursuit but teamwork and collaboration are vital to evolve one's work and for survival and sustainability. Scientific integrity and ethical behaviour are paramount in any scientific research training. Evolutionary approach to collaboration	Authentic scientific task Time to evolve skills Multiple models for collaborative writing in research Mentoring	Master/Apprentice Model Community of Practice Model (Expert/Novice)

Teamwork in science

The two academics interviewed agreed that scientific research is practised in a collaborative environment but at the same time it relies on individual initiative and performance. They described a tension between fostering individual passion and expertise and the benefits of collaboration with peers.

Barrie: … it's also a characteristic of a scientist that they're very individualistic and they're not easily cornered into agreeing to do things that the team does…I mean we have a proud tradition [in] academia of being very feisty about being our own masters.
For a person who's been in there for a long time like myself, I have deliberately gone in [co-operative research (de-identified)] mode, if you like, in parallel with my own research interest and I'm trying to draw my colleagues into that because I see it as an opportunity for us to actually work as a team collaborating, putting all of our different expertise together.

And that is a good setting to train students in because they're going to enter a real world where they're going to have to work collaboratively. So it's good having our own feisty attitude towards our own projects running, in a sense, in parallel with something where we have team objectives and milestones etcetera and where we have to subjugate this tendency ... it has to be individualistic to the needs of the team.

But, you know the honour students are right at the base of that and they haven't had that experience and so I'm not surprised at their reactions having been given these tasks.

Tim: I had to always temper the tendency to look at the problem just purely from my preferred point of view in the sense of this is how ... And then I think an easy example of this probably if they draw a diagram how they think it works and I draw it these things will look just very, very different and then ... but then it's not my place to enforce my view on the other side and equally I expect the other side not to enforce their view on me and so that requires that you, I don't know, come to a mutually agreeable conclusion [on] how to tackle the problem

Barrie: So we join forces with people who are experts.

Joint authorship of scientific publications is recognized as the norm by these scientists. They note that the construction of an effective research paper often draws on a diverse range of inputs which must be acknowledged by authorship. The inclusion of trainee or junior scientists is seen as both a recognition of intellectual contribution and therefore ethically important, and also as training in collaboration.

Barrie: … more and more there are many authors on because that's the other thing we teach our students always err on the side of generosity ...So if you think somebody's made an important contribution even though it might not be equal to the other authors include them as an author.

Tim: Because it's ... yeah, sometimes it's also not the contribution people have made to a particular ... individual publication might not necessarily be obvious in the figures or in the text but sometimes it's just the intellectual contribution in the sense of how they shaped the way how individuals in the team have gone about the project that made a big difference, and I've had some interesting conversations with other co-authors on particular publications in the past where they question my end and I felt that this particular individual should be on because they may not have contributed an actual piece of data but what they have done is they provided an additional understanding to the question we were pursuing that it's not ... you cannot quantify by words written or 20 words written or one figure prepared.

Tim described scientific collaborations that developed organically over time. He emphasized the importance of mutual respect and the value of synergy. These views were echoed by Barrie.

> *Tim: I found that over time now I think there's also a certain ...I don't know if that's the right term but evolutionary approach to collaboration.*
>
> *Our teams grow organically in the sense that we start somewhere; people are added maybe one or two at a time but they join essentially an entity.*
>
> *There're certain people you can work really well [with] and this is just because they are ...and for lack of a better word there's a shared understanding of how one would like a collaboration to work out and how to ...yeah, to actually make sure that the team is more than just the sum of the parts, and then with other people that just doesn't work... certainly I've ended up working with a lot of people and there are some where you work for six months and then you kind of got somewhere and then like it just ... there was no synergy if you will.… and then those just tend to die off and then others tend to develop into something that are really powerful and that you can continue on with for many, many years. And so two weeks ago I had a colleague from Canada over who I've been working with for five years now and even though I see her maybe once every two years or so we have a very, very strong collaborative relationship ...*
>
> *... and I think that's then a case where it's not just about individual people working on the same thing but that turns into something where there's huge synergy and they will be much more effective together rather than individually.*

Developing collaboration skills

Barrie and Tim identified three key factors that they considered were important to assist research trainees to develop collaboration skills: authenticity of task, sufficient time for development and mentoring. They described multiple tasks for trainees to practise collaborative writing in the scientific research environment.

Both academics were unsurprised by student discomfort with working in teams. They emphasised that scientific teamwork should be taught in an authentic research setting. Collaboration was interpreted specifically as collaboration on a specific research question.

> *Barrie: … I'm not surprised that maybe honours students haven't been through that yet [working in a research lab with a group to "accept, tolerate input" "from their colleagues"] and so although honours students are supervised in a group [i.e. in the research laboratory] and so they're beginning that journey or learning to work with other people so maybe forcing them into an artificial situation where they have to solve a problem together is different from what they would've experienced …and that's why they found it uncomfortable.*
>
> *Tim: We can make the argument that the individual lab head essentially has to set the basic tone I guess in the team and then people start adding on but then it grows just, yeah, like a tree whereas in this particular case people get thrown in together... it's an artificial team because there is no purpose to it beyond the actual exercise, whereas I think what I certainly find with my team is that they, yeah, they very much internalise "We are here*

because we want to do something in particular" … and then there is the added fact that it is an assessment and these two things ... an assessment makes it even more artificial ...

Staff noted that sufficient time is required to develop team collegiality. Tim suggested that teams might require more time to develop than was available for this task in the honours year.

Barrie: So, you know the teamwork starts [in honours] but that's teamwork perhaps at a different level; they get encouragement and succour from each other by talking about their particular problems with their colleagues. You see them going off to coffee or lunch together and so forth; it's perhaps more friendship or building a family relationship than what it is working as a team by doing experiments together; I think that rarely at honours but the foundations are laid as I said by having a lab meetings.

Tim: … to incorporate a team assessment like the one that was done 2010 I think one would have to find a way where one can essentially grow individual units within the honours to the point where the people actually work together and if you were to then give these groups or these kind of preformed groups a group exercise I think the outcome would be very different because they are established dynamics and there's a way how to work together already and because essentially what you assess in the exercise that was done in 2010 is that you pressure cook them into rapidly making up some sort of group dynamic and somewhere how to work as well as the actual scientific exercise of assimilating the literature and then producing something and I think that is probably too much in a single goal.

The academic staff described a number of situations in research where science research trainees practise collaborative writing with supervisors and other laboratory members. They listed a range of examples from preliminary discussion of ideas and review to independent contributions to a joint publication such as a scientific paper or poster. The roles of the supervisor and student are distinct and reflect the difference in expertise. This creates a directionality in the relationship (student-to-student versus staff-to-student). Barrie noted that this collaboration is more about mentoring rather than teamwork.

Barrie: I think we would probably ask a student to come up with the first draft of a poster and so they could put the idea into planning it; it may finish up looking very different after all the co-authors have had a look at it so it's a rule; it's a requirement; it's an ethical requirement that all the authors should have an input in the paper and the publishing of it… And they have to appropriately acknowledge people in their thesis for example and hand it in ... so they learn all of that in honours; they learn a lot but it's more about being an individual and what the individual responsibilities of a scientist [are] ... I wouldn't call that teamwork so much it's just mentorship and supervision.

Well, [they work] collaboratively with their supervisor if you like but, you know it's not so much teamwork it's learning how to behave as a scientist.

Research training models

Two strong models were implied by Tim and Barrie's descriptions of research training. The first involved a master (supervisor)/apprentice (student) model where research training rests on 'good practice' being modelled by supervisors and senior colleagues. The second is a

community of practice model (expert/novice) where a student is inculcated into becoming a scientific researcher through being in a research laboratory.

> *Barrie: … the group is in a sense working primarily on the concepts, ideas, intellectual pursuits of the supervisor and other people are welcome to put their ideas in so it's not completely dominated in that way…I have a group where we get funded for group work … and so we've got a working group where we assign tasks to the people in the group and they're in a much more master/servant relationship where the head of the group says, "We have to meet these milestones and we're going to achieve them by allocating tasks". …there's a consensus about how to allocate those tasks and those tasks are divided largely on the person's experience and ability to deliver on the milestones.*

> *Tim: One of the things that I try and encourage the students, and particularly the honours students when they come into the lab, is … I try and get the students to go and spend a little bit of time with everybody to actually pick-up what these people are good at and so just by the fact that they have to learn from say three or four different people in the lab that means that they have to get used to working with other people and they have to pick up things from other people and then try and take all of these different approaches together and then turn them into something that for them works for their project, and so I don't know whether or not that's forcing them to collaborate or not.*

Discussion

The introduction of a collaborative group writing task into the honours year has uncovered interesting insights into perceptions of teamwork by participating students and through reflections from current science academics working with honours students. The students recognized that scientific research is about working in a team environment and that collaborative writing is a key skill for scientists. However, in this task the most negative statements were that they did not like the task and that they prefer not to work in groups. Although negative perceptions of this task will have influenced student perceptions, it is still surprising that students who see themselves working in a team environment in the future report that they are uncomfortable working in a group situation.

Academic staff reflecting on the task echoed the value of collaboration in scientific practice. Both the academics emphasized the importance of working collaboratively for the work of any scientist to evolve, despite scientists being highly individualistic and possessive about their work. However, for the academic staff, a primary focus for an honours year is to inculcate the novice student into a scientific research community. The traditionalist model they advocate is one of immersion into a community of practice (Lave & Wenger, 1991) which sees the honours student as a novice who learns from a community of experts by infusion and observation. There is a hierarchy of knowledge in the laboratory from the Head leader to the honours student who is at the bottom as novice researcher. Here, collaboration and expertise and learning are directional and one-way from expert-to-novice, or master-to-student.

Further, both the academics highlighted that research training is based on authentic tasks that emerge from 'being in' and 'working on research tasks' in a laboratory setting. Hence, the academics empathized and echoed the tensions and difficulties inherent in having student *do* the group writing task for assessment in an 'artificially' constructed group. However, the students were less concerned by the authenticity of the task. The students discussed

teamwork issues much more than writing skills or content, implying that teamwork function was more demanding. It appears that difficulties with group processes can overwhelm consideration of other aspects of the task.

Another tension emerged between preparation for teamwork tasks and other curriculum demands. The students alluded to their lack of preparation in collaborative skills in undergraduate study. The academic staff described teamwork skills emerging through research training rather than explicit direct teaching. This highlights the open question of whether or not, honours is an appropriate context for teaching collaboration explicitly, especially due to the intensity of the honours year. The 'pressure-cooker' nature of the course is complicated by the competition for postgraduate research training opportunities. Both staff and students said that marking (assessing) teamwork was contrived and fraught with difficulty.

It is important to reflect on these issues and their implications for redesign of the group writing assessment task. Firstly, the aspects of time and timing are vital factors for any teamwork. The Honours year has a full curriculum as well as individual research projects. Coursework assignments are a normal part of this honours program and have variously been placed either in shorter segregated time or, as in this case, over a longer period with students permitted to continue experiments at the same time. The students did not express a preference for dedicated time for coursework or for a longer duration for the assignment. However, they did comment that extra effort was required to operate in a group which may have been perceived as an increased demand on precious time.

Overall, student marks in an Honours year compete for postgraduate scholarships and research laboratory entry. It is not that surprising those students would not be as open to undertaking 'teamwork' given time constraints and the highly individualistic and competitive year. Further, the academic mentors perceive that teams evolve across authentic and prolonged exposure and involvement in authentic research laboratory teams and projects, in 'slow-time' and by infusion. The authors, however, were keen to promote 'fast time' team collaboration so that students would be explicitly 'skilled' in teamwork and collaboration skills irrespective of whether they were to continue to postgraduate study or the work force. Many workplace teams can involve short-term projects with high staff turnover. Even though our aim was to prepare students for laboratory research collaborative writing and the Honours year seemed an optimal location by the authors, from a student perspective, the stakes are too high. It may well be that this would be better done in third year where the stakes are not so high for students.

There are various models and types of groups outlined by Davies (2009, p. 566): informal learning groups, formal learning groups, and study teams that tend to be task-focused and shorter-term groups that dissolve once the task is achieved (Davis, 2002). This contrasts with organisational self-managed work teams that can be more permanent and longer-term groups, as well as work project teams that are task-focused around longer-term projects. In this case, the research mentors were more aligned to the research laboratories with longer-term projects that facilitate infusion models of teamwork learning based on expert/novice models. This group writing task was conceptualised deliberately as a short-term task focused activity. The group writing task was appropriately conceived and sufficiently complex to engage students in that it was "additive" where each group member needed to contribute something to the joint writing task. Various group work factors (Davies, 2009) from task type and complexity

to group size, as well as assessment issues of recognition of effort and incentives and penalties were considered.

As recommended, each student within the group was assessed on individual effort and the final team product to recognize both individual effort and the added value of collective work (Davies, 2009). The inclusion of peer evaluation was controversial with students suggesting alternative ways to support constructive feedback between group members would be helpful. One such tool is a "web-based program" titled "CALM" (Critical Analysis and Learning in Macroeconomics) which facilitates team members providing anonymous team feedback (Johnston & Olekalns 2002). Additionally, a significant factor that might allow for better team dynamic and time investment would be to reduce the group size from 5-6 to 3-4 as group size is critical for effective teamwork (Strong and Anderson 1990). Further refinements might include the explicit use of *Wikis* to accelerate the writing process amongst group members.

In terms of team roles, whilst there was a focus on writing task roles such as editor, planner and so on, perhaps more explicit teaching of team processes, dynamics and roles could be valuable. Such considerations might include highlighting for example, Belbin Team Roles (Belbin Associates, 2012) and their relationship to task complexity and team composition (Higgs, Plewnia & Ploch, 2005), as well as the impact of MBTI Personality Types (The Myers and Briggs Foundation, n.d.) on group dynamics, and/or insights into students' learning style preferences (e.g. *Index of Learning Styles* by Felder & Soloman, n.d.). Understanding individual and team dynamic responses on this level might assist students to better scaffold and value their similarities/differences and strengths/weaknesses for successful group cohesion and task completion. However, including these features adds a further time issues in a crowded and intensive Honours curriculum. Whilst there are various models of how to infuse and embed communication skills and graduate attributes into undergraduate programs (Al-Mahmood & Gruba, 2007; Gruba & Al-Mahmood, 2004), the Honours year is specialised.

Given all the issues raised by the students, the collaborative group writing task introduced in 2010 was not repeated in the following year based on the student feedback and discussion with students and the honours committee. The course was changed to emphasize breadth in content (study outside the primary research project) and active learning from guest seminars: "... at this point in time this is not something we want to repeat and so we produced other things where we felt that we could teach them [the students] things that we felt would be nearly as important as a form of teamwork" (Tim). The honours committee did retain an alternative teamwork task, and perhaps a less time-consuming one than the collaborative group writing task of 2010, of getting students to read the same research article and produce/write the abstract collectively. However, neither the 2010 curriculum nor the subsequent revised curriculum appears to address the issue of developing teamwork skills within the honours year.

Effective teamwork requires a sophisticated set of skills: negotiation, organization, leadership and management (Tanner et al., 2003). Discussion with the students in the focus group shows they have a developed idea of the skills needed for successful teamwork and are able to identify key issues. The students reported limited past experience with group tasks which leaves them underprepared for a collaborative working environment. The academics discussing teamwork in honours saw teamwork in research being best developed in an authentic environment over a longer period beyond the honours year. The traditional honours

research training model does not explicitly develop teamwork for students. For those who choose different paths, this study suggests the only opportunity to develop these skills is either in the undergraduate curriculum or through explicit scaffolding in the honours year. Moving beyond traditional models of honours research through innovative practice requires evaluation of and reflection on both student and staff voices to gain insights into their divergent perceptions of teamwork.

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