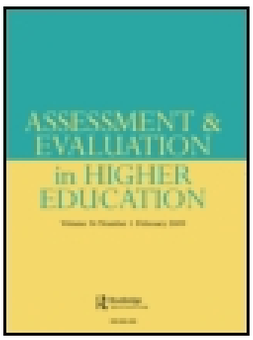

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Assessment & Evaluation in Higher Education

ISSN: 0260-2938 (Print) 1469-297X (Online) Journal homepage: http://srhe.tandfonline.com/loi/caeh20

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**To cite this article:** Laura Wilson, Susie Ho & Rowan H. Brookes (2017): Student perceptions of teamwork within assessment tasks in undergraduate science degrees, Assessment & Evaluation in Higher Education, DOI: 10.1080/02602938.2017.1409334

**To link to this article:** https://doi.org/10.1080/02602938.2017.1409334

ASSESSMENT & EVALUATION IN HIGHER EDUCATION, 2017
https://doi.org/10.1080/02602938.2017.1409334

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# Student perceptions of teamwork within assessment tasks in undergraduate science degrees

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**ABSTRACT**

Teamwork assessment creates a more comprehensive educational experience by broadening the diversity of skills that students develop. Developing teamwork skills is particularly important due to a recognised skills gap among science graduates. This study investigated student perceptions of developing teamwork skills during their undergraduate science degrees. A mixed methods approach was used, which included the analysis of both quantitative and qualitative online survey data. The key findings showed that, although students understood the importance of developing teamwork skills for their future, a substantial proportion did not feel sufficiently prepared with these skills by their science degree. To develop teamwork skills, more students valued working in teams during laboratory sessions, team sports and informal study groups than non-laboratory based formal teamwork assessment. In support of previous teamwork studies across disciplines, the most cited factors contributing to poor teamwork experiences were difficulties scheduling meetings and unequal contribution among team members. This study indicates pedagogical improvements that may enhance the teamwork experience of students during assessments.

**KEYWORDS**

Group work; teamwork; employability; assessment; undergraduate

## Introduction

The inclusion of teamwork into an undergraduate curriculum has many benefits. For example, in an international study involving over 17,000 students, Roseth et al. (2008) showed that students involved in a collaborative learning experience achieved higher academic results than those in an individualistic learning environment. Assessment and activities that integrate teamwork also create a more comprehensive educational experience by broadening the diversity of skills science undergraduates can develop within their degree (Bose et al. 2004; Davies 2009). The social nature of teamwork has been shown to improve the mental health and social competence of students (Smith 1996; Strom and Strom 2011). In addition, teamwork gives students interpersonal skills and experience negotiating tasks with their peers (Edmondson and Maguire 2001).

Beyond university, teamwork is an effective tool for fostering transferable skills relevant to a variety of career paths (Bridgstock 2009). In a systematic review of teamwork pedagogy, Riebe, Girardi, and Whitsed (2016) argue that teamwork has moved from a *desirable* skill in the workplace to an *essential* requirement. This is primarily because of the important communication and collaboration skills gained through teamwork assessment and activities (Bosworth 1994; Oakley et al. 2007; Tarricone and Luca 2002).

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### Developing teamwork skills in students

There are many evidence-based approaches for effectively designing teamwork assessment (Burke 2011; Davies 2009). These approaches include the use of peer evaluation (Brooks and Ammons 2003), forming small teams (3–4 members), appropriate task complexity and workload for distributing amongst a team (Strong and Anderson 2011), and increasing allocated class time for doing teamwork activities (Pfaff and Huddleston 2003). Others advocate for a focus within the curriculum on the *process* of completing the activity, rather than the outcome (Riebe, Girardi, and Whitsed 2016). Despite many evidence-based approaches for fostering teamwork skills in undergraduate studies, implementation of teamwork pedagogy remains challenging. Addressing these challenges, some higher education institutes have focused on the professional development of academic teaching staff (Burbach et al. 2010).

Both students and employers perceive science graduates are lacking in some generic transferable skills (Jackson 2010), such as interpersonal communication and collaboration (AC Nielson Research Services 2000; Curtis and McKenzie 2001; Prinsley and Baranyai 2015; Sheldon and Thornthwaite 2005). To be prepared for careers both in and outside scientific research, science undergraduates need to be provided with explicit teamwork training (Gibert, Tozer, and Westoby 2017).

It has been suggested that the teamwork skills gap among science graduates results from the tendency of undergraduate science course curricula to focus on content-based learning (Rotherham and Willingham 2010). While this approach can be successful in teaching skills like critical thinking, it does little to foster the more soft transferable skills, such as those associated with teamwork (Nielsen and Holmegaard 2016; Rotherham and Willingham 2010). The current paper explores the student perspective of developing these transferable teamwork skills within an undergraduate science degree. A further research paper investigating the academics' perspective of teamwork in science, by one of this paper's authors, has also been published (Brookes 2017).

For the purpose of this study, 'teamwork' will be defined as the collaborative and interdependent effort of multiple people to achieve a common goal. This is distinct to 'group work', which can be defined as individual accomplishments within the context of a group (Baker, Day, and Salas 2006).

### Student perspectives on teamwork assessment

The student voice should be taken into account when considering approaches for fostering teamwork skills within a curriculum. This is because the success of pedagogy is largely reliant on student feedback and engagement, as well as perceptions about the value of the teamwork within the curriculum (Carini, Kuh, and Klein 2006; Pintrich 2003; Walker 2001). A substantial body of research outlines the student perspective of teamwork across different disciplines, particularly business and management. This research shows that a dominant concern of students is the presence of 'free-loaders' or 'social-loafing', whereby one or more team members contribute less than others (Garcia-Bayonas and Gottschall 2008; Pfaff and Huddleston 2003). Further negative student perspectives about teamwork include difficulty in scheduling meetings (Burdett 2003), challenges of working across cultures (De Vita 2002), unfair grading approaches, difficult interpersonal dynamics (Curşeu 2011), greater need for instructor guidance (Oakley et al. 2007), and a preference for individual work (Garcia-Bayonas and Gottschall 2008).

### Missing voices. The science student perspective of teamwork

Science education literature reviewing the student perspective on assessments used to develop teamwork skills is limited (but see Bose et al. 2004; Garcia-Bayonas and Gottschall 2008; Gibert, Tozer, and Westoby 2017; Johnson, Al-Mahmood, and Maier 2012; Shibley and Zimmaro 2002). A notable exception is a study by Varsavsky et al. (2014), which surveyed 400 undergraduate science students on their perceptions of both technical and generic skills development in the curriculum. This found that, although students perceived teamwork skills to be important for their future, teamwork skills were not prevalent enough in the curriculum. Another study by Johnson, Al-Mahmood, and Maier (2012)

examined science students' perceptions of teamwork tasks during their honours year. The authors found that, while students recognised the relevance of collaborative writing in a scientific career, they perceived that they were ill-prepared with collaborative skills from their bachelor's degree (Johnson, Al-Mahmood, and Maier 2012).

### *Study aims*

In recognising the absence of science student voices from research into teamwork skills development, this study asks three main questions:

(1) Do undergraduate science students value teamwork skills and do they perceive that they are adequately prepared with these skills during their studies?
(2) What are students' experiences of teamwork during assessments?
(3) What are students' perceptions on assessment format and activities for the development of their teamwork skills?

## Methodology

### *Research design*

We used a survey with a mixed methods approach including both quantitative and qualitative data. This mixed methods approach provided an opportunity for a greater understanding of the research topic than relying on a single method (Sadan 2014). The survey enabled us to gain data from a greater number of participants. Quantitative data was generated using scaled response questions, including Likert-attitude scale questions (1 – strongly disagree to 5 – strongly agree), multiple choice and ranking questions. Open ended questions were used to gain a more nuanced understanding of the quantitative data.

### *Survey instrument*

We developed our survey based upon a range of survey instruments from the existing literature on teamwork in higher education (Garcia-Bayonas and Gottschall 2008; Rahman et al. 2010; Walker 2001). The survey was composed of 31 items and could be completed within 10 min. The first section of the survey contained demographic information (e.g. age, gender, major discipline). A series of tick box questions explored whether students had undertaken teamwork, how many teamwork assignments they had completed, and whether any teamwork skills were explicitly taught within the curriculum. The remainder of the survey (items 13–31) included closed-ended and open-ended questions that focused on student's perceptions of the value of teamwork skills in different contexts, including for their future career progression, their positive and negative experiences of teamwork, and their views on assessment formats (e.g. assessed vs. unassessed or oral vs. written reports). The survey instrument was developed and delivered on the SurveyMonkey website (SurveyMonkey Inc., Palo Alto, California, USA).

### *Expert opinion and piloting*

After its initial development, the survey was independently audited by two external education researchers. Both researchers reviewed the survey design and the clarity of the questions. The draft survey questions were then piloted with eight undergraduate science students. Based upon feedback, amendments were made to the order and wording of questions and further questions were added.

### *Population and survey distribution*

Participation in this study was open to current science undergraduates from Monash University (Melbourne, Australia) from late-May to the end of July 2016. The survey was advertised using social media, posters around the campus and announcements on a learning management platform (Moodle). An incentive was offered for participating; respondents who opted in were placed in a draw for the prize of a gift voucher. The survey was open to undergraduate students from any of the following courses: Bachelor of Science, Bachelor of Science double degree, Bachelor of Science Advanced – Research (Honours) and Bachelor of Science Advanced – Global Challenges (Honours). Students across all year levels and disciplines were included to obtain a more comprehensive understanding of student perceptions of teamwork assessment. Overall 201 students responded to the online survey, though not all students responded to every question. The largest proportion of students were in the first year of their degree (43%). The remaining participants came from second, third and fourth year in relatively equal proportions, with 3% comprising fifth year students. There was a skew towards students majoring in biology (50%), which the researchers were unable to rectify via targeted advertising. All procedures complied with Monash University Human Research Ethics Committee guidelines (MUHREC approval number: CF16/1568 – 2016000817).

### *Data analysis*

We analysed the quantitative data using Microsoft Excel (Version 15.0, 2013) and R-Studio (Version 3.1.2, 2014). To transform the scaled questions into numerical data, we first quantified the Likert-attitude scale responses. We then calculated and presented standardised descriptive summary statistics (e.g. means, standard errors and percentage of response). To test for significant differences in response between different demographic groups (gender, year level and scientific discipline), a single-factor non-parametric analysis of variance was conducted (Kruskal-Wallis test; Chan and Walmsley 1997). The significance threshold was set at 0.05. Where appropriate, a *post hoc* Dunn's test (Zar 1999) was conducted to determine which demographic groups were showing significantly different responses.

The qualitative data from the open-ended survey questions were analysed using NVivo (QSR International Ltd. Version 11, 2016). Open coding was used to identify and analyse the prevalence of different themes that emerged from the responses (Elo and Kyngas 2003). Selected excerpts from the open-ended responses have been de-identified and presented within the results. After the coding took place, 10 semi-structured interviews were undertaken to provide the primary researcher with a more nuanced understanding of the open-ended survey responses and emergent themes. This interview data is not presented in the results.

## Results

### *Perceptions of the value of teamwork skills and their development within a science degree*

The quantitative and qualitative results suggest that science students view teamwork skills as valuable for their future career. However, a substantial proportion of respondents do not feel their degree adequately prepares them with these skills.

A key finding from the quantitative results is that the vast majority of respondents (93%; 185 students) agreed or strongly agreed with the statements that teamwork skills are 'necessary for a career *within* science' and 'a career *outside* science' (Table 1). This finding highlights a perception among respondents that these skills are broadly transferable and equally valuable for science and non-science careers. Despite this, only 60% of respondents (120 students) agreed or strongly agreed that teamwork skills are developed during a science degree. More students reported that extracurricular activities (87%, 174) and paid work (70%, 140) developed teamwork skills.

Approximately 59% of respondents agreed or strongly agreed with the statement 'My science degree is adequately preparing me with [teamwork skills] for my future career' (reinforcing the similar statement

**Table 1.** Science undergraduates' perceptions of the value of teamwork skills and the formats in which they are developed.

| Survey statement | Mean ± SE 1–5 Likert scale | % strongly agree or agree (%) |
|---|---|---|
| Teamwork skills are necessary for a career in science | 4.49 ± 0.05 | 92.50 |
| Teamwork skills are necessary in a career outside science | 4.50 ± 0.05 | 92.50 |
| Teamwork skills are developed during a science degree | 3.81 ± 0.07 | 60.00 |
| Teamwork skills are developed during extracurricular activities alongside study | 4.32 ± 0.04 | 87.00 |
| Teamwork skills are developed at paid work during study | 4.14 ± 0.05 | 69.50 |

Notes: This table displays the mean and standard error (SE) values given by students for Likert-attitude scale questions responding to the following statements given below. The Likert-attitude scale has been quantified as follows: Strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1). The percentage (%) of participants who selected either agree or strongly agree is also shown. $n = 200$.

in Table 1). There was a significant difference between the responses from students from mathematical and biomedical disciplines ($\chi^2 = 31.28$, df = 15, $p = 0.009$). On average, biomedical students ($\mu = 4.29$) responded more positively than mathematical students ($\mu = 3$; Figure 1). There were no significant differences between other disciplines (i.e. psychology, physics, astronomy, earth sciences, biological sciences, chemistry).

When students were asked to select the specific skills gained from teamwork from a provided list, communication, collaboration, leadership and negotiation skills, or those skills explicitly related to interactions with others, were more frequently selected than debating, self-management and time management (Figure 2). As one student explained: teamwork 'allows us to develop skills that we otherwise may not if we were working alone, or with friends, such as negotiation, leadership and collaboration, which are vital skills for the future'.

In an open response to the statement, 'My science degree is adequately preparing me with [teamwork skills] for my future career', students were asked to briefly explain their rating. The predominant theme was the perception that their science degree does provide sufficient *opportunity* for developing teamwork skills. This was cited by 56% of respondents (84 students; $n = 154$). For example, 'There have been so many group assignments throughout my degree that I have a lot of experience working in a group'. Several students referred to the value of these opportunities for their career. For example,

> Group work is essential in all careers and is a skill that must be learned throughout our lives. Having the chance to do so within this course provides a great opportunity to gain this exposure and ultimately, prepare myself for the workforce.

The next most frequently cited themes highlighted a view that, although there was a lot of opportunity for teamwork, the assessment tasks could be improved to better foster teamwork skills. Students cited

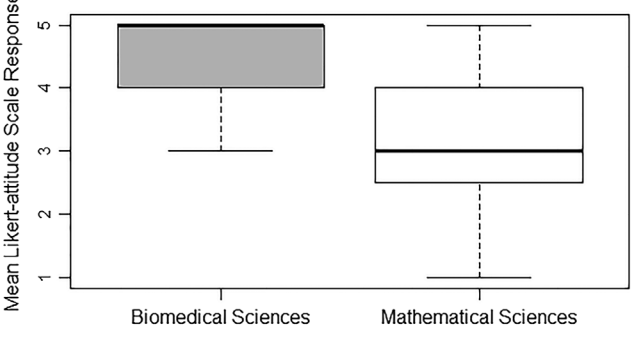


**Figure 1.** A box-plot displaying disciplinary differences in perceived teamwork skills development. The boxplot shows mean values for biomedical and mathematics students in response to the question 'My science degree is adequately preparing me with [teamwork skills] for my future career'. The Likert-attitude scale was quantified: 5 being Strongly agree – 1 Strongly disagree. There were no significant differences between other scientific disciplines.

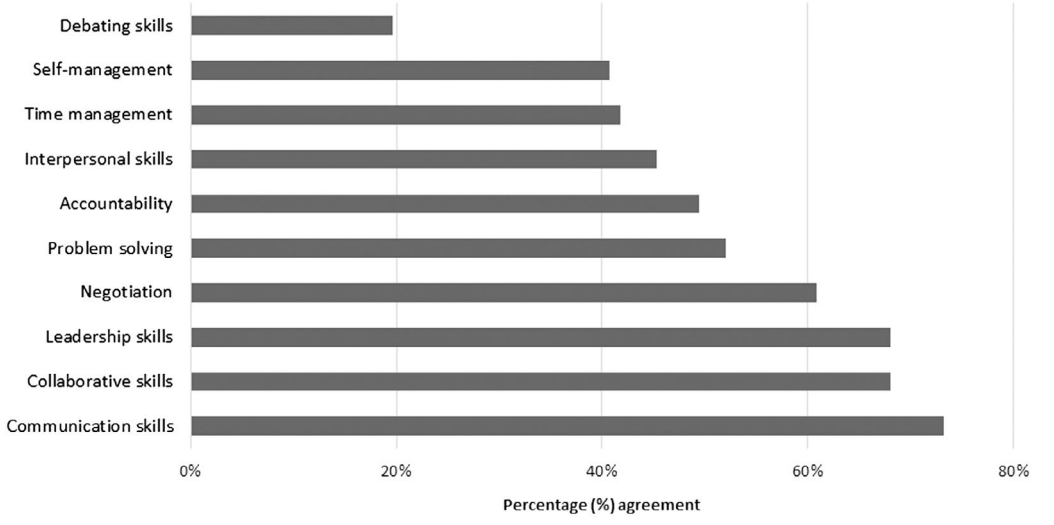


**Figure 2.** Student's perceptions of skills gained from teamwork. Figure displays percentage (%) of participants selecting a given response to the question 'Please select which of the following skills that you have gained from teamwork:' $n = 194$.

a lack of structure around assessments to encourage equal contribution and participation from group members (35%; 15 students). A typical response was:

> While the degree in science does give me opportunity to work in groups, I do believe that there could be focus on the best way to work in groups and have more accountability for the team members who do less work.

Some respondents (23%) referred to the superficial and inauthentic nature of university teamwork assessment relative to real-world work contexts: 'I don't believe that the group work we undertake now and the conditions, restrictions and allocation of group projects corresponds to what would be undertaken in a real-world example'.

### *Students' experiences of teamwork*

The quantitative and qualitative data indicated that respondents had mixed attitudes towards their overall teamwork experiences. Certain factors were frequently perceived to lead to more positive teamwork experiences and outcomes, such as meeting new people and having regular allocated class time for teamwork tasks. The negative aspects of teamwork experiences were often related to issues of scheduling and unequal contributions between group members.

Respondents were asked to select from a range of responses (from highly positive to highly negative) following the question 'What is your experience of completing [teamwork] during assessments?' Almost half of the survey respondents (48%) reported that their overall experience with teamwork assessment had been positive or highly positive, while 28% were neutral, and 25% had negative or highly negative experiences ($n = 198$).

Students were asked to report their perspective about what contributed to a positive *experience* from a range of factors predetermined by the researchers (Figure 3). The most frequently selected factors were 'meeting new people' (71%, 142 students), closely followed by 'sharing the workload between team members' (67%, 133), 'getting to work with friends' (56%, 112), and 'peer-teaching experiences' (53.5%, 107). Approximately 30% of respondents reported feeling more motivated when working with others during team assessments. Less than 20% of respondents believed that their experience was improved because the final assignment was better than what could be achieved individually. In reflection of the earlier question on teamwork assessment experiences (where 25% stated they had negative or highly

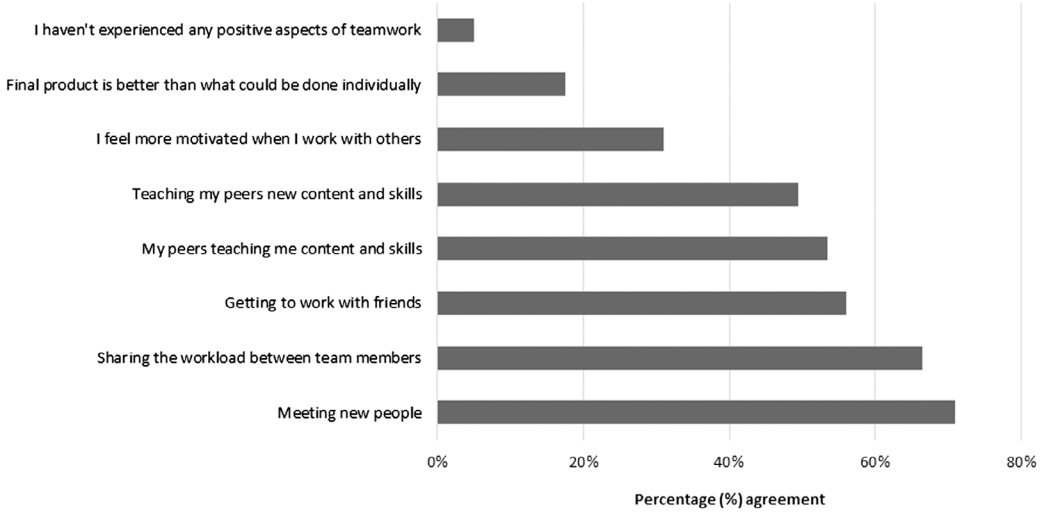


**Figure 3.** Student perceptions of positive aspects of teamwork assessment tasks. Figure displays percentage (%) of participants selecting a given response to the question 'In your experience, positive aspects of teamwork assignments include:' $n = 200$.

negative experience), 5% (10 students) reported that they had not experienced any positive aspects of teamwork (Figure 3).

Students were then asked to report what factors contributed to a positive *outcome* of team assessment from a range of factors on a list (Figure 4). The three most commonly cited factors that students believed to contribute to a positive team outcome were: (i) 'having allocated regular class time to work on teamwork tasks' (81%, 147 students), (ii) 'being assessed individually as well as a team' (78%, 142), and (iii) 'a small number of people (<3) in the team' (74%, 135; Figure 4). Infrequently cited factors included, 'working in larger teams (>3)', 'working without academic supervision', 'having a long time to complete the project' (>1 month), and 'getting peer-feedback' (Figure 4).


**Figure 4.** Student perceptions of the factors that contributed to a positive teamwork outcome. Figure displays percentage (%) of participants selecting a given response to the question 'In your experience, which of the following factors contribute to a positive group outcome?' $n = 182$.

Students were also asked to report their perspectives on what contributed to a negative *experience* of teamwork from a range of factors on a list (Figure 5). These largely corresponded to the factors perceived to lead to a positive outcome (Figure 4). In descending order the four most frequently cited factors were: trying to schedule group meetings and one or more group members not contributing/unfair workload distribution (84%, 167 students); relying on the work of students for a final grade and time management between group members (75%, 149; Figure 5). Interpersonal conflict, peer evaluation and distracting team members were less frequently cited (Figure 5). There were no respondents that only reported experiencing positive aspects of teamwork assessment.

Students were asked, in an open-ended response, to explain their reasoning for selecting the factors that contributed to positive outcomes. While the respondents were prompted to talk about positive factors impacting teamwork assessment, many instead discussed their negative experiences, in alignment with Figures 4 and 5. For example, 'The most annoying part of group work is the lack of a formal schedule on when parts should be done' and 'I usually do most of the work. So I want my own marks to reflect that and not the laziness of others'.

Students most frequently discussed the importance of having scheduled class time for teamwork (18%, 22 students). The following comment was typical with regards to the frustrations that students expressed: 'A lot of the hassle with group work is trying to work out time to meet and work'. Students also frequently cited that individual assessment was a fairer assessment of the efforts and contribution of each member within the group (25%, 31 students). For example, a common comment was:

> When there is also individual assessment, those students that work hard are more likely to get the marks they deserve and the more lazy students are encouraged to put more effort in as they cannot solely rely on the work of others.

Within the context of the whole study, in response to various survey questions, many of the respondents related the scheduling of class time to other interrelated factors that impacted their experience of teamwork assessment, such as:

> It can be hard to find times that suit everyone if it's outside formal class time particularly for larger groups so this can make it a less positive experience … The size of the group and its effect really depends on the people in the group – in general it is easier to work in smaller groups because it is simpler to divide the workload and easier to find times everyone is available and communication is easier when there is less people, but the problem is that in a smaller group if one or two members aren't contributing positively or are difficult to work with it affects the project majorly whereas it is more manageable when there are more people.

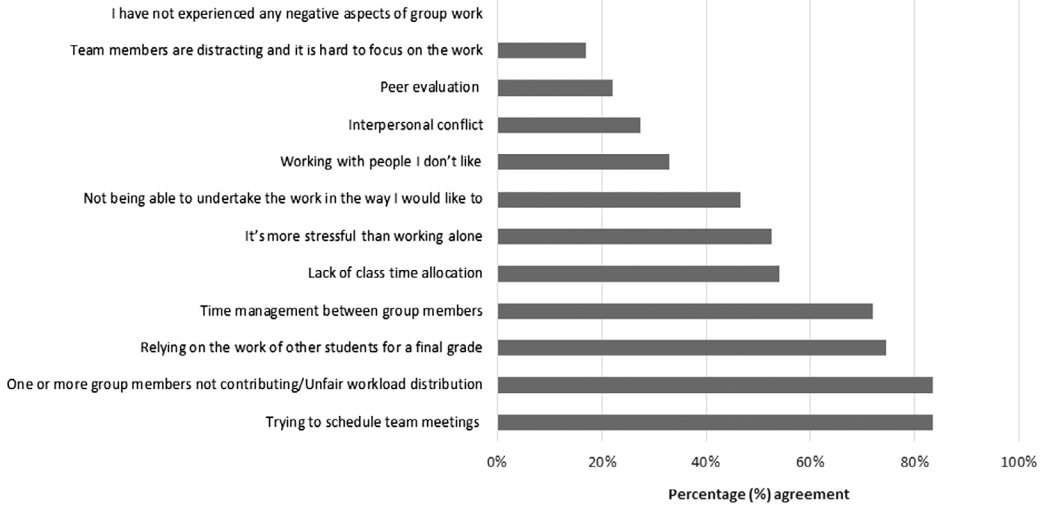


**Figure 5.** Student perceptions of negative aspects of teamwork assessment tasks. Figure displays percentage (%) of participants selecting a given response to the question 'In your experience, negative aspects of teamwork assignments include:' $n = 200$.

### *Perceptions of activities for developing teamwork skills*

A key finding is that students perceive that various extracurricular activities, in addition to curricular activities, are useful for developing teamwork skills. Students were asked to rate activities, provided in a list, based upon their perceived usefulness for developing teamwork skills (Table 2). The activities most frequently reported as useful or very useful were: (i) working in groups within laboratory sessions (82%), and (ii) team sports (80%). Many students also reported that informal study groups (71%), being on committees (67%), formal group assessment tasks (66%) and group discussions (65%) were useful or very useful. The least cited activity for the development of teamwork skills was using online educational forums (23%).

With regard to teamwork within laboratory sessions, significant differences were found in responses between students from different disciplines and year levels. Fifth year students displayed a lower preference for laboratory-based teamwork than students from years one to four ($\chi^2 = 17.05$, df = 4, $p = 0.002$). Considering the small proportion of the survey population made up of students in their fifth year (3%, 6 students), this variance does not allow for rigorous interpretation. Differences existed between psychology vs. mathematical science (df = 15, $p = 0.035$) and chemistry vs. mathematical science (df = 15, $p = 0.037$). The average perceived usefulness of laboratory sessions was lower for mathematical students ($\mu = 2.25$; $\chi^2 = 32.84$, df = 15, $p = 0.005$). This result could be due to a lower prevalence of classes called 'laboratory sessions' within the mathematical science curriculum compared to other disciplines at the university. There were no disciplinary differences for the other activities listed in Table 2.

### *Perceptions of obstacles to teamwork*

Respondents were asked in an open-response 'What are the biggest obstacles with the assessment formats you have experienced for group work?' ($n = 120$). Within the survey, 'assessment formats' were defined as orals, reports, posters, research projects and essays. Similar to questions on student experience, coding showed the dominant obstacles were issues related to scheduling time to work together (23%, 27 students), uneven workload (22%, 26) and factors related to the assignment design (19%, 23). Other factors cited were student attitudes about university or assignments, communication difficulties and assignment marking that did not consider contributions (13%, 15). There were several factors that were infrequently mentioned as an obstacle (with 10 or fewer students reporting these), such as student working styles, the need for more tutor support and technological barriers. Four students stated they had no obstacles with assessment formats when undertaking teamwork assignments.

Within the context of this study, the following open-response comment was typical of students who expressed scheduling time to work together as the biggest obstacle (23%): 'Finding time outside of class time in which we can all meet up is possibly the worst thing about group work'. Many respondents made reference to the busy schedules they had both within university and beyond: '[An obstacle is] Finding a time to meet up with everyone on a frequent basis. Very hard outside of prac and tutes as everyone has a different timetable and work commitments'. Students expressed the desire to have

**Table 2.** Table displaying student's perceptions of the usefulness of activities for developing teamwork skills.

| Activities for developing teamwork skills | Mean ± SE 1–4 Likert scale | % useful or very useful (%) |
|---|---|---|
| Working in groups during a laboratory | 3.21 ± 0.06 | 82.00 |
| Team sports | 3.23 ± 0.06 | 80.00 |
| Informal study groups | 2.92 ± 0.06 | 70.50 |
| Being on committees | 3.01 ± 0.06 | 66.50 |
| Formal teamwork projects | 2.72 ± 0.07 | 65.50 |
| Group discussions | 2.81 ± 0.07 | 64.50 |
| Discussion forums on Moodle | 1.90 ± 0.07 | 22.50 |

Notes: This table displays the mean and standard error (SE) values given for Likert-attitude scale questions responding to the statements given below. The Likert-attitude scale has been quantified as follows: Very useful (4), useful (3), to some extent (2) and not very useful (1). The percentage (%) of participants who selected either useful or very useful is also shown. $n = 200$.

class time scheduled to work on assignments (5 students). For example, [An obstacle is] 'Lack of time during class to work on the assessment task, as it is difficult to get people together when we have different timetables'.

The respondents also expressed substantial frustration about the impact of perceived uneven or unfair workload contribution (22%). A typical response was simply: '[An obstacle is] having team members not pull their weight'. One respondent discussed how this impacted upon the functioning of the group: 'When there's a lack of involvement from one group member, it can be demoralising and quite damaging to the group as whole'.

The assignment design was frequently mentioned (19%) as an obstacle for the students to overcome. The comments tended to relate to the format (e.g. written tasks being difficult to negotiate), unclear assignment instructions, and the duration. For example, one student explained 'Essays are the hardest and you have to write separate components and then stitch together and spend hours and hours editing and making sure it flows and the writing style is continuous'. Other comments related to how assignment design could add to frustrations amongst the team, for instance, 'Sometimes projects will have some silly requirements like 'at least 10 pages', which generally makes group work unpleasant. Ambiguous criteria also leads to team stress'.

## Discussion

### *Science undergraduates value teamwork, but perceive a skills gap*

This study suggests that science students value teamwork skills for a variety of careers (93%), yet many (~40%) believe teamwork skills are inadequately developed within their science degree. This aligns with Varsavsky et al. (2014), who found that most science students surveyed had a high regard for teamwork skills including for future use. Perceptions of the importance of teamwork skills were somewhat higher than perceived improvements in this skill during the degree, which supports findings in the present study. Varsavsky et al. (2014) used a similar survey design allowing some comparison. The study explored student perceptions of future use, confidence, inclusion, improvement and importance across a range of scientific and transferable skills developed in the curriculum (Varsavsky et al. 2014), whilst the present study more strongly emphasised student perceptions of teamwork experience and skills development.

This is an important finding since previous studies surveying university students, scientific research team leaders and employers about the value of teamwork skills have found they are highly valued for a range of careers (AC Nielson Research Services 2000; The World Economic Forum 2016). Non-discipline specific transferable skills, such as teamwork, are important to develop because science graduates find employment across a variety of industries, with only 42% being specifically science-based (Anderson, McInnis, and Hartley 2003).

The students' perceptions correspond to the views of employers, who have noted that science graduates are lacking in teamwork skills, such as communication and collaboration (Noriko et al. 2003; Prinsley and Baranyai 2015; Sarkar et al. 2016). Furthermore, past graduates of science degrees have also noted a disparity between the skills they developed within their degree and those required of them in the workforce (Australian Council of Educational Research 2008; Sarkar et al. 2016). It is clear there is room for improvement in approaches to develop teamwork skills.

### *Allocating class time for teamwork*

Difficulty finding time to work together was a significant factor contributing to poor teamwork experiences. Notably, despite asking a range of questions to prompt both positive and negative experiences related to teamwork, students kept returning to the challenge of scheduling group meetings as a significant obstacle to successfully undertaking teamwork. The challenge of finding time to meet and work outside of class has been noted in several other studies (Burdett 2003; Davies 2009; Garcia-Bayonas

and Gottschall 2008). For example, Burdett (2003) found that 37% of students cited this as the most negative factor in teamwork tasks.

By providing time for face-to-face collaboration within class, educators allow students to bypass the stress and difficulty of scheduling group meetings. This can be important, given that outside of classes students may experience conflicting schedules due to study timetables and/or work commitments (Burdett 2003; Garcia-Bayonas and Gottschall 2008). For instance, the proportion of students undertaking paid work concurrently with study appears to be growing steadily (Applegate and Daly 2006). We recognise, however, that dedicating time to undertake teamwork during classes may not always be possible depending on how a unit is structured.

Among all the open-ended responses within the survey, many of the student experiences of team assessment would fit the description of 'group work' (individual accomplishments within the context of a group) rather than 'teamwork' (collaborative and interdependent efforts towards a common goal). For example, students often cited that they divided the workload between group members, going on to complete their sections individually until it was necessary to combine. During teamwork assessment, the dynamic is more likely to be that of a 'group' than a 'team' due to time constraints relating to both the unit curriculum and the students' schedules (Davies 2009; Warkentin, Sayeed, and Hightower 1997; Zeff and Higby 2002). Insufficient time for face to face collaboration could reduce the students' ability to work as an interdependent and cohesive unit, therefore promoting a divided workload approach.

The divided workload approach is a pre-cursor to one of the dominant issues reported in this study, namely unequal contribution of work from one or more group members. This can subsequently lead to dysfunctional teamwork experiences, which diminish students' abilities to learn and develop skills (Luca and Heal 2006). Similar findings regarding unequal contribution in groups have been widely covered in the literature, looking at teamwork in other university disciplines (Burdett 2003; Pfaff and Huddleston 2003; Walker 2001).

If educators can develop a curriculum and assessment approach that builds in in-class time for teamwork, it will enable students to spend less time negotiating basic scheduling requirements and distributing the workload. This may allow student teams to develop more nuanced and collaborative interpersonal skills.

### *Preference for teamwork in laboratories and extracurricular activities*

Students preferred working in groups within laboratories, extracurricular activities and participating in study groups over some other types of more formal teamwork assessment for teamwork skills development. Bose et al. (2004) perceived cooperative learning in university laboratory classes to be a viable method for preparing students for 'real-world' teamwork in professional laboratory settings. The use of cooperative learning for students in a laboratory environment has also been shown to create a more positive student perception of the learning environment, when compared to students learning independently through lectures (Martin-Dunlop and Fraser 2007; Shibley and Zimmaro 2002). Within many of the undergraduate science disciplines, this approach also provides a disciplinary opportunity to use laboratories as a method to foster both generic teamwork skills and technical discipline-specific skills simultaneously (Hofstein and Lunetta 2004). This approach provides an efficient response to concerns that integrating more generic skills development in science curricula would require the sacrifice of time spent developing discipline-specific skills and knowledge.

### *Limitations*

With the exception of the six fifth year students, no significant differences in responses were found between year levels or between biology students and other disciplines. When interpreting our findings, it is still crucial to acknowledge the large proportion of biology (50%) and first year students (43%) in the survey population. First year students in particular may not have had the opportunity to develop the full suite of skills offered throughout the undergraduate curriculum. Furthermore, although the

survey population was substantial, the respondents made up less than 5% of the students enrolled in science degrees at Monash University in 2016 (6045 total enrollments). Therefore, these factors restrict the extent to which we can generalise these results.

## Conclusion

The majority of science undergraduates surveyed in this study value the development of teamwork skills for a career within or outside of science. However, based upon their undergraduate experience, a substantial proportion of these same students see themselves as ill-equipped with teamwork skills for the future. Students found scheduling group meetings to be a dominant issue that negatively impacted their teamwork experience and cited a preference for more allocated class time for teamwork. In support of previous studies, another dominant theme was the prevalence of unequal contribution of workload between group members. Students displayed a marked preference for undertaking teamwork activities in laboratory classes and extra-curricular activities over formal teamwork assessment beyond the laboratory. Understanding the student perspective of teamwork is a crucial topic for science education research. The pedagogical implications of this research may inform the broader challenge of addressing the teamwork skills gap in science undergraduates.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Notes on contributors

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