

# THE PERFORMING SCIENCES

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## ABSTRACT

A group of students enrolled in the Bachelor of Biomedicine at the University of Melbourne undertaking the core 2<sup>nd</sup> year subject Molecular and Cellular Biomedicine (BIOM20001) chose to participate in a physical performance-based assessment (*The Performing Sciences*). As part of the assessment activity, participating students were supported to design and deliver a performance that explicated and elaborated a concept or process from the Biochemistry and Molecular Biology topic within the subject, using one or more of the following performance genres: physical performance, performance art or interpretive dance. The project engaged teaching staff from the biomedical sciences and the performing arts to develop interdisciplinary and cross-disciplinary approaches to teaching and learning. Participant responses to the student experience reflection survey indicate that the project effectively facilitated student learning of the course concepts, encouraged interaction between students and promoted student engagement. The findings suggest that involving students in collaborative, creative and non-traditional forms of assessment in university science education allows students to develop important transferable skills, as well as foster their intrinsic motivation to learn science.

## AIMS

The aim of the project was to enable students to unlock their imagination and creativity using embodied modes of performance to communicate scientific concepts. The project also aimed to facilitate active and interactive learning and to foster student engagement; build the students' confidence in public presentation, develop their skills in verbal and nonverbal communication; and to enhance their capacity for teamwork and collaboration.

## INTRODUCTION

The use of performance in science education has both a pedagogical rationale and broader educational benefits that relate to social learning and transferable skills development. Firstly, performance methods offer a form of 'active learning,' which has been shown to enhance student learning outcomes more effectively than didactic teaching methods or 'rote' learning (White, Larson, Styles, Yuriev, Evans, Rangachari, Short, Exintaris, Malone, Davie, Eise, McNamara & Naidi 2016). By engaging students in the processes of imagining, visualizing and embodying scientific concepts, performance techniques have the potential to promote deep-learning and knowledge retention. Secondly, performance provides opportunities for students to engage in social and interactive forms of learning, contributing to the development of cohort experiences in large undergraduate degrees. While forming social connections is an important aspect of the student experience in itself, educational literature also suggests that interaction between peers improves learning outcomes and contributes to reduced rates of student attrition (Baik, Naylor & Arkoudis 2015). Peer interaction through collaborative performance-making also fosters skills in teamwork and public presentation, which are important skills for science students to develop for their future careers.

The use of performance in science education has proven to have pedagogical benefits for a range of science educators at secondary school level. For example, in an activity that used physical embodiment to teach students about the changing states of molecules, Metcalfe and co-workers found that drama provided a 'vehicle for developing important insights' of scientific principles, offering 'an alternative approach to teaching what is recognised as a difficult topic to teach' (Metcalfe, Abbot, Bray, Exley & Wisnia 1984; p.80). Similarly, in their handbook for science secondary school teachers, Abrahams and Braund (2012) make a compelling case for the effectiveness of using drama in chemistry, physics and biology classes. Their descriptions of fifteen drama sessions for each of the science disciplines focus on the physical embodiment of scientific concepts as a method to facilitate deeper learning. While performance is less commonly employed in science higher education, in recent years researchers have begun to report on the value of using performance techniques, such as dramatic role-plays, in science and medical education to develop skills in areas including

communication and argumentation (Archila 2017; Middlewick, Kettle & Wilson 2012) and to foster student engagement (Ünalán, Uzuner, Çifçili, Akman, Hancioğlu. & Thulesius 2009). Like these studies, our project illustrates the role that performance can play in motivating students to learn science and also highlights the potential for embodied performance to enhance students' understanding of complex scientific concepts

## **METHOD**

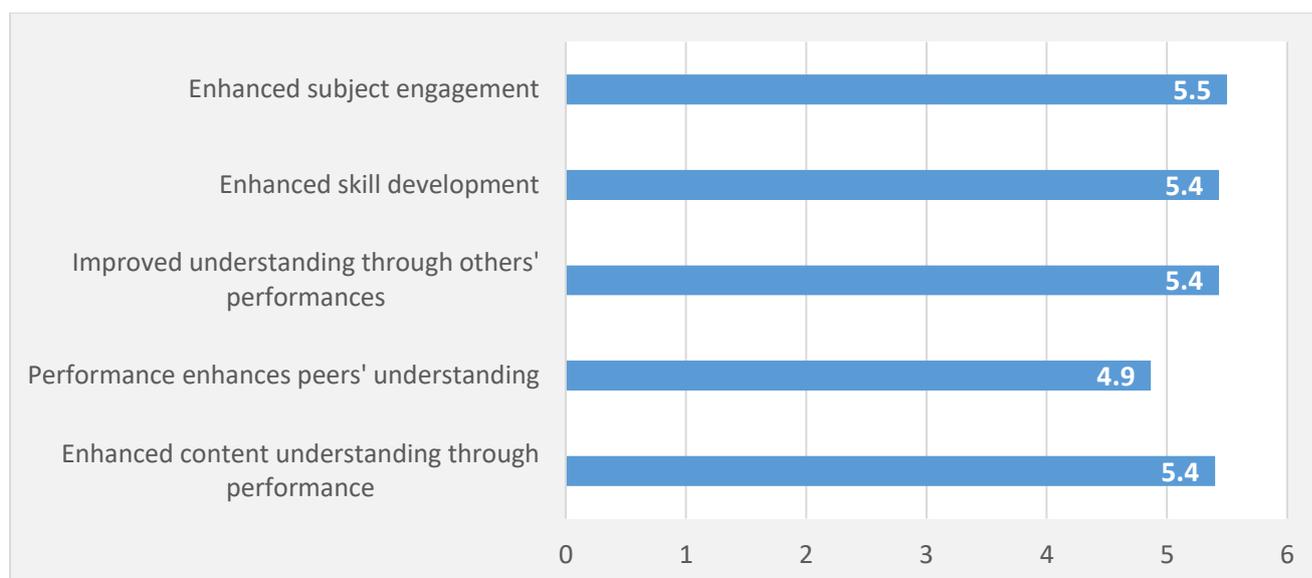
Ninety students (out of a class of 520) registered for the 42 places in *The Performing Sciences* project. These student volunteers scripted and presented a short performance illustrating a concept from the Biochemistry and Molecular Biology component of the multidisciplinary curriculum. In week 1 of the project, the students participated in a 3-hour devising and performance workshop and then the 42 participants self-allocated into seven groups, composed of between five to seven students, to work collaboratively on embodying a biochemical concept or process of their choosing. The seven topics chosen were: glycolysis, adenosine triphosphate (ATP) synthesis, passive vs. active membrane transport, hydrophobic interactions, glucose transport, enzyme activity and protein folding. In week 2, the students participated in a second 3-hour workshop, where they developed their performances and received two rounds of iterative feedback from teaching staff on both the scientific content and theatrical elements of their performances. In preparation for week 3, students received guidance material on formulating and providing constructive feedback to their peers. In week 3, groups presented a dress rehearsal of their ~ 5 minute long performances to the other participants. Each group received additional feedback on science content and theatrical elements from teaching staff and students viewed a video recording of their performance. The audience, which was composed of the other participants, formulated peer-peer feedback for each group of performers. The moderated anonymous peer-peer feedback was collected and delivered online to the participants within 48 hours, so that it could be integrated by the performers. In week 4, the final performances were delivered and filmed. At the end of the program the students completed an experience reflection survey. Consent was obtained (University of Melbourne Human Research Ethics Approval 1851159.1) to film the performances and to utilize the video documentation for research, as well as to analyze the peer-peer feedback and survey data for use in scholarly outputs. Students, who participated in the project, received the full 2% for the assessment, in place of a score for an online quiz based on content of a 2-hour computer-aided tutorial that the rest of the class carried out. Students in *The Performing Sciences* were free to participate in the tutorial and also take the online quiz if they wished.

## **RESULTS**

Data gathered through the experience reflection survey and the feedback provided by participating students to their peers was analyzed. The analysis of these data was informed by the aims of the project, the characteristics of 'worthwhile' feedback (Bound 1991), and literature on how the inclusion of performance in school settings can influence learning (Metcalf et al. 1984; Ødegaard 2003).

## **STUDENT EXPERIENCE REFLECTION**

In the experience reflection survey, which was completed by 27 respondents, students were asked to reflect on how participation in *The Performing Sciences* influenced their engagement in the subject BIOM20001, affected their understanding of the course content, and helped them develop new skills.



**Figure 1: Relationship between participation in *The Performing Sciences* and enhanced engagement, skills development and subject content understanding. 1 = strongly disagree, 6 = strongly agree, n = 27.**

Figure 1 illustrates that, on average, students agreed that participating in *The Performing Sciences* enhanced their engagement in the subject ( $M=5.5$ ,  $SD=0.7$ ), helped them develop new skills ( $M= 5.4$ ,  $SD=0.8$ ) and helped them understand the content of the course through both their own and their peers' performances ( $M=5.4$ ,  $SD=0.7$  and  $M=5.4$ ,  $SD=0.8$ , respectively).

Respondents were asked to explain their agreement ratings in open-ended comments. Students reported an enhanced understanding of the topic that their performance explored. This understanding was associated with topic-based in-depth research that they had done to design and deliver the performance as a group. Some students also reported that they felt they had a better understanding of the topic because of the physical performance itself, suggesting that some kinesthetic learning had occurred.

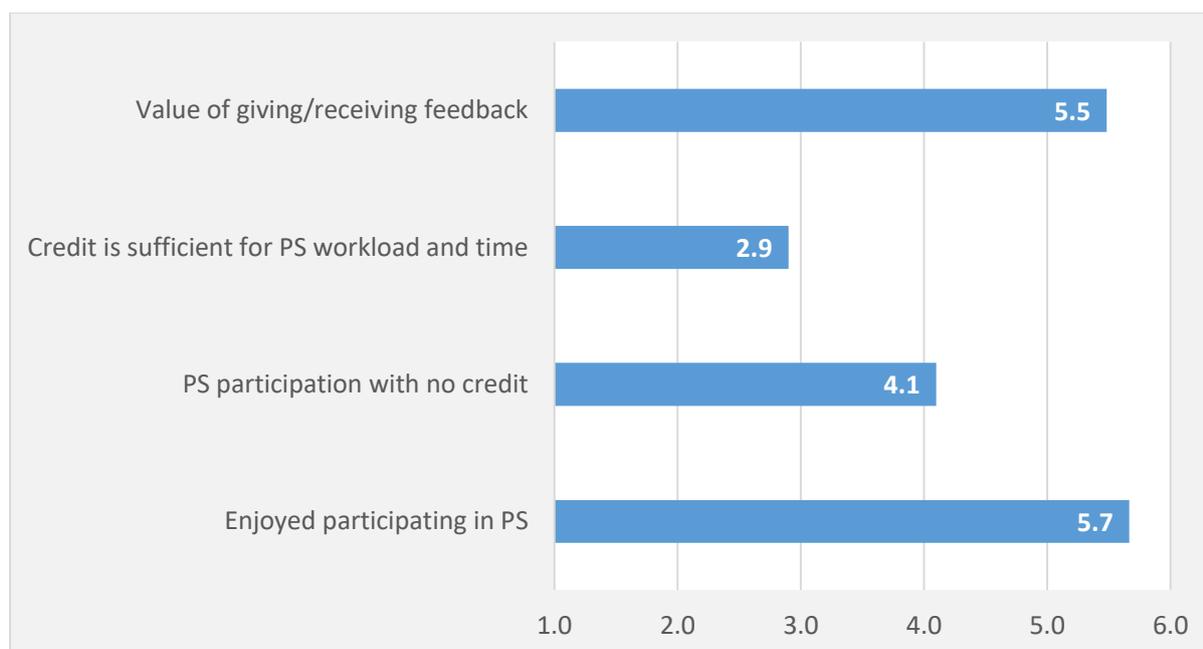
*'We had to research some aspects in depth to portray them with our bodies and theatrically, this made us really understand the concept in order to perform it.'* (Student survey respondent)

Most students reported that they felt the performances helped other students understand the topics better. They felt they benefitted from watching their peers' performances, as they provided an opportunity for revision, visual learning, and importantly the performances sparked their interest in the subject content.

*'I certainly did learn from watching other groups perform! So I'm sure our performance will too.'* (Student survey respondent)

There were some reservations in comments associated with enhanced understanding. Students explained that while their peer's performances helped to increase their understanding of, or in some cases revise, course content, the performances alone were not sufficient to understand the intricacies of some of the concepts being covered.

*'Definitely, some performances come to mind when I think of certain topics. But I remember very general points rather than the small intricate details. I think that with these performances, it is important to depict even the tiniest details because most of the time they are the most important in terms of understanding a topic.'* (Student survey respondent)



**Figure 2: Perceptions of the value of feedback and credit for participation in *The Performing Sciences*. 1 = strongly disagree, 6 = strongly agree, n = 27.**

Figure 2 illustrates the respondents' perceptions of the value of giving and receiving feedback in *The Performing Sciences* and the degree to which the credit for participation was sufficient. On average, students disagreed that the two percent credit awarded was commensurate with the workload and time spent participating in *The Performing Sciences* ( $M= 2.9$ ,  $SD= 1.4$ ). However, there was some disagreement among students about this, with a significant group of students indicating that they would still participate in the project, even if there was no credit awarded.

The process of giving and receiving feedback was rated as very helpful among participating survey respondents. Students explained that the feedback process helped to consolidate their understanding of the content of their own and their peers' performances.

*'Giving feedback is great as it makes you critical of your own work as well, seeing what may or may not work. Receiving feedback is even better, as someone can pinpoint what areas you may have missed, leading to better overall understating of your areas of improvement.'* (Student survey respondent)

The peer-peer feedback task was supported by a structured process, where guidance was given to students to ensure that feedback was constructive and aligned with the assessment criteria.

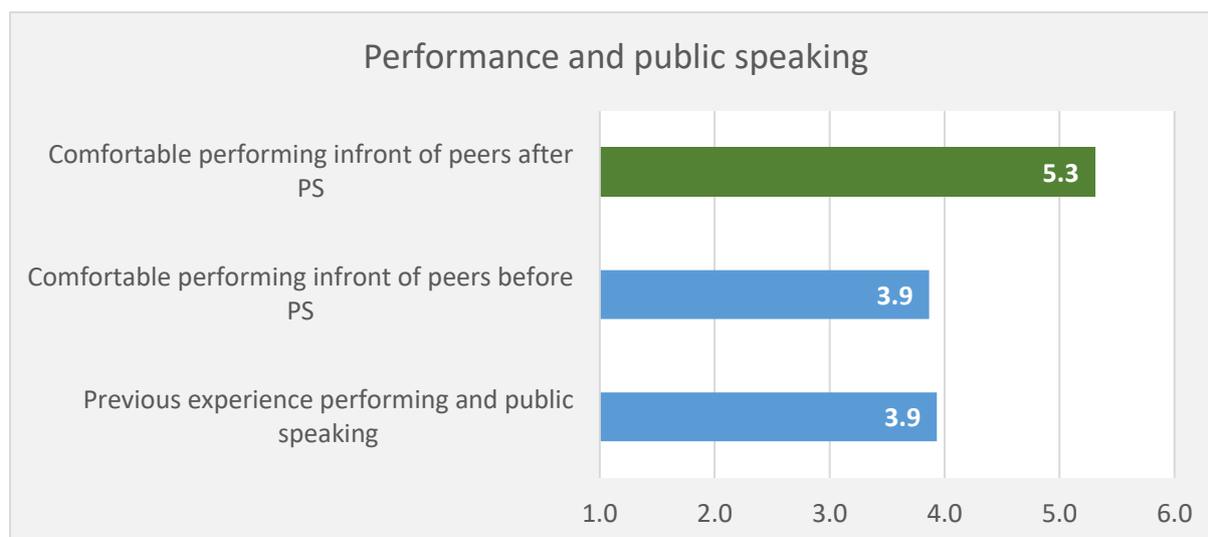
Overall, most students reported they enjoyed *The Performing Sciences*, the majority strongly agreed that they enjoyed participating in the project ( $M=5.7$ ,  $SD=0.6$ ) and that they valued giving and receiving feedback as part of the project ( $M=5.5$ ,  $SD=0.8$ ).

*'Working with Terry and Rinske will definitely be one of the highlights of my uni degree.'* (Student survey respondent)

*'I have acquired a new way of looking at things in general. This experience has simply been invaluable.'* (Student survey respondent)

The reflection questionnaire also asked students to consider how they felt performing in front of their peers before participating in *The Performing Sciences* and then how they felt afterwards. The results are outlined in Figure 3, with 27 students reporting that on average before participating they felt somewhat comfortable, but after participating the mean score indicates that on average they strongly agreed that they felt comfortable ( $MD=+1.4$ ,  $SD=1.4$ ). While variance is high, the majority (69%) of participating students reported an increase in comfort level after participating in *The Performing*

Sciences, and the remaining 31% reported no difference in comfort level after participating in the project.



**Figure 3. Experience and confidence in performance and public speaking. 1 = strongly disagree, 6 = strongly agree, n = 27.**

When asked to reflect on what they had enjoyed most and least about participating in *The Performing Sciences*, respondents (n=9) reported that they enjoyed the workshops and activities they completed as part of the project. Several reported that they had learned new skills, or had the opportunity to remember skills that they had learned earlier, such as how to communicate ideas with their body.

*'The workshops sessions were my favourite, the odd exercises, and games that slowly but surely taught us about space and planes and our bodies was great. Also, lots of fun!'* (Student survey respondent)

An equally commonly reported theme in these comments (n=9 respondents), was the opportunity to work with other students, some of whom they would not otherwise have had the opportunity to meet, and to work in groups to produce their performances.

*'I really enjoyed the experience and interacting with my group and other students.'* (Student survey respondent)

*'I enjoyed meeting new people the most.'* (Student survey respondent)

The other two themes that emerged in these comments were associated with working with the teaching staff delivering *The Performing Sciences*. Student survey respondents noted that they enjoyed the enthusiasm of the staff members and, that as a result, they felt comfortable trying new ways of learning and engaging in activities which were a little out of their comfort zone. This suggests that the teaching ability and enthusiasm of the staff played a central role in generating interest and motivation among the students. The engagement of teaching staff with expertise in performance is also likely to be essential to the success of the method and implies that in future iterations it will be important to either employ teaching staff who specialise in performance or to offer performance training to science teachers.

*'Totally drawn to the charisma of Rinske and Terry, you guys are just amazing.'* (Student survey respondent)

Finally, a small number of students (n=2), reported that they found the experience of participating in *The Performing Sciences* to be less stressful than other 'typical learning settings'.

## PEER-PEER FEEDBACK

Students participating in *The Performing Sciences* were asked to provide feedback on the dress rehearsals of other performances, and were supplied with a resource that described the characteristics of constructive feedback (Boud 1991). It should be noted, that students were not explicitly asked to provide feedback on the scientific accuracy or relevance of the performance. Rather, they were asked to comment on how successful their peers' performance was in representing, illustrating and communicating the chosen scientific concepts or process, as well as how successful it was in utilizing appropriate performance techniques and genres to engage the audience. Because of logistical difficulties, one group could not attend the week 3 dress rehearsals and three of the seven groups presented their final performance at the end of the dress rehearsal session, because they could not attend the week 4 session. Therefore, online peer-peer feedback could only be delivered to three groups.

*Performance 1: Hydrophobic Discrimination – The Musical.* A total of 9 students provided feedback on this performance. All 9 comments included a supportive positive statement about the performance. Most of these comments involved encouraging peers to be more confident in their performances. All comments included one or several suggestions for improvement, and these suggestions included; spatial position, voice projection, and order and structure of the performance.

*'[The] musical was very good although I think a bit more emphasis on the fact that the first four actors are portraying water molecules are needed. Furthermore, the ending requires more improvement to show that the process is over so the audience is not left confused. Finally, the singers need to be more confident in their singing to engage the audience a bit more. Overall [a] great performance.'* (Student survey respondent)

*Performance 2: GLUT1.* For the second performance, 7 students provided feedback. All comments also included at least one positive supportive statement about the performance. Several suggestions for improvement were given and included; maintaining the volume of music/sound throughout the performance, the order and structure of the performance and spatial positioning.

*'GLUT1 [glucose transporter 1] has a fantastic entry that is very powerful when all the members march on to the stage. However, since the background music has changed a bit after the introduction. Perhaps the tone of lipid bilayer and glucose should be different, and more emotional change involved.'* (Student survey respondent)

*Performance 3: The Chaperone.* This received feedback from 14 students. Similar to feedback on *GLUT1* and *Hydrophobic Discrimination – The Musical*, feedback included positive statements about the performance, particularly with respect to the choice of music, humour, costumes, and choreography. Suggestions for improvement included; spatial positioning, 'labelling'/introducing each performer to help improve the clarity of the messaging, order and structure of the performance and expressive choreography.

*'The act was very expressive and engaging. The performers showed great energy and put together quite a sentimental piece. The only thing that would be a bit confusing to some audience members is the role of each performer. I reckon an introduction of every character would make an already beautiful performance even better. The performance scientists acted out the scene using body language which I think could be a tad bit more expressive. Overall, the act was irresistibly informative.'* (Student survey respondent)

Overall, the feedback provided for each of the performances was constructive, illustrating that the students had gained a sound understanding of the characteristics of giving effective peer feedback following guidance from the teaching staff. Interestingly, the feedback itself was largely focused on the nature of the performance, rather than scientific content being communicated through the performance.

## **STUDENT RECOMMENDATIONS FOR IMPROVING *THE PERFORMING SCIENCES***

In the reflection questionnaire, students were asked to provide some suggestions for how *The Performing Sciences* could be improved. The main suggestions for improvement included:

- a) Structure: The structuring of the project was reported to be fairly flexible, and some students suggested that they would like a little more structure to understand what to expect and what outcomes they might expect from participating in the project.
- b) Time commitment: While the students completing the reflection questionnaire found participating in *The Performing Sciences* valuable, a group of them agreed that the credit awarded for participation did not reflect the time commitment they had afforded to participate, design and rehearse their performance.

*'Maybe only one general workshop before organising own performance, as it's hard to commit to 3 hour blocks every week.'* (Student survey respondent)

*'It was a big time commitment and was frustrating when you gave up lectures/work to attend and then had people in your group who wouldn't do the same.'* (Student survey respondent)

Students reported that they felt that having fewer workshops would have enabled them to spend more time working on their performances, which may have resulted in higher quality performance pieces. It was also suggested that all the workshops should be scheduled to take place during the semester, particularly for students who do not live in Melbourne and had to travel to attend the sessions.

*'I think two sessions would be adequate with more emphasis on the actual performance. The first session was a lot of fun and did get people comfortable but I think by the end of the first session we should have been working on our performances.'* (Student survey respondent)

## **CONCLUSIONS**

The experiences of the students from BIOM2001 who participated in *The Performing Sciences* highlight the value of the project in fostering student engagement and responses to the survey show that overall they found it to be very positive for their learning.

The majority of the skills gained from participating in the project were not exclusive to science education, but rather focused more broadly on the development of the student, with self-reported skills including teamwork, confidence and bodily expression. While only a small number of students referred to their participation in *The Performing Sciences* as a stress-relieving experience, there is a body of literature concerning the positive relationship between performance and art, self-expression and stress relief (Walsh, Chang, Schmidt & Yoepp 2005; Chan 2013; Leckey 2011). We plan to explore this aspect in the future.

The findings of the student questionnaire and feedback given on their peers' performances indicates that *The Performing Sciences* positively influenced the process of active learning and created a situation in which students were able to engage with their lecturers and their peers in a safe and supportive environment, and this learning environment was reported to be less stressful than a traditional lecture or tutorial environment.

Further trials of the project, informed by the feedback and recommendations given by the student participants, could test different iterations of workshop scheduling and timing, along with a consideration of what credit proportion is commensurate with students' time investment. Additional trials could also examine the impact the project has on skill development and the learning of subject content and whether this differs for students with prior experience with drama in science.

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